CONSTRUCTION COST MANAGEMENT

LEARNING FROM CASE STUDIES

SECOND EDITION

KEITH POTTS AND NII ANKRAH

Construction Cost Management

Second edition

In this updated and expanded second edition, Keith Potts and Nii Ankrah examine key issues in construction cost management across the building and civil engineering sectors, both in the UK and overseas. Best practice from pre-contract to post-contract phases of the project life cycle is illustrated using over 70 case studies, including major projects such as Heathrow Terminal 5, Crossrail and the London 2012 Olympics.

More case studies, worked examples, legal cases and current research have been introduced to cover every aspect of the cost manager's role. Whole-life costing, value management and risk management are also addressed, and self-test questions at the end of each chapter support independent learning.

This comprehensive book is essential reading for students on surveying and construction management programmes, as well as built environment practitioners with cost or project management responsibilities.

Keith F. Potts is a former Principal Lecturer at the School of Technology, University of Wolverhampton, UK. He was an external examiner in Quantity Surveying and Award Leader of the RICS-accredited MSc in Construction Project Management.

Dr Nii A. Ankrah is a Senior Lecturer at the School of Technology, University of Wolverhampton, UK. He lectures in Quantity Surveying, Commercial Management and Construction Project Management both in the UK and overseas.

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Keith Potts and Nii Ankrah

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This book is dedicated to our wives Lesley and Akosua for their loving support and to the memory of our fathers Leon and Samuel who encouraged an interest in construction.

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Preface

This second edition updates *Construction Cost Management: Learning from case studies* which was first published in 2008. Following feedback from independent academic reviewers the structure of the book was kept the same but each chapter was brought up to date and modified where appropriate.

With a new joint author – Dr Nii A. Ankrah – each chapter was thoroughly reviewed and enhanced with the addition of further case studies in both the building and civil engineering sectors. A thorough review of relevant published academic articles was undertaken and, where appropriate, further academic references and relevant websites were also included. These additions now make the second edition a suitable starting point for many procurement and cost management-related dissertation topics.

Since the publication of the first edition we have received useful information from many senior quantity surveyors and commercial managers representing consultants, public and private clients and contractors and major specialist contractors. The chapters on the NEC3 and FIDIC *Red Book* have been considerably enhanced after feedback from a wide range of students and practitioners with experience of working in different countries. These, together with observations received from undergraduate and postgraduate students at the University of Wolverhampton, have further enriched the content of this book. Finally, we would like to thank our valued fellow colleague Pauline Corbett for her invaluable comments – they have always been pertinent and knowledgeable.

This revised edition thus captures the essence and key issues of construction cost management not only in the UK but in an international context. Any errors or omissions are, of course, our responsibility.

Abbreviations

4ps	Public Private Partnership Programme
AC	actual cost
APC	Assessment of Professional Competence
APM	Association of Project Management
ATC	Assessment of Technical Competence
BCIS	Building Cost Information Service
BIM	Building Information Modelling
BLRs	Building Law Reports
BMS	Budget Monitoring System
BofQs	Bill of Quantities
BOOT	Build, Own, Operate and Transfer
BOT	Build-Operate-Transfer
BRE	Building Research Establishment
BREEAM	BRE's Environmental Assessment Method
BRS	Building Research Station
CABE	Commission for Architecture and the Built Environment
CDM 2007	Construction (Design and Management) Regulations 2007
CESMM4	Civil Engineering Standard Method of Measurement 4th Edition
CIB	Construction Industry Board
CIC	Construction Industry Council
CIOB	Chartered Institute of Building
CIRIA	Construction Industry Research and Information Association
COSHH	Control of Substances Hazardous to Health
CPI	Cost performance index
CPM	Critical Path Method
CV	cost variance
CVR	Cost-value reconciliation
D&B	Design and Build
DAB	Dispute Adjudication Board
DBB	design–bid–build
DBFO	Design, Build, Finance and Operate
DETR	Department of the Environment Transport and the Regions
DfES	Department for Education and Skills

EA	employer's agent
ECI	Early Contractor Involvement
EMV	expected monetary value
eot	extension of time
EPC	Engineering Procurement Construction
EPC	engineer–procure–construct
EPCM	Engineering Procurement Construction Management
ERDF	European Regional Development Fund
EU	European Union
EV	earned value
EVM	earned value management
FCO	Foreign and Commonwealth Office
FM	facilities management
GDP	gross domestic product
GFA	gross floor area
GMP	guaranteed maximum price
GNLRT	Greater Nottingham Light Rapid Transit
GNRT	Greater Nottingham Rapid Transit
GRIP	Governance for Railway Investment Projects
HA	Highways Agency
HKMTRC	Hong Kong Mass Transit Railway Corporation
ICE	Institution of Civil Engineers
ICE	ICE Conditions of Contract
ICE 5th	ICE Conditions of Contract Measurement Version 5th Edition
IPS	Interim Payment Schedule
JCT	Joint Contracts Tribunal
JCT CE	Joint Contracts Tribunal Constructing Excellence Contract, formerly the BE
JDB	The Joint Development Board
JLE	Jubilee Line Extension
JLE	London Underground Jubilee Line Extension
JVC	joint venture company
KPI	Key Performance Indicator
LCA	life-cycle assessment
LABVs	Local asset-backed vehicles
LDEDCA	Local Democracy Economic Development and Construction Act
LDEDC Act 2009	Local Democracy, Economic Development and Construction Act 2009
LRT	Light Rail Transit
MAC	Managing Agent Contractor
M&E	Mechanical and Electrical
MEAT	Most Economically Advantageous Tender
MDB	Multilateral Development Banks
MF	Model Form
MOD	Ministry of Defence
MPA	Major Projects Association
MPTC	maximum price target cost
NAO	National Audit Office
nCRISP	New Construction Research and Innovation Strategy Panel
NEC	NEC3 Engineering and Construction Contract
NEC3	NEC contract

NEC ECC	NEC Engineering and Construction Contract
NET	Nottingham Express Transit
NJCC	National Joint Consultative Committee
NPV	net present value
NRM	New Rules of Measurement
OBC	Outline Business Case
ODA	Olympic Development Authority
OGC	Office of Government Commerce
OJEU	Official Journal of the European Union
PFI	Private Finance Initiative
PFII	Private Finance 2
PM	Project Manager
PPC	Association of Consultant Architects Project Partnering Contract
PPP	Public Private Partnership
PSC	Professional Services Contract
PSC	Public Sector Comparator
PV	planned value
PWDD	price for works done to date
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
RMS	root mean square
SAP	Standard Assessment Procedure
SCC	Schedule of Cost Components
SMM7	Standard Method of Measurement 7th Edition
SPCB	Scottish Parliament Corporate Body
SPI	schedule performance index
SPV	Special Purpose Vehicle
SSAP9	Standard Statement of Accounting Practice number 9
SSCC	Shorter Schedule of Cost Components
VFM	value for money
WBS	Work Breakdown Structure
WLC	whole-life costing

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1 Introduction and overview

1.1 Setting the scene

There have been many significant changes in the construction sector within the past decade. Notably, the sector has witnessed the growth of partnering and alliancing which require better management of the supply chain, and an increasing use of the NEC Contract (NEC3) which requires a team-based proactive approach to project delivery.

New financial models have been developed including Private Finance Initiative (PFI), Local Asset Backed Vehicles (LABVs) and variants of these in which private sector consortia design, build, own and operate public facilities in partnership with the public sector. Great advances have been made on the technical front with the growth of Building Information Modelling (BIM) and other web or cloud-based project management platforms. Enlightened clients have also been demanding more sustainable developments and construction projects.

Yet the same fundamentals apply – clients wish to obtain their increasingly more complex projects within budget and on time and to the necessary quality. Cost management, a function traditionally undertaken by quantity surveyors, therefore remains of critical importance to project success. One of the pioneer quantity surveyor construction project managers was Francis Graves who undertook the task of Project Controller in 1972 on the massive 5-year-long Birmingham NEC Exhibition Centre project. He considered his terms of reference on this project very straightforward – Get it finished on time and get value for money! This maxim still resonates today and forms the core of the services offered by all quantity surveying firms on construction and engineering projects.

It is significant to observe however that the practice of cost management and the role of the quantity surveyor is changing in response to all the pressures highlighted above. Indeed, many are moving on from the core skills of contractual and financial management to embrace the key role of the client's strategic adviser and project manager. Evidence of this development can be seen from an analysis of three of the top Quantity Surveying Consultants' websites which shows their involvement in a wide range of strategic services which are increasingly being offered throughout the life of the asset (Table 1.1).

It is within this context that this book is written to map out some of the key principles and techniques that underpin cost management practice and signpost some of the critical developments in the construction sector that will continue to shape the future role of the cost manager.'

Table 1.1 Range of services offered by leading construction cost consultants

Company	*Cost Management Services*
EC Harris	**Asset Investment and Finance** **Asset Performance Facilities Management** **Strategy and Transformation** **Cost Commercial and Risk Management** underpinned by the following services: Cost and Value Management; Whole-Life Costing; Risk and Opportunity Management; Taxation and Capital Allowances; Strategic Procurement and Contract Strategy; Commercial Management and Quantity Surveying **Contract Solution** We work with clients to try to prevent complex construction and engineering disputes and where disputes have already arisen, to resolve them swiftly and effectively. We provide sector specific procurement, contract and management strategies that help our clients realise their project objectives and reduce the risks associated with the construction and engineering delivery process and to operate and apply the legal and contractual processes that govern them **Programme and Project Management**
Turner & Townsend	**Business Performance**: Asset and Strategy Planning; Business Case Development; Carbon Advisory and Sustainability; Change Management; Funder's Advisory Services; Organizational Design; Performance Improvement; Procurement and Supply Chain Services; Risk and Opportunity Management **Delivering Projects**: Programme Management; Project Management; Cost Management and Engineering; Contract Services and Dispute Management; Portfolio Management; Technology **Operations**: Facilities Management; Health and Safety
Franklin + Andrews	Services are focused on the three main phases of the whole life of a capital asset: **From the conception of the business need** Providing strategic advice at the outset of a capital project **Through its construction** Once the capital project has been defined and the delivery strategy agreed, we offer a range of services to assist in the delivery of the capital project **To its operation** As an integral part of the process for deriving maximum value from the built asset, we advise clients on the entire life-cycle of the asset covering: Operation; Maintenance; Refurbishment; Disposal or Renewal

Source: Websites www.echarris.com; www.turnerandtownsend.com; www.franklinandrews.com – cited 12 March 2012

1.2 Construction overview

The construction sector is strategically important for Europe, providing the infrastructure and buildings on which all sectors of the economy depend. With almost 20 million operatives directly employed in the sector, it is Europe's largest industrial employer accounting for 7 per cent of total employment and 28 per cent of industrial employment in the European Union (EU). It is estimated that 44 million workers in the EU depend in one way or another on the construction sector. Construction contributes more than 10 per cent of the gross domestic product (GDP) and more than 50 per cent of the gross fixed capital formation of the EU, representing about €1.36 trillion in 2011 (Europa).

The industry continues to thrive, given the ever-pressing need to address the regeneration of many urban areas of Europe, in particular in the newly acceded countries and the realization of major trans-European infrastructure works.

Being a subset of the wider EU market, the UK construction industry similarly makes a considerable contribution to the national economy, accounting for over 7 per cent of the national gross domestic product. Just over 2.14 million workers work in construction. In 2011 the construction sector represented £110 billion of expenditure – 40 per cent being in the public sector, with Central Government being the industry's biggest customer.

Other major clients/promoters by value and number of projects procured are shown in Table 1.2. Significantly, these major clients have shown the lead in embracing the new

Table 1.2 Top clients/promoters in the UK by number and value of projects to year ending 31 December 2011

Company	*Number of projects*	*Total value (£m)*	*Main procurement/contract types*
Top Clients by value			
Siemens Limited	5	15,009.6	Engineering Procurement Construction (EPC)/Engineering Procurement Construction Management (EPCM) Bespoke form of contract
Mainstream Renewable Power	1	15,000.0	EPC/EPCM Selective competition
Essex County Council	32	4,166.2	Various (Traditional, Framework Agreements, Target Cost, Term) RIBA Plan of Work process Competitive tender 60% Price and 40% Quality split Contracts varied (including some based on NEC, JCT)
British Energy Generation Limited (EDF)	1	4,000.0	EPC/EPCM Competitive tender NEC
Network Rail Infrastructure Limited	58	2,074.2	Framework Agreements Governance for Railway Investment Projects (GRIP) process Competitive tender Contracts varied (including some based on ICE, JCT, MF)
Top Clients by number			
Tesco Stores Limited	68	1,117.1	Various e.g. Framework Agreements, D&B, Prime contracting Standard Tesco contracts
Network Rail Infrastructure Limited	58	2,074.2	As above
Taylor Wimpey	49	1,235.0	Traditional, D&B Selective competition NEC, JCT
Barratt Homes	39	735.3	Traditional e.g. JCT style
Essex County Council	32	4,166.2	As above

Source: Developed based on www.building.co.uk/business-barometer/clients and various other sources, e.g. www.networkrail.co.uk; www.edfenergy.com; www.essex.gov.uk – accessed 17 May 2012 procurement routes and conditions of contract. What they all seek is value for money and it is within this context that cost management, and the role of the cost manager, takes significance.

1.3 Cost management in construction

Cost management in construction and the role of the quantity surveyor in delivering these services has developed significantly and continues to evolve to meet the changing needs of clients. This evolution has been driven in part by the impetus for change in procurement and contract strategies generated by the numerous reports on the state of the UK construction industry published in the last 70 years (see Murray and Langford, 2003). These reports and other relevant key recommendations are reviewed in Chapter 2 in order that best practice, which needs to be reflected in the role of quantity surveyors, can be identified.

Beyond these, the role of the quantity surveyor also continues to be influenced by the requirements of professional bodies. For instance the Royal Institution of Chartered Surveyors' (RICS) Assessment of Professional Competence/Assessment of Technical Competence (RICS, 2006) identifies that quantity surveyors may be working as a consultant in private practice, for a developer or in the development arm of a major organization (e.g. retailer, manufacturer, utility company or airport), for a public sector body or for a loss adjuster. On the contracting side, quantity surveyors could be working for a major national or international contractor, or local or regional general contractor, for a specialist contractor or subcontractor, or for a management-style contractor. It identifies the need for competence in:

- preparing feasibility studies or development appraisals
- assessing capital and revenue expenditure over the whole life of a facility
- advising clients on ways of procuring the project
- advising on the setting of budgets
- monitoring design development against planned expenditure
- conducting value management and engineering exercises
- managing and analysing risk
- managing the tendering process
- preparing contractual documentation
- controlling cost during the construction process
- managing the commercial success of a project for a contractor
- valuing construction work for interim payments, valuing change, assessing or compiling claims for loss and expense and agreeing final accounts
- negotiating with interested parties
- giving advice on the avoidance and settlement of disputes.

These guidelines for the RICS Assessment of Professional Competence in Quantity Surveying and Construction were issued in July 2006 (Isurv.com).

Similarly, professional bodies like the Construction Industry Council (representing all the professions), the Association of Project Management, the Major Projects Association and the Chartered Institute of Building all identify key skills and competencies applicable to modern day quantity surveyors, which are constantly under review.

It is evident from the foregoing that not only is cost or commercial management critical to achieving value-for-money outcomes but also that the requirements for effective performance of this role are constantly evolving. This inevitably necessitates constant review and evaluation of cost or commercial management practice to ensure that both industry and academia keep pace with these changes and with best practice.

1.4 Learning from case studies

A few examples will suffice to illustrate the role that case studies play in identifying best practice (and indeed bad practice), thereby providing learning opportunities from both successful and failed projects which will provide the basis for delivering best value to clients through the effective performance of cost management services. Indeed, very often the distinction between successful and failed projects is blurred.

Many of the **1970s UK North Sea oil projects** went way over budget, yet, following the subsequent surge in oil prices, were clearly successful projects. The **Thames Barrier at Greenwich** was a project plagued by poor industrial relations, finishing 3 years late in 1984 and at ten times the original budget, yet, when the barrier was later used, the innovative designed project was successful and London was saved from flooding. Today the barrier is raised six times per year compared to once in 6 years as originally anticipated. Clearly there are important lessons to be learnt from all projects.

The Sydney Opera House in Australia became the symbol for the Millennium Olympics in 2000 and somehow reflected the healthy swagger of the emerging continent. The competition for the project was won in 1957 by Danish architect Jorn Utzon, whose first design according to members of the jury was hardly more than *a few splendid line drawings*. This comment could also have been made many years later in connection with Enric Miralles' first submission on the Scottish Parliament building.

The billowing concrete sailed roof had never been built before. It should therefore have been no surprise that the $A7 million project escalated to over $100 million and the planned construction period of 5 years was finally extended to 14 years (1959–1973). The architect was put under so much pressure over the escalating costs that he left the project half-way through, after which his designs were modified. As a result, the building is perfect for rock concerts but not suitable for staging classical full-scale operas (Reichold and Graf, 1999).

Another iconic building is **the Pompidou Centre in Paris**, a building famous for being *inside-out* with all the structural frame, service ducts and escalators being on the outside, allowing a flexible floor space within. The audacious steel and glass National Centre for Art and Culture was designed by two young unknown architects, Renzo Piano and Richard Rogers, to last, as George Pompidou reminded architects, for four or five centuries.

After opening in 1977 the centre rapidly became a huge success, with more than 7 million visitors a year making it the most popular tourist destination in Paris. After 20 years' use the building was showing its age, including rusting on the structural frame, and was in need of a major renovation. In October 1997 the whole centre closed, reopening in January 2000, which allowed not only for the refurbishment but also for improvements to the internal layout at an estimated cost of US$100 million (Poderas, 2002).

Significantly the UK Government now requires whole-life costing to be considered with project evaluation. It is interesting to speculate as to whether the Pompidou Centre would have passed such a test if the building were proposed to be built in the UK today.

The **Millennium Dome at Greenwich** was designed to be the UK's showcase to celebrate the new millennium. With a diameter of 365 metres, the Dome was the largest single-roofed structure in the world, with a floor area the size of 12 football pitches (Wilhide, 1999).

However, the project was plagued throughout by problems and bad publicity, typified by the Millennium New Year's Celebration when the great and the good were left stranded for hours at Stratford Station. Open to the public for 1 year, the Millennium Dome was closed to visitors on 31 December 2000 and remained unused for 6 years, apart from the Ministry of Sound New Year's Eve dance parties.

The £758 million project was seen as a major part of the regeneration of East London and was built on 120 hectares of contaminated wasteland.

The Millennium Dome was designed by architect Richard Rogers and consulting engineer Buro Happold with a joint venture of John Laing/Sir Robert McAlpine acting as construction managers with target cost contracts incorporating *pain and gain share* clauses. What is often forgotten is that the design and construction of the Dome was a highly significant and successful achievement being completed on time and within budget. The author (Potts) visited the project in 1999 and was particularly impressed with the teamwork approach with everyone – client, consultants, contractors and subcontractors – working in the same open-plan office.

The project was largely reported by the press to have been a flop: badly thought out, badly executed and leaving the Government with the embarrassing question of what to do with it afterwards. During 2000 the organizers repeatedly asked for and received more cash from the Government. Part of the problem was that the financial predictions were based on an unrealistically high forecast of visitor numbers at 12 million; in the event there were only 6.5 million.

The Dome has been refurbished into a soundproof 22,000-seater sports and entertainment complex and reopened in June 2007 under the new name of The O2. Since its refurbishment The O2 arena has hosted many high-profile concerts and sporting events including basketball and gymnastics at the 2012 Olympics.

London Underground's Jubilee Line Extension (JLE) was at the time one of Europe's largest infrastructure projects. The JLE comprised more than 30 major contracts linking the UK Government's parliamentary HQ at Westminster to London's emerging financial centre at Canary Wharf and beyond to Stratford. The entire project comprised a 10-mile underground extension with 11 stations – six completely new and five substantially enlarged or rebuilt – and four crossings under the River Thames.

It posed a huge management challenge, creating magnificent station architecture, but became infamous for overrunning on both time and budget.

The overall construction period for the project was 72 months, compared to the original 53 months, whilst the out-turn cost for the project rose from £2.1 billion in October 1993 to £3.5 billion in December 1999. The project was completed in December 1999, just in time for the Millennium celebrations in the Dome at Greenwich, significantly after Bechtel had taken over the management of the project in September 1998.

The JLE Conditions of Contract were a hybrid of the ICE fifth edition and the FIDIC form, modified by the Hong Kong Mass Transit Railway Corporation (HKMTRC) and Singapore Mass Rapid Transit. The civil engineering contracts were based on bills of quantities subject to admeasurement.

Each contract contained an Interim Payment Schedule (IPS), which was based on a series of defined milestones within four main cost centres; the idea being that payment was only made if the defined milestone was achieved. A fundamental aim of this approach was to motivate contractors to achieve progress whilst at the same time avoiding the need to base monthly payments on measured works. The system had worked well in Hong Kong and in the early stages of the JLE.

Unfortunately, due to the changing requirements of the JLE scheme in the early stages of the project and the tight timescale, the working drawings issued at contract award remained incomplete. This resulted in extensive changes to the programmes causing delay and disruption, and extensions of time and acceleration measures, and the milestones had to be continuously revised. The Major Projects Association (MPA) observed that the project culture was too adversarial and inflexible (as were the contracts used) (MPA, 2000).

The Scottish Parliament building in Edinburgh, which won the tenth RIBA (Royal Institute of British Architects) Stirling Prize, is another classic tale worthy of further investigation. Initially conceived by the Barcelona architect Enric Miralles, it was completed 20 months late with a final cost of £430 million from an initial budget of £40 million. The building has been subject to much criticism, particularly from taxpayers in Scotland. Much of this is documented in Lord Fraser's Report entitled *The Holyrood Inquiry* (2004), the Spencely Report (2000), two Auditor General Reports (2000 and 2004) and the *Holyrood Inquiry* website, where there is access to the actual correspondence between the parties.

The above case studies provide a flavour of the many ways in which projects can succeed or fail. The Major Project Association (MPA, 2003) identifies the major reasons for project failure as:

- poor project definition
- unclear objectives
- unrealistic targets
- inadequate risk evaluation
- client inexperience
- poor forecasting on demand
- lack of effective sponsor and strong leadership
- poor communication and lack of openness
- inadequate stakeholder management
- management focus wrongly targeted at the back end rather than at the front-end of the project.

These are important observations that ring true in the case studies reviewed on the previous pages, and indeed in all the case studies quoted throughout this book. At the same time these case studies also provide best practice exemplars of effective cost and project management, many of which are catalogued in knowledge centres such as:

- www.majorprojects.org/knowledge/pasteventsknowledge.php
- www.constructingexcellence.org.uk/resources
- www.neccontract.com/news/index.asp?Type=Newsletters
- http://learninglegacy.independent.gov.uk
- www.nao.org.uk/publications.aspx?y=All&s=434&c=All&t=488
- www.scl.org.uk
- www.building.co.uk.

The foregoing reinforces the sole purpose of this text, which is to showcase the lessons on cost management inherent in all major construction projects, and this is reflected in the discussions that follow in the subsequent chapters.

1.5 Overview of chapters

Construction Cost Management: Learning from case studies, second edition, follows the same format as the first edition. It has been brought up to date and expanded throughout with a wide range of references by leading international academic researchers. The text is organized into four sections: Part I Introduction – Chapters 1 and 2; Part II Management of the pre-contract stage – Chapters 3–6; Part III Key tools and techniques – Chapters 7–9; Part IV Procurement strategies – Chapters 10–12; Part V Management of the post-contract stage – Chapters 13–15; and Part VI Contracts and case studies – Chapters 16–18.

Part I Introduction

Chapter 2 'Reports and recommendations' is a comprehensive overview of the post-war construction reports aimed at improving the efficiency of the industry. It examines the relevant key recommendations of the reports and the follow-up initiatives in order that best practice can be identified.

Part II Management of the pre-contract stage

The most important issue on any project is getting the right people for the job. Chapter 3 'Selecting the consultants and contractors' gives a detailed overview of some successful selection methodologies.

Chapter 4 'Pre-contract cost management' reviews the different approaches in the industrial, civil engineering and building sectors.

Chapter 5 'Cost management on PFI projects' examines the management structure and key success factors on these complex projects, and the roles of the project manager and quantity surveyor.

Chapter 6 'Contractor's estimating and tendering' reviews the whole tendering process from enquiry to submission, identifying the key risks within the process.

Part III Key tools and techniques

This section embraces three key issues encountered by construction cost managers. Chapter 7 'Value management' looks at the techniques used in a value management exercise with an abundance of case studies. Chapter 8 'Risk management' reviews the key issues involved in managing risks for both the client and contractor with an examination of the techniques and tools used. Chapter 9 'Whole-life costing' examines the important technique of whole-life costing.

Part IV Procurement strategies

This section reviews the alternative procurement strategies. Chapter 10 'Organizational methods (Part 1)' reviews the traditional and design and build strategies with new sections on guaranteed maximum price and alliances, and an expanded section on partnering. Chapter 11 'Organizational methods (Part 2)' examines the management approaches.

The expanded Chapter 12 'Payment systems and contract administration' now embraces Schedules of Prices and has a more comprehensive target cost section.

Part V Management of the post-contract stage

Increasingly the contractor is the major player on a construction project and Chapter 13 'Contractors' cost control and monitoring procedures' describes the different contractors' cost control systems encountered on building and large infrastructure projects. Reference is made to the use of the earned value analysis approach on a large project in Abu-Dhabi.

Chapter 14 'Change management – valuing variations' introduces the principles in setting up a change control system and continues with a comprehensive review of the principles involved in the valuation of changes or variations. This chapter also includes a review of some of the relevant legal cases concerning variations.

Chapter 15 'Claims management' examines the key issues involved in establishing the basis of a claim and the generic principles involved in their evaluation. It is noted that the NEC3 contract requires the submission of quotation *before* the acceptance of the change proposal through the compensation event procedure. However the JCT contracts and the FIDIC *Red Book* 1999 clearly acknowledge the potential for the submission of claims *after* the event.

Part VI Contracts and case studies

All construction projects are administered through the conditions of contract, which should be signed by both parties. In practice this is often a version of a standard conditions of contract with additional amendments. Chapter 16 ‘The NEC Engineering and Construction Contract’ and 17 FIDIC *standard forms of international construction contract* include a brief analysis of two important standard forms of contract, representing best practice in the UK and overseas. In the past decade the UK construction sector has moved towards greater collaboration and cooperation particularly through the use of the NEC3 contract. Research by Lord *et al*. (2010) identified a complete contrast in China, the largest construction market in the world, which has nurtured a change towards the more formal contractual system of rights and responsibilities, electing to use the FIDIC *Red Book* 1999 as a basis for all its major construction contracts.

These contracts are all subject to the laws of the home country. In the UK these are enacted through Acts of Parliament, e.g. the amendments to the statutory payment, adjudication and suspension rules under Part II of the Housing Grants, Construction and Regeneration Act 1996 (Construction Act 1996) introduced by Part 8 of the Local Democracy, Economic Development and Construction Act 2009 (LDEDC Act 2009) apply to construction contracts.

Additionally, pertinent government regulations must be adhered to in the management of the project, e.g. The Construction (Design and Management) Regulations 2007 (CDM 2007). Government regulations are particularly relevant for site-based operations, e.g. The Lifting Operation and Lifting Equipment Regulations 1998.

Case law is also relevant in the case of administration and contractual disputes, e.g. *Henry Boot Construction v Alstom Combined Cycles Ltd* (2000) CA BLR 247 and (1999) TCC BLR 123. These issues are all discussed in some depth. However, further details may be obtained from the Building Law Reports (BLRs) which have reported on hundreds of key judgments since 1976. A list of the disputes covered in the BLRs can be found on www.i-law.com.

The final chapter – Chapter 18 – ‘Case study: Heathrow Terminal 5’ describes the successful best-practice mega-project which embraced the principles of lean construction demanded by Sir John Egan.

For information on the major follow-up construction project in the UK – the construction of the 2012 London Olympics – readers should access the Learning Legacy website developed by the Olympic Delivery Authority in which they share the knowledge and lessons learned, together with the *NEC Users’ Group Newsletter*, London 2012 Special issue.

1.6 Conclusions

This chapter has set the scene and identified the role of the construction commercial manager within the wider discipline of project management. The role of the commercial manager has developed, embracing many aspects of project management, including:

- strategy: strategic planning, value management and risk management, whole-life costing;
- control: project control cycle, developing a schedule, controlling the cost;
- technical issues: tendering procedures, contractors’ estimating;

- commercial matters: financial management of the pre-tender, tender and post-tender stages, procurement, managing change, managing claims, legal awareness and contracts.

The aim of this book will be to embrace the subject of construction cost management as identified within Sections 2, 3, 4 and 5 of the APM's Body of Knowledge, the Construction Industry Council's *Construction Project Management Skills* framework and the RICS's APC/ATC guidelines for construction surveyors. The linking of these sections acknowledges the reality of the role of the quantity surveyor/commercial manager who is increasingly embracing construction project management.

Commercial and contractual management is not easy; traditionally it demanded experienced, dedicated personnel with an understanding of the construction technology and an in-depth knowledge of measurement and estimating, variations and claims, and contract procedures. The new strategies now demand professionals with a wider knowledge of procurement strategies and project management – particularly planning and control systems, corporate governance, strategic positioning, organizational behaviour, supply chain management and the management of change.

However, it is not the strategy or the wording of the contract that ensures success or failure, rather it is the attitude of the people involved. A genuine team spirit must be created with all team members having a *can do, will do* attitude (MPA, 2001).

Now it's time for you to answer a few questions! Best of luck.

1.7 Questions

Question 1

Identify the changing roles of the commercial manager within the UK construction industry.

Question 2

What are the qualities required of a successful commercial manager within the construction sector?

Question 3

How do clients control their investments and when?

Question 4

How can the contractor control the project?

Question 5

How can a contract contribute to effective project management?

Question 6

The erstwhile Office of Government Commerce have identified the *Common Causes of Project Failure*, and produced a useful guideline document (OGC, 2005) primarily aimed at those managing projects across Government.

Critically evaluate the management of projects within your own organization against the eight key questions raised in the OGC document.

Question 7

When it was completed in 2000 the Centre Block at the Royal Brisbane Hospital, valued at A$180 million (£90 million), was one of the largest hospital projects in Australia. Critically review the management structure, the contractual arrangement and the key success factors on this major project.

1.8 References/further reading

Agile Construction Initiative (1998) *The Government Client Improvement Study*, A Report for HM Treasury Procurement Group and the Government Construction Client Panel (GCCP), University of Bath.

Anglo-American Council on Productivity (1950) Building: Productivity Team Report*, Report of a visit to the USA in 1949 of a Productivity Team representing the Building Industry, London and New York.*

APM (2006) *APM Body of Knowledge* 5th edition, Association for Project Management, High Wycombe, UK (ISBN: 978-1-903494-13-4). Reproduced with permission.

Auditor General for Scotland (2000) *The New Scottish Parliament Building: An examination of the management of the Holyrood project*, Audit Scotland.

Auditor General for Scotland (2004) *Management of the Holyrood Building Project*, Audit Scotland.

Centre Block at the Royal Brisbane Hospital project: www.ciia.qut.com/docs/4_RBH.pdf – cited 20 May 2012.

CIOB (2002) *Code of Practice for Project Management for Construction and Development,* 3rd edition, CIOB.

Construction Industry Council (2002) *Construction Project Management Skills*, CIC.

Cooper, P. (2000) *Building Relationships: The history of Bovis 1885–2000*, Cassell & Co.

Davis Langdon annual reports: www.davislangdon.com/upload/StaticFiles/EME%20Publications/Brochures/AnnualReview_2008_09.pdf – cited 10 May 2012.

Egan, J. (1998) *Rethinking Construction: Report of the Construction Task Force on the scope for improving quality and efficiency of UK construction*, Department of the Environment, Transport and the Regions (DETR).

Europa: http://ec.europa.eu/enterprise/sectors/construction/files/compet/sustainable_competitiveness/ecorys-final-report_en.pdf; www.imf.org – cited 10 May 2012.

Fraser, Rt Hon. Lord of Carmyllie (2004) *The Holyrood Inquiry*, SS Paper No. 205, Session 2, Astron, Edinburgh.

Holyrood Inquiry: www.holyroodinquiry.org – cited 18 April 2007.

i-law.com: www.i-law.com – accessed 20 February 2012.

Isurv. com: www.isurv.com – accessed 16 July 2011.

Latham, M. (1994) *Constructing the Team, Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry*, *Final Report*, HMSO.

Learning legacy: http://learninglegacy.independent.gov.uk – accessed 12 December 2012.

Lord, W., Liu, A., Tuuli, M.M. and Zhang, S. (2010) A Modern Contract: Developments in the UK and China, Proceedings of the Institution of Civil Engineers, Management, Procurement and Law,163, November, pp.151–159.

Major Projects Association (2000) *The Jubilee Line Extension*, Seminar held at the ICE, London, 17 November.

Major Projects Association (2001) *Hong Kong International Airport*, Seminar held at the ICE, London, 23 April.

Major Projects Association (2003) *Learning from Project Failures*, Seminar held at the Royal College of Pathologists, London, 13 November.

Mitchell, R. (2003) *Jubilee Line Extension: From concept to completion*, Thomas Telford.

Murray, M. and Langford, D. (2003) *Construction Reports 1944–98*, Blackwell Publishing.

National Audit Office (2005) *Improving Public Services Through Better Construction*, Report by the Comptroller and Auditor General, HC 364-I Session 2004–2005, 15 March, HMSO.

NEC Users' Group Newsletter, London 2012 Special Issue, No. 58, April 2012, www.neccontract.com – accessed 29 May 2012.

OGC document: www.dfpni.gov.uk/cpd-coe-ogcnaolessons-common-causes-of-project-failure.pdf – cited 23 March 2012.

Poderas, J. (2002) *Centre Georges Pompidou Paris*, Prestel.

Reichold, K. and Graf, B. (1999) *Buildings that Changed the World*, Prestel.

Report by the Comptroller and Auditor General (2000) *The Millennium Dome,* HC 936, Session 1999–2000, 9 November, The Stationery Office.

RICS (2002) *APC/ATC Requirements and Competencies*, July, edition 1, RICS.

RICS (2006) *RICS Assessment of Professional Competence in Quantity Surveying and Construction*. Available at: www.isurv.com (cited 16 July 2011)

Spencely, J. (2000) *Scottish Parliamentary Corporate Body Report on the Holyrood Project*, SP Paper 99, Session 1, The Stationery Office.

Wilhide, E. (1999) *The Millennium Dome*, Harper Collins Illustrated.

2 Reports and recommendations

2.1 Introduction

The past two decades or so have seen the publication of many significant reports relevant to project management of the built environment (embracing both building and civil engineering), including significantly Latham (1994) and Egan (1998) and those issued by the erstwhile UK Government's Office of Government Commerce (part of HM Treasury) and the National Audit Office.

These major studies have highlighted the inefficiencies of traditional methods of procuring and managing major projects – in particular the fallacy of awarding contracts solely on the basis of the lowest price bid, only to see the final price for the work increase significantly through contract variations and with projects often completed late. Indeed this was often the traditional ploy on major works – submit a low bid in the anticipation of making a profit on the variations and claims. Experience has shown that acceptance of the lowest price bid does not provide value for money in either the final cost of construction or through-life and operational costs. Relations between the construction industry and government departments have also been typically characterized by conflict and distrust which have contributed to poor performance. Most of these reports have highlighted alternative ways forward typified by comments in the *Modernising Construction Report* (NAO, 2001) as follows:

> Estimates of the cost of these inefficient practices are inevitably broad brush, but studies have identified the potential for major savings – 30 per cent in the cost of construction. Specifically by industry adopting a more collaborative approach strongly founded on a competitive process with appropriate risk sharing in which value for money is obtained by all parties through a clear understanding of the project's requirements, transparency as to costs and profits, underpinned by clearly understood rights and obligations, and appropriate incentives. More attention to design and early involvement of the whole construction team could also improve the operational efficiency of the completed buildings resulting in potentially greater savings over the whole life of the building.
>
> NAO, *Modernising Construction*, 2001, p. 4

Whilst the list is not exhaustive, it is still appropriate to review the recommendations contained within most of these major reports, which should contain the key criteria for change and enable identification of recommended best practice. This insight will help establish criteria and benchmarks against which the practices revealed by the case studies can be measured.

The Latham (1994) and Egan (1998) reports in the mid-1990s were particularly significant and prompted a radical review of established practices and procedures in order to identify *best practice*. Unlike previous UK government reports on the construction industry, which were basically ignored, the Latham report *Constructing the Team* (1994) and the Egan report *Rethinking Construction* (1998) have had a profound impact on the UK construction industry. These reports, together with Egan's follow-up report, *Accelerating Change* (2002), have challenged the industry to throw off the old adversarial practices and reinvent itself in order to become world class. More significantly they created a willingness to work together to consider changes and how they could be best implemented for the benefit of the industry and the clients on whom it depends.

The UK Government, as a best practice client, has in response instigated major changes in procurement and project management practice. Case studies indicate that the new approaches are having a significant impact by increasing the client's certainty of outcome and value for money.

It is important that all those engaged in the construction process understand these changes as they come into effect through parliamentary statute, new forms of contract, new processes and codes of practice. All should be conscious of the changed responsibilities and liabilities that will arise and the opportunities as well as risks that they provide for their business.

2.2 Post-war reports

In 1949, whilst Britain was still experiencing chronic shortages in skilled labour, materials and construction equipment, a British Building Productivity Team visited America under the auspices of the Anglo-American Council on Productivity. The report of the team, published in 1950, identified the factors which were considered responsible for the higher productivity levels in America. These included complete pre-planning of the job; coordination of subcontractors' work; adequacy of supplies of labour and materials; availability and use of mechanical aids; recognition of the importance of continuous research into the production of materials and into building techniques; and the positive attitude of the American workers.

Significantly, the Anglo-American report concluded by stating that the 'Building owner, architect, quantity surveyor, contractor and subcontractors should all cooperate more closely to reduce building costs' (Anglo-American Council on Productivity 1950: 65). The report also included a chapter devoted to tendering procedures and provided a comprehensive description of the two systems – American without quantities and British with quantities, commenting that 'Consideration should be given to the simplification of the Standard Method of Measurement' (Anglo-American Council on Productivity 1950: 65).

The Anglo-American report was typical of the numerous reports on the state of the UK construction industry published since the World War II. Murray and Langford (2003) catalogue these reports as follows:

- *Placing and Management of Building Contracts:* The Simon Committee Report (1944) within which the 'BofQ considered best basis for estimating the cost of the whole project and for valuing variations';
- *The Working Party Report to the Minister of Works:* The Phillips Report on Building (1948–1950);
- *Survey of Problems before the Construction Industry:* A Report prepared by Sir Harold Emmerson (1962) which established that 'efficiency in operations depends on the quality of the relationships and better co-ordination between the building owner, the professions (architect, surveyor, engineer) and the contractors and subcontractors';

- *The Placing and Management of Contracts for Building and Civil Engineering Work:* The Banwell Report (1964), which argued that 'banding together of those who have suitable work in prospect is to be encouraged, which will allow construction to benefit from industrialisation and standardisation', 'a common form of contract for all construction work, covering England, Scotland and Wales, is both desirable and practicable', 'contractors should apply to the selection of subcontractors the same standards of fairness which they expect when they themselves are chosen', 'in order to achieve a firm price contract, for any scheme, all the critical details need to be worked out, thereby leaving as little as possible to chance';
- *Tavistock Studies into the Building Industry:* Communications in the Building Industry (1965) and Interdependence and Uncertainty (1996);
- *Large Industrial Sites Report* (1970);
- *The Public Client and the Construction Industries:* The Wood Report (1975) which concluded that 'a project requires a sole senior representative, with sufficient expertise, authority and time, and public officials may need advice to enable them to play this role effectively today';
- *Faster Building for Industry:* NEDO (1983);
- *Faster Building for Commerce* (1988).

With the exception of the Tavistock Studies, these were all government-sponsored reports, produced by large committees. Most made recommendations for improvement but were mainly ignored due to poor client involvement and no follow-up legislation to reinforce their findings. Significantly, Banwell (1964) recommended that a common form of contract be used for all construction work. This only started to become a reality 30 years later – with the introduction of the new engineering contract (now referred to as the NEC contract).

2.3 The Latham Report, *Constructing the Team* (1994)

The terms of reference were to consider current procurement and contractual arrangements, and current roles, responsibilities and performance of the participants, including the client, with regard to:

- the processes by which clients' requirements are established and presented
- methods of procurement
- responsibility for the production, management and development of design
- organization and management of the construction process
- contractual issues and methods of dispute resolution.

The report makes 30 major points to which the industry has responded well. Perhaps most significant was the establishment of the Construction Industry Board (CIB), which all parties in the industry contributed to and supported. A number of working groups were set up under the aegis of the CIB to find ways to implement the report's recommendations.

Main conclusions and recommendations

Clients (government and private sector)

- set up a new construction clients' forum (see www.clientsuccess.org.uk);
- be best practice clients (see www.ogc.gov.uk and http://www.constructingexcellence.org.uk/);

- publish a Construction Procurement Strategy Code of Practice (see *A Guide to Best Practice in Construction Procurement* by Clive Cain published in 2001 by Construction Best Practice Programme);
- promote a mechanism for selecting consultants on quality as well as price (see CIB Working Group 4 'Selecting consultants for the team: balancing quality and price' published in 1996).

Industry

- adopt target of 30 per cent real cost reduction by the year 2000;
- improve tendering arrangements/registration (with Government) (see www.constructionline.co.uk);
- draw up a code of practice for selecting subcontractors (see CIB Working Group 3 'Code of Practice for the selection of subcontractors' published in 1997);
- implement the recent reports on training and the education of professionals;
- improve public image;
- produce coordinated equal opportunities action plan.

Contracts

- develop standard contract documentation based on a set of principles;
- include independent adjudication, pre-pricing of variations and trust accounts for payments (the Housing, Grants, Construction and Regeneration Act 1996 gave rights to the parties to refer a dispute arising under a contract to adjudication; pre-pricing of variations now included in standard forms of contract, e.g. JCT 11 and NEC3; trust accounts are now being introduced);
- introduce recommendations for increased use of the New Engineering Contract;
- produce a complete standard family of interlocking contract documentation;
- set up contract committees – restructuring.

Legislation

- introduce legislation against unfair contracts (the Housing, Grants, Construction and Regeneration Act 1996 included terms on fair payments);
- introduce legislation to underpin adjudication and trust account proposals (see comments above);
- implement Department of Environment (DoE) working party proposals on liability legislation (this relates to suppliers' exclusion clauses – not implemented);
- introduce mandatory latent defects insurance (defects which cannot be seen as opposed to 'patent' defects which can be seen – not implemented).

Sir Michael Latham also identified what a modern contract should contain, which is particularly relevant when considering the main contractor/subcontractor contract.

Lord (2008) undertook a critical review of the principal provisions of the standard contracts produced by the Joint Contracts Tribunal (JCT), the Institution of Civil Engineers (ICE) and the New Engineering Contract (NEC).

He concluded that:

> The JCT and ICE forms of contract were found to have retained the principal features more conducive to promoting an adversarial relationship as opposed to the modern requirements

Panel 2.1 A modern contract

The most effective form of contract in modern conditions should contain:

1. a specific duty for all parties to deal fairly with each other, and with their subcontractors, specialists and suppliers, in an atmosphere of mutual cooperation;
2. firm duties of teamwork, with shared financial motivation to pursue those objectives. These should involve a general presumption to achieve 'win-win' solutions to problems which may arise during the course of the project;
3. a wholly integrated package of documents which clearly defines the roles and duties of all involved and which is suitable for all types of project and for any procurement route;
4. easily comprehensible language, and with guidance notes attached;
5. separation of the roles of contract administrator, project or lead manager and adjudicator. The project or lead manager should be clearly defined as the client's representative;
6. a choice of allocation of risks, to be decided as appropriate to each project but then allocated to the party best able to manage, estimate and carry the risk;
7. all reasonable steps to avoid changes to pre-planned works information. But, where variations do occur, they should be priced in advance, with provision for independent adjudication if agreement cannot be reached;
8. express provisions for assessing interim payments by methods other than monthly valuation, i.e. milestones, activity schedules or payment schedules. Such arrangements must also be reflected in the related subcontract documentation. The eventual aim should be to phase out the traditional system of monthly measurement or remeasurement, but meanwhile provision should still be made for it;
9. a clearly set out period within which interim payments must be made to all participants in the process, failing which they will have an automatic right to compensation, involving payment of interest at a sufficiently heavy rate to deter slow payment;
10. provision for secure trust fund routes of payment;
11. while taking all possible steps to avoid conflict on site, provision for speedy dispute resolution if any conflict arises, by a predetermined impartial adjudicator/referee/expert;
12. provision for incentives for exceptional performance;
13. provision where appropriate for advance mobilization payments (if necessary, bonded) to contractors and subcontractors, including in respect of off-site prefabricated materials provided by part of the construction team.

Source: Latham (1994)

for a collaborative and trusting relationship. Some attempts have been made by the JCT and ICE to promote collaborative working and to incorporate the features of a modern contract but this relies heavily on overarching documents which in the main are not binding on the parties and simply exhort collaborative behaviour. The single, most notable exception to this was the JCT Constructing Excellence Contract.

On the other hand, the NEC family of contracts were found to have embraced virtually all the requirements for a modern contract in an integrated way and, could be argued, were the most conducive to assisting with implementation of the various drivers for change.

2.4 Levene efficiency scrutiny (1995)

Although the Latham Report clearly tried to improve performance of the UK construction industry and provide a catalyst for change, further reforms were required especially in the way Government departments procured contracts. The *Levene Scrutiny* focused in greater detail on the role of various government departments and agencies in the procurement of construction work and how they would perform as *best practice clients* (Efficiency Unit Cabinet Office, 1995).

The review was undertaken with two fundamental aims: to improve value for money in the procurement of public works and to improve the competitiveness of suppliers to government.

The report concluded, as Latham had already stated, that the UK construction industry was in poor shape and that the performance of the government departments was a contributing factor. The report proposed five action points, developed into 22 recommendations that were designed to facilitate government departments' more effective management of their projects and to encourage the industry to be more proactive and less adversarial.

2.5 Construction Procurement Guidance, HM Treasury (1996)

This series of guides were produced following the recommendations of the Latham Report (1994) and the Efficiency Scrutiny of Government Construction Procurement (1995). The guidance provided best practice advice at a strategic level and covered the client's role in the procurement process; it was specifically aimed at encouraging a change in culture.

The reports made up a family of documents comprising:

No. 1 Essential requirements for construction procurement
Set out roles and responsibilities of the Investment Decision-maker, the Project Owner and Project Sponsor and the training they required.

No. 2 Value for Money (VFM) in construction procurement
Set out a VFM framework (a structured list of activities undertaken in a project including approval gateways, risk and value management techniques and control procedures), where best VFM is the optimum combination of whole-life cost and quality to meet the customers' requirement. The National Audit Office (NAO) does not consider that achieving VFM means accepting the lowest bid – they have not criticized a project on these grounds when other considerations were more important. It must be emphasized, however, that the intention is also not to stifle innovation through rigid adherence to mechanistic procedures.

No. 3 Appointment of consultants and contractors
Set out the consultancy roles and responsibilities, details of the appointment process and the structure of the project team.

No. 4 Team working, partnering and incentives
Embraced the concept of teamwork declaring that 'Teamwork should be a core requirement for every element of a major project and partnering should be adopted as far as possible on all new and existing contracts. Incentives should be included to provide benefits to clients.'

No. 5 Procurement strategies
Recommended the following procurement strategies: Public Private Partnerships, design and construct (and, where appropriate, maintain and operate), prime contracting and framework

agreements. Traditional forms of construction procurement should only be used where there is a very clear case that they will deliver better value for money than other procurement routes in terms of whole-life costs and overall performance.

No. 6 Financial aspects of projects
Provided information on preparing budget estimates and dealing with risk allowances.

No. 7 Whole-life costs
This guide identified that the primary purpose of whole-life costs is to provide the Investment Decision-maker with the information necessary to make the best decisions in terms of project strategy and procurement route.

No. 8 Project evaluation and feedback
Identified that project evaluation includes three elements:

- formal reviews at project gateways (including post-occupancy evaluation);
- less formal ongoing evaluation and reporting (particularly during the development and construction stages);
- evaluation and reporting of specific activities.

'The fundamental part of project evaluation and feedback is to make sure that lessons learned from one project are transferred effectively to other projects.'

No 9 Benchmarking
The guide considered that the primary purpose of benchmarking is to improve the performance of the organization. Benchmarking is a tool that allows organizations to help themselves. It is an essential part of continuous improvement and is a continuous and long-term process and not a one-off instant solution.

2.6 Construction Industry Board (CIB) Working Groups (1996/97)

Following Sir Michael Latham's Report, *Constructing the Team*, the Construction Industry Board (CIB), representing the professions and consultants, main contractors, subcontractors, clients, materials suppliers and the Government, produced reports from 12 Working Groups as follows:

WG1 *Briefing the team*
WG2 *Constructing success*
WG3 *Code of practice for the selection of subcontractors*
WG4 *Selecting consultants for the team: balancing quality and price*
WG4 *Framework for a national register for contractors*
WG5 *Framework for a national register for consultants*
WG6 *Training the team*
WG7 *Constructing a better image*
WG8 *Tomorrow's team: women and men in construction*
WG9 *Educating the professional team*
WG10 *Liability law and latent defects insurance*
WG11 *Towards a 30% productivity improvement in construction*
WG12 *Partnering in the team*

The document, WG1, *Briefing the team*, contains a checklist for construction productivity – this is essentially the solution to Latham's challenge for the industry to make a 30 per cent real cost reduction:

- change the industry culture
- introduce clear, concise and comprehensive standards of briefing
- ensure design and construction processes work as one
- foster teamwork and partnership
- rationalize project structures
- establish industry standards for information technology
- make quality the main requirement of all elements of the design and construction process
- improve the understanding and effective application of risk management techniques
- health and safety should be part of the cost-benefit analysis
- develop standard products, components and processes
- prefabrication and preassembly should be part of design considerations
- improve designers' knowledge and understanding of the performance of components and materials
- designers need urgently to embrace new technologies
- life cycles, and all-life costs of buildings and their fittings must be a principal part of design and maintenance considerations
- quality and value must not be ignored in the pursuit of the lowest price
- the management experience of buildings and projects, and the associated costs, should be constantly fed back to, and adopted by, designers in new designs
- benchmarking must be used to measure improvements in practice and productivity
- shared construction experience must be given to trainees during their education
- focus research and innovation; integrate current research projects; improve information flow; invest in implementation
- establish public relations channel; focus on productivity gains; highlight successes.

2.7 The Egan Report, *Rethinking Construction* (1998)

Rethinking Construction is the name of the report produced by Sir John Egan's Construction Task Force. The report, commissioned by John Prescott, the Deputy Prime Minister, was published in July 1998. The central message of *Rethinking Construction* is that, through the application of best practices, the industry and its clients can collectively act to improve their performance.

The *Rethinking Construction* report proposed the creation of a *movement for change* which would be a dynamic, inspirational, non-institutionalized programme to champion radical continuous improvement within the construction industry. The report led to further action to facilitate cultural change, with particular emphasis on the need for involvement of the whole of the supply chain. Another such change was the launch of the Movement for Innovation (M4i) in November 1998, which since 2004 has been part of Constructing Excellence.

The report also encouraged recognition that the industry can and indeed must do much better. This led to M4i capturing 180 demonstration projects submitted by clients and contractors, which exemplified some of the innovations advocated in Sir John Egan's report. Many of the demonstration projects did exceed Sir John Egan's targets in productivity, profits, defects and reduced accidents.

The report identified what can be summarized within the '5:4:7 mantra' as: five drivers which needed to be in place to secure improvement in construction; four processes that had to be significantly enhanced; and seven quantified improvement targets.

Drivers for change

1 committed leadership
2 focus on the customer
3 product team integration
4 quality-driven agenda
5 commitment to people.

Improving the process

1 product development
2 partnering the supply chain
3 product implementation
4 production of components.

Targets for improvement (annual)

1	Capital cost	–10 per cent
2	Construction time	–10 per cent
3	Predictability	+20 per cent
4	Defects	–20 per cent
5	Accidents	–20 per cent
6	Productivity	+10 per cent
7	Turnover and profits	+10 per cent.

To enable the construction industry to achieve the targets, radical changes were identified within the Egan Report. One such change was the replacement of traditional contract strategies with integrated supply chain-led strategies, such as design and build, alongside long-term partnering relationships based on clear measurement of performance and sustained improvements in quality and efficiency, which continued the theme from the earlier Latham Report.

Key recommendations within the Egan Report were summarized by Bennett and Baird (2001) as follows:

- The industry and its major customers need to rethink construction so as to match the performance of best consumer-led manufacturing and service industries.
- Integrated processes and teams should be introduced as a key driver for change.
- The industry should organize its works so that it offers customers brand-named products, which they can trust to provide reliably good value.
- The industry should work through long-term relationships using partnering, which aims at continuous improvements in performance.
- Benefits from improved performance should be shared on an openly fair basis so that everyone has real motivation to search for better answers.
- Project teams should include design, manufacturing and construction skills from day one so that all aspects of the processes are properly considered.
- Decisions should be guided by feedback from the experience of completed projects so that the industry is able to produce new answers that provide even better value for the customer.
- Standard products should be used in designs wherever possible because they are cheaper and, in the hands of talented designers, can provide buildings that are aesthetically exciting.

- Continuous improvements in performance should be driven by measured targets, because they are more effective than using competitive tenders.
- The industry should end its reliance on formal conditions of contract, because in soundly based relationships in which the parties recognize the mutual interdependence contracts add significantly to the cost of projects and add no value to the customer.

Indeed, this latter point was one of the more controversial comments made within the Egan Report:

> The Task Force wishes to see: an end to the reliance on contracts. Effective partnering does not rest on contracts. Contracts can add significantly to the cost of a project and often add no value for the client. If the relationship between a constructor and employer is soundly based and the parties recognize their mutual interdependence, then formal contract documents should gradually become obsolete. The construction industry may find this revolutionary. So did the motor industry but we have seen non-contractually based relationships between Nissan and its 130 principal suppliers and we know they work.

In reality, this may be a step too far for many within the construction industry.

The targets set by *Rethinking Construction* have been met by several major construction clients. However it appears that the benefits are not cascading down the supply chain. After achieving the necessary cost and time reduction for several years running without the anticipated increase in turnover and profits, there comes a time when contactors begin to wonder whether it has been worth the effort (comment from commercial manager of major contractor in 2004).

The UK government policies have now increased the need for all public sector clients to fully implement the principles of *Rethinking Construction* which are now firmly established and recognized as best practice.

Key performance indicators

A key feature in the promotion and implementation of improvement targets demanded by Sir John Egan in his report, *Rethinking Construction*, was the creation of Construction Industry Key Performance Indicators (KPIs) in 1999. Over the years, the number of KPIs has grown considerably. Different suites are available for Consultants, M&E Contractors and Product Manufacturers. The Centre for Construction Innovation (CCI) through its 'KPIzone' also provides an economic suite with separate subsets of the data for New Build Housing, New Build Non-Housing, Repair and Maintenance and Refurbishment (Housing and Non-Housing), and Infrastructure. A separate suite of 'social' KPIs called 'Respect for People' are also available which evaluate organizational elements such as Health and Safety and Equality and Diversity. An Environmental suite measures KPIs such as Mains Water Use, Waste and Impact on Environment (see CCI website).

The construction industry KPIs are published each year by Constructing Excellence using performance data collected from across the UK construction sector by the Department for Business, Innovation and Skills. The 'KPIzone' suite of products provide organizations of any size and from all sectors of the construction industry with an easy way of measuring and benchmarking performance against this national data (see *kpizone* within CCI website). The 'KPI Engine' allows users to benchmark their company and project performance against the construction industry KPI and, additionally, allows them to access a more sophisticated set of benchmarking and reporting options such as comparing their performance over time, between projects and against averages.

2.8 *Modernising Construction*, National Audit Office (2001)

This report identified how the procurement and delivery of construction projects in the UK could be improved. Its recommendations were made to four key groups: the Department of the Environment, Transport and the Regions; the Office of Government Commerce; line departments commissioning construction projects; and the construction industry itself. The main recommendations are summarized as follows:

The Department of the Environment, Transport and the Regions

- provide more coordinated direction to initiatives to promote better performance by the construction industry;
- use its influence as a member of the Movement for Innovation Board to ensure that demonstration projects are truly innovative;
- develop more sophisticated performance measures; for example, indicators need to measure:
  - the operational – through-life – running costs of the completed building;
  - the cost effectiveness of the construction process;
  - quality of completed construction;
  - health and safety indicators.

The Office of Government Commerce

- disseminate good practice more widely.

Line departments

- actively measure improvements in construction performance;
- train more staff to be effective construction clients.

The construction industry

- make greater use of innovation to improve public sector construction.

The *Modernising Construction* report contained a number of case studies from different sectors which identified the following lessons learned: importance of pilot projects/client's briefing and PM structures; integration of the supply chain from the outset; continuous improvement; change in staff attitudes; development of new processes and procedures; open policy/open book accounting; understanding each party's objective; milestone payments can help; clearly understood problem resolution – bottom up; importance of skilled staff; keeping the project team together; partnering can reduce costs; importance of risk management, value management and value engineering; performance measurement; joint bonuses; modern methods of construction – prefabrication/just in time; involving contractor early in design process; site meetings should be more creative; and collaborative working produces better solutions.

Appendix 4 of the *Modernising Construction* report contains an excellent review of partnering by Norman Fisher and Stuart Green from the University of Reading entitled 'Partnering and the UK construction industry: the first 10 years – a review of the literature'.

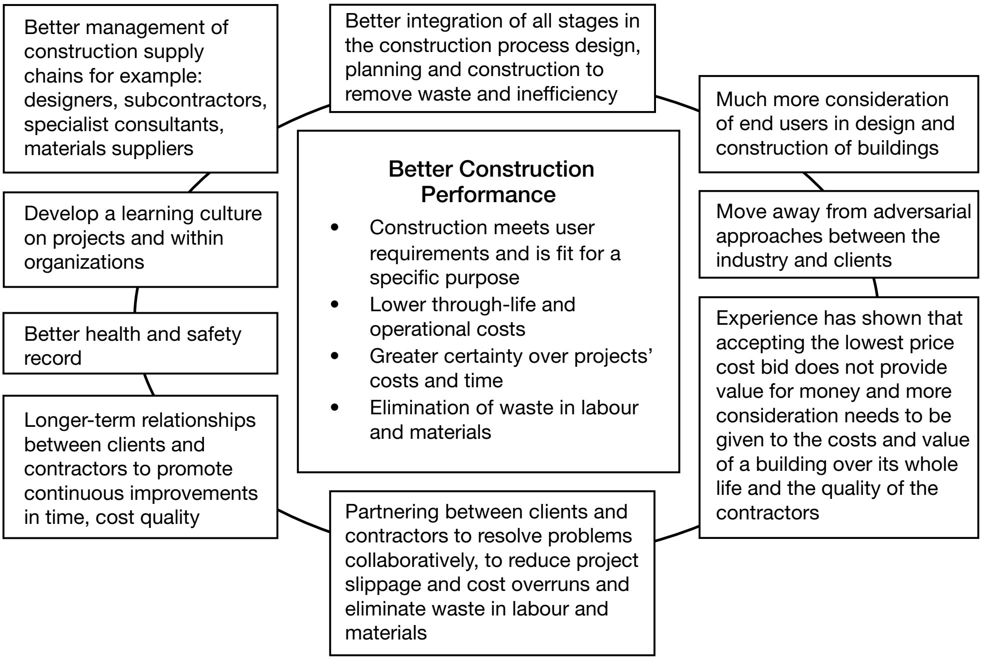


Figure 2.1 Better construction performance: what is needed?

Source: National Audit Office analysis of Latham, Levene and Egan Reports, reported in Modernising Construction (2001)

2.9 The Second Egan Report, *Accelerating Change* (2002)

Four years on from the Egan Report the Strategic Forum for Construction produced a follow-up report *Accelerating Change*. This report tackled some of the barriers to progress against the Egan targets and identified ways of accelerating that change.

The vision of the authors was for the UK construction industry to realise maximum value for all clients, end users and stakeholders and exceed their expectations through consistent delivery of world-class products. The vision is being taken forward by the Strategic Forum for Construction (SFfC), a cross-industry/government body.

The four key areas on which the SFfC focused were:

1 client engagement
2 integrating teams and supply chains
3 people issues
4 enhancing the value of the product.

Six headline targets were identified by the SFfC:

Target 1: 20 per cent of construction projects (by value) should be undertaken by integrated teams and supply chains by the end of 2004, rising to 50 per cent by the end of 2007.
Target 2: 20 per cent of clients should embrace the principles of the Clients' Charter by 2004; target to increase this to 50 per cent by 2007.
Target 3: By 2006, 300,000 qualified people should be recruited and trained in the industry.

Target 4: By 2007, there should be a 50 per cent increase in applications to built environment higher and further education courses and by 2010 an increase in the annual rate of apprentice completions to 13,500.

Target 5: By 2010, there should be a fully trained, qualified and competent workforce on all projects.

Target 6: By the end of 2004, 500 projects should have used the Design Quality Indicators (DQIs). By the end of 2007, 60 per cent of all publicly funded PFI projects (having a value in excess of £1 million) should use DQIs and 20 per cent of all projects (having a value in excess of £1 million) should use DQIs.

In essence *Accelerating Change* reinforced the challenges set out in *Rethinking Construction* calling for a most ambitious year-on-year improvement.

2.10 Achieving Excellence in Construction Procurement Guides, Office of Government Commerce (2003)

Achieving Excellence was launched in March 1999 to improve the performance of central government departments and other public bodies, following major failures in time and cost overruns. It aimed to provide a step change in construction procurement performance and value for money achieved by government on construction projects, including maintenance and refurbishment.

The key thrust of *Achieving Excellence* was the delivery of value for money. This is not the lowest cost, but the optimum combination of whole-life cost and quality to meet the users' requirement.

The *Achieving Excellence* suite of procurement guides replaced the 1996 *Construction Procurement Guidance* series. The new series reflected developments in construction procurement and built upon government departments' experience of implementing the *Achieving Excellence in Construction* initiative.

The suite consists of 11 core guides together with two high-level documents. Electronic versions have hyperlinks across the set and to related products, such as the OGC Successful Delivery Toolkit and external websites. The significant OGC Gateway Process model is described in detail in the *Achieving Excellence Guide 3* – Project procurement lifecycle.

A – High-level guides

Checklist for managers: supplements the *Gateway Checklist for Managers*. Provides a checklist of key questions that investment decision-makers should ask before approving a project and during its implementation.

Pocketbook: provides step-by-step outline of the procurement process together with a summary of tools and techniques.

B – Core guides

01 Initiative into action: provides an overview of *Achieving Excellence* and the new procurement guides.

02 Project organization – roles and responsibilities: provides detailed explanation of the key roles, responsibilities and skills required.

03 Project procurement lifecycle: provides step-by-step description of the decision points and processes involved in the management of construction projects. It sets the project management procurement process in the context of *Gateway Reviews*. It explains what is done and when, who is usually involved and the information required to manage the project (especially the Project Execution Plan).

C – Supporting guides

04 Risk and value management: provides practical detail on risk and value management as essential tools for project success.

05 The integrated project team – team working and partnering: provides a detailed description of what needs to be done when selecting the team.

06 Procurement and contract strategies: provides advice and recommendations on integrated procurement routes (PFI, Prime Contracting and Design and Build) explaining when to use a particular procurement strategy.

07 Whole-life costing and cost management: provides advice on producing whole-life cost models and explains what needs to be done to keep costs under control at key stages in the project.

08 Improving performance – project evaluation and benchmarking: explains how to measure project performance throughout the life of a project and explains how to use KPIs to measure and improve performance.

09 Design quality: highlights the importance of good design in achieving value for money.

10 Health and safety: identifies how clients' decisions and activities impact on health and safety issues.

11 Sustainability: sets out the future strategy on the practicalities of sustainable construction procurement.

The OGC (Achieving Excellence) case studies include the Birmingham Construction Partnership, Lincolnshire County Council Highways framework and the Derby Hospitals £333 million PFI scheme, details of which are available via the UK Government Web Archive.

2.11 *Improving Public Services through Better Construction*, National Audit Office (2005)

Part 3 of the report and the supporting case studies set out examples of good practice which have enabled organizations in both the public and private sectors to improve their construction delivery. The good practices have allowed the completed projects to be delivered on time and to cost, and have helped improve the quality of the final built asset.

In addition the report recommended that government departments:

1. create more certainty in the market, with longer-term funding and programme planning;
2. strengthen their leadership of construction programmes and projects and put in place strategies for developing construction project management capabilities;
3. engage fully with the Gateway process and obtain independent advice and challenge at the concept and business case stages when considering potential construction projects;
4. consider the development of a sustainability action plan to cover all aspects of their construction activity;
5. make decisions about construction projects based on sustainable whole-life value;
6. make more transparent to suppliers the criteria for tender evaluation and make the most of their funding and purchasing power to influence suppliers' behaviour;
7. keep competitive tension in framework and partnering arrangements to provide greater assurance that construction costs represent fair value, and improve the effectiveness of contract strategies to manage better risk and maximize the opportunities for improved performance;
8. encourage collaborative working through collaborative forms of contract and fair payment practices, and seek opportunities to pursue the case for project-wide insurance where appropriate and in agreement with their suppliers;

9 evaluate the post-completion and occupancy performance of projects in terms of the Achieving Excellence strategic targets, whole-life value, including financial performance and the delivery of better services and sustainable development, and embed the lessons in future activity;
10 should consider where relevant developing quantifiable cross-government strategic targets focused on sustainable construction.

Additional recommendations were made to the erstwhile Office of Government Commerce advising them on the leadership and support that they should provide to all public sector organizations. The report also included a useful self-assessment tool in the form of a *maturity grid* enabling public sector clients to assess their readiness and capability to tackle construction projects and to target areas for improvement.

2.12 "*Never Waste a Good Crisis*", Constructing Excellence (2009)

The subtitle to this report neatly conveys its aim: *A review of progress since Rethinking Construction and thoughts for our future*. The report concluded that there had been some progress since the Egan Report of 1998, but nowhere near enough. The 500 or so demonstration projects monitored by Construction Excellence and their predecessors did indeed show superior performance relative to the rest of the sector. However, this was against a backdrop of fairly entrenched behaviour, with many stating that the benefits of partnering did not reach the supply chain. Data from the Construction Industry's KPIs introduced in 1998 overall showed some improvement to performance. However, on *predictability* the 2009 KPI data still showed only a 50:50 chance that a project would come in on cost or on time, with client-approved changes accounting for half this variation.

The 'Executive summary' challenged the industry to adopt a new vision for the industry based on the concept of the *built environment* and highlighted the importance of understanding how value is created over the whole life cycle of an asset, rather than simply looking at the building cost. The report considered that it was now time for the supply side of the industry to demonstrate that it can create additional economic, social and environmental value through innovation, collaboration and integrated working – in short, the principles outlined in *Rethinking Construction*.

2.13 "Government Construction Strategy", The Cabinet Office (2011)

On 31 May 2011 The Minister for the Cabinet Office, Francis Maude, published the UK Government's new Construction Strategy.

It is claimed that the strategy will reform the way in which government procures construction across all sectors and, in doing so, will reduce costs by up to 20 per cent by the end of the parliamentary term, helping both the government and the construction sector. It will replace adversarial cultures with collaborative ones and will demand cost reduction and innovation within the supply chain.

The report identifies that the right model for public sector construction procurement in the UK is one in which:

- clients issue a brief that concentrates on required performance and outcome;
- designers and constructors work together to develop an integrated solution that best meets the required outcome;
- contractors engage key members of their supply chain in the design process where their contribution creates value;

- value for money and competitive tension are maintained by effective price benchmarking and cost targeting, by knowing what projects should cost, rather than through lump sum tenders based on inadequate documentation;
- supply chains are, where the programme is suited, engaged on a serial order basis of sufficient scale and duration to incentivize research and innovation around a standardized (or mass customized) product;
- industry is provided with sufficient visibility of the forward programme to make informed choices (at its own risk) about where to invest in products, services, technology and skills; and
- there is an alignment of interest between those who design and construct a facility and those who subsequently occupy and manage it.

Significantly, the report also indicated a commitment to embrace Building Information Modelling (BIM) for all Government projects by 2016. BIM is essentially value-creating collaboration through the entire life cycle of an asset, underpinned by the creation, collation and exchange of shared 3D models and intelligent, structured data attached to them (see BIM task group website). It is considered that BIM technologies, process and collaborative behaviours will unlock more efficient ways of working at all stages of the project life cycle.

Use of BIM in construction

BIM adoption in the construction industry varies quite widely. It is considered that there are broadly four stages on the adoption/maturity continuum. Bew (2011) identifies these as:

Stage 0: unmanaged CAD (2D) with paper-based information exchange, resulting in poor data capture and analysis, which detract from performance improvement.

Stage 1: where 2D or 3D CAD drives process with some degree of online collaboration providing a common data environment which helps with information consistency. Significantly, from a cost manager's perspective, even at this level of maturity commercial data is still managed traditionally as stand-alone.

Stage 2: which appears to be the highest level of adoption in the UK currently, is a 3D shared environment but with separate BIM models held by the different participants. Even in this shared environment, commercial data is still managed by a separate Enterprise Resource Planning (ERP) system with little integration to the BIM model;

Stage 3: described as the 'Holy Grail' refers to a fully open process and data integration between all current systems, enabled by the industry standard IFC (Industry Foundation Classes) file format.

Cost management under Stages 0 and 1 is largely traditional. However, as project teams progress towards the 'Holy Grail' more data will be at the disposal of the cost manager, implying more precision in assessments of cost. The full transparency and certainty that BIM provides on proposed developments implies more accurate quantities and elimination of risk, which in theory means that contractors would not have to price an extra margin for 'unknown unknowns' (Knutt, 2011). Ray Crotty in the April 2012 edition of *Construction Manager* also offers further insight on the impacts of Stage 3 BIM adoption. He refers to how perfect, complete, trustworthy and computable tender documents will result, which will drive efficiency in construction where bidders are compelled to compete on the basis of their ability to do construction work, not on their (mis)interpretation of incomplete documentation. In this environment every line item can be directly linked with a component in the model and priced explicitly, and every price can then be compared automatically and challenged as appropriate with no claims opportunities. Crotty suggests that this is what will drive Design for Manufacture and Assembly (DFMA).

Clients' requirements are also likely to be more long term in nature, with greater emphasis on maintenance, upkeep and refurbishment planning (Knutt, 2011), all of which implies that whole-life value is likely to become a prime concern of cost management practice.

Some of the issues arising in this quest to be 'BIM-enabled' that will be of interest to the quantity surveyor/cost manager include the implications for professional indemnity insurance, project insurance, contracts, plans of work, information overload, challenges of cultural change, roles of data managers, and tendering and prequalification procedures. Some pilot projects and research initiatives are currently being implemented from which lessons are to be extracted with regard to key performance indicators, contracts, cost management and cultural changes required. However, significant progress has already been made in respect of some of these issues. For instance the Construction Industry Council (CIC) has developed a unified plan of work that is BIM compliant with data drops specified (indeed, the new RIBA plan of work also has a BIM overlay). What is also clear is that the need to adopt BIM and to ensure its effective deployment will mean moving away from traditional contracting that reinforces silo mentality, towards wider use of collaborative contracting strategies involving frameworks, target cost contracting and gain/pain share mechanisms which are supportive of a BIM environment (Knutt, 2011). Publicly Available Standard (PAS) 1192-2:2012, which documents the delivery of BIM-enabled design and construction information, is also being introduced.

Significantly BIM capability will be a feature of prequalification questionnaires, implying that the quantity surveyor will need to know how to differentiate between different levels of BIM maturity/capability and match these to the project needs.

These are some of the key challenges that will confront the quantity surveyor.

2.14 *Infrastructure in the New Era*, Constructing Excellence and Pinsent Masons LLP (2011)

In 2011 Constructing Excellence ratified a 'seamless team approach' and confirmed three overriding principles for project success: (1) common vision and leadership; (2) collaborative culture and behaviours; and (3) collaborative processes and tools. Six critical success factors were also identified: (1) early contractor involvement; (2) selection by value; (3) aligned commercial arrangements; (4) common processes and tools; (5) performance measurement; and (6) long-term relationships. The findings of the report are shown in Figure 2.2.

2.15 Reflections

Many reports have been and will continue to be published on the construction industry. Indeed, as at the time of writing, a new report had been commissioned in the UK by an All Party Parliamentary Group for Excellence in the Built Environment on the performance of public sector clients in construction procurement, calling for a desperately needed 'revolution'. All these reports have made a substantial contribution to the construction best practice body of knowledge; they have identified the following key issues in order to improve the project management process:

- leadership and commitment from the client's senior representative;
- involvement of the key stakeholders throughout the project;
- roles and responsibilities clearly understood by everyone involved in the project, with clear communication lines;

Definition	'Working together in a seamless team to common objectives that deliver benefit for all through mutually beneficial (i.e., including commercial) alignment'

↓

Three overriding principles	Common vision and leadership	Collaborative cultures and behaviours	Collaborative processes and tools
	An absolute focus on the end purpose based on a clear understanding by all participants of what represents value for the client and end users. Leadership needs to establish this common vision and then constantly relate progress by the project to this vision to reinforce the team's goal.	Collaborative behaviours include teamwork and joint problem-solving. Participants demonstrate values such as trust, fairness, openness, no-blame, honesty and transparency.	Adopting the processes and tools which support the development of the collaborative culture and deliver benefits, such as information collaboration platforms, open book costing, lean and waste elimination, and project bank accounts.

↓

Six critical success factors	Early involvement	From the start, engage with all those who have a value contribution to make, including specialist contractors, manufacturers, commissioning consultants, facilities managers, etc. and pay for their input. Ensure no party has to implement decisions which they have had no part in discussing and developing.
	Selection by value	Select on quality, especially of the potential relationships, wholelife costs and benefits. Avoid historic ('traditional') procurement routes such as design-bid-build with lowest price tendering focused on upfront capital reduction. Appoint the best not 'cheapest' and focus on out-turn cost and whole-life legacy value.
	Aligned commercial arrangements	Adopt commercial arrangements that underpin all the above principles: collaborative forms of contract (NEC, PPC, JCT CE), risk management and risk sharing, incentivization such as open book cost management, target cost with gain share, fair/prompt payment mechanisms (e.g. single project bank accounts), project insurances. Avoid historic risk dumping forms of contract, exploiting suppliers on price, or late payments.
	Common processes and tools	Avoid duplication of roles and effort through e.g., co-location, extranets, Building Information Models and management. Implement value management and other lean techniques to eliminate all waste. Pay on milestones, not monthly valuations, which are a wasteful process.
	Performance measurement	Adopt client-focused Key Performance Indicators. Measure and review throughout the project to indicate progress towards success and use a yardstick for continuous improvement activity. Include measures and reviews of behaviours as well as hard processes.
	Long-term relationships	Look for benefits of teams who have learned to work together efficiently by using standard supply chains, frameworks and similar tools rather than tendering every package every time. Minimize waste by working with people who have developed a culture of trust and inclusivity while understanding the need to continually question, challenge and improve.

Figure 2.2 Collaborative working principles, *Constructing Excellence*, June 2011

Source: reported in Infrastructure in the New Era, 2011

- an integrated project team consisting of client, designers, constructors and specialist suppliers, with input from facilities managers/operators;
- an integrated procurement process in which design, construction, operation and maintenance are considered as a whole;
- design that takes account of functionality, appropriate build quality and impact on the environment;
- commitment to excellence in health and safety performance;

- risk and value management that involves the entire project team, actively managed throughout the project;
- award of contract on the basis of best value for money over the whole life of the facility, not lowest tender price;
- commitment to continuous improvement; and
- commitment to best practice in sustainability.

These factors challenge the industry to produce projects which achieve *best value*, with a need to understand the balance between quality and whole-life cost. The corollary to this is that cost management must also evolve to respond effectively to this challenge. Some of the emerging issues are considered in the chapters that follow.

2.16 Questions

Question 1

Identify the purpose of a contract.

Question 2

How do the contracts used within your organization score against Sir Michael Latham's recommendations for a modern effective contract? Consider employer/contractor and contractor/subcontractor.

Question 3

An international contractor wins a £50 million project for construction of a fast-track high rise city centre tower block from a major financial institution with whom they've worked many times before. The relationship between the constructor and employer is soundly based. The contract is contained in 120 words on one page, including just the name of the client and contractor, their addresses, the project name and location, the design documents, the start and completion dates, contract sum and the payment schedule.

The client introduces changes and acceleration instructions throughout. The final cost of the project to the contractor is £60 million. The contractor argues that the contract should be valued on a cost reimbursement basis. The client's retort is that the £50 million quoted was on a guaranteed maximum price basis.

After 3 years of bitter negotiating the parties have still not settled and agree to go to arbitration. The lawyer's fees for each side are £5 million and rising!

Is this scenario possible? And how should it be resolved? You decide.

Question 4

Critically compare and contrast the OGC Gateway Process with the RIBA Plan of Work.

OGC framework for construction procurement: http://webarchive.nationalarchives.gov.uk/20110601212617; www.ogc.gov.uk/documents/CP0063AEGuide3.pdf, pp. 6–7 – accessed 20 December 2012.

RIBA Plan of Work: www.architecture.com/Files/RIBAProfessionalServices/Practice/FrontlineLetters/RIBAPlanofWork2013ConsultationDocument.pdf – accessed 20 December 2012.

Question 5

Identify the changes to practices and procedures which have been made within your own organization (either employer, main contractor, specialist contractor or consultant) in the past decade.

Question 6

The document, WG1 *Briefing the team*, contains a checklist for construction productivity (see section 2.6). With the benefit of hindsight see if you can think of any other relevant items which are not included in the WG1 report.

Question 7

Critically review the lessons that the construction industry can learn from other sectors (contained within *Rethinking Construction*).

Question 8

Review one of the five Movement for Innovation (M4i) demonstration projects included in *Modernising Construction* (Appendices 9 to 13) and make a 10-minute presentation to your peers on the key recommendations.

Question 9

Critically review and identify the key lessons learnt in one of the ten case studies in the National Audit Office Report, Case Studies: *Improving Public Services through Better Construction*, 2005 and make a 10-minute presentation to your cohort – see www.procure21plus.nhs.uk/resources/downloads/071015%20-%20Milton%20Keynes%20Walk-in%20Centre%20-%20JC.pdf – cited 23 September 2012.

2.17 References/further reading

Achieving Excellence in Construction (2003) Procurement Guides 01 to 11, Office of Government Commerce.

Bennett, J. and Baird, A. (2001) *NEC and Partnering: The guide to building winning teams*, Thomas Telford.

Bew, M. (2011) 'Preparing for BIM bang', Construction Manager, March, p. 12.

Cabinet Office (2009) 'Never waste a good crisis': A review of progress since Rethinking Construction and thoughts for our future, Constructing Excellence: www.constructingexcellence.org.uk/news/article.jsp?id=10886 and www.cabinetoffice.gov.uk – accessed 20 October 2012.

Collaborative working principles (2011), *Infrastructure in the New Era, Constructing Excellence and Pinsent Masons LLP*: www.pinsentmasons.com/pdf/InfrastructureInNewEra.pdf.

Construction Industry Board (1996/97) *Construction Industry Board Reports*, Thomas Telford.

Construction Manager (2012) 'BIM briefing', *Construction Manager*, April, pp. 16–21.

Dixon, M. (Ed.) (2000) *Project Management Body of Knowledge*, 4th edition, Association for Project Management.

Efficiency Unit Cabinet Office (1995) *The Levene Scrutiny*, HMSO.

Egan, J. (1998) *Rethinking Construction: The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction*, London, Department of the Environment Transport and Regions Construction Task Force: www.constructingexcellence.org.uk/news/article.jsp?id=10886.

Knutt, E. (2011) 'Building BIM', *Construction Manager*, March, pp. 14–18.

Latham, M. (1994) *Constructing the Team: Final report of the government/industry review of procurement and contractual arrangements in the UK construction industry*, HMSO.

Lord, W. (2008) *Embracing a Modern Contract – Progression since Latham?*, *RICS Construction and Building Research Conference*, COBRA 2008, Dublin Institute of Technology, 4–5 September.

National Audit Office (NAO) (2001) *Modernising Construction*, Report by the Comptroller and Auditor General, HC 87 Session 2000–2001: 11 January, London, The Stationery Office.

National Audit Office (NAO) (2005) *Improving Public Services through Better Construction*, The Stationery Office.

Strategic Forum for Construction (2002) *Accelerating Change: A report by the Strategic Forum for Construction*, chaired by Sir John Egan, Rethinking Construction c/o Construction Industry Council.

UK Government Web Archive: http://213.251.150.223/tna/20110822131357; www.ogc.gov.uk/case_studies_all_construction_case_studies.asp – accessed 26 August 2012.

Websites

www.bimtaskgroup.org – accessed 20 December 2012.

www.cabinetoffice.gov.uk (Government Construction Strategy):

http://213.251.150.223/tna/20110822131357. www.ogc.gov.uk/case_studies_all_construction_case_studies.asp – accessed 26 August 2012.

www.ccinw.com/kpizone/Home/index.php – accessed 22 November 2012.

www.clientsuccess.org.uk (Construction Clients Group).

www.constructingexcellence.org.uk (identifies and disseminates best practice).

www.kpizone.com – accessed 28 February 2012.

www.nao.gov.uk (National Audit Office).

3 Selecting the consultants and contractors

3.1 Introduction

The client is the key member of any team engaged in a construction project and will need to establish means of acting efficiently within the team to ensure the success of the project. Responsibilities of the client are both legal and contractual and include:

- appointment of consultants and contractor(s);
- health and safety under the CDM regulations;
- defining and specifying the outcomes required from the project;
- making appropriate decisions and giving approvals within a set timescale;
- providing payment to contracted parties for services provided.

The client may also wish to consider at the outset of the project how many of the client's responsibilities they may wish to delegate to the consultant/construction team, e.g. through the appointment of a client's representative, the delegation of design or cost decisions or the entire transfer to others by means of a financing agreement to construct and manage the project.

> It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money – that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do.
>
> The common law of business balance prohibits paying a little and getting a lot – it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that, you will have enough to pay for something better.
>
> John Ruskin, 1860

It is now a UK Government requirement that all public sector procurement should be on the basis of value for money (VFM) and not lowest price alone; this philosophy applies to the selection of both consultants and contractors.

The recommendations require that robust mechanisms should be developed to evaluate the quality and price, including whole-life costs, in a fair and transparent manner. Selection procedures are also required to comply with the EU procurement rules where these are applicable.

There are three separate stages in the appointment process of consultants and contractors:

Stage 1 – the initial stage

During the initial stage it is necessary to identify what the consultant or contractor should do under the contract, consider the selection options – including open, selective or negotiated, identify specific health and safety requirements, develop the contract requirements and, in the public sector, consider the EU Procurement Directives.

Stage 2 –the selection process

The second stage involves setting the selection and award criteria, inviting expressions of interest, developing a longlist and reducing to a shortlist. In the public sector this will involve advertising in the *Official Journal of the European Union* (OJEU) – formerly known as the OJEC. On major projects this will normally involve the compilation of a pre-qualification questionnaire.

The selection process will involve the following stages:

- establishing the selection criteria;
- developing the weightings for the selection criteria;
- identifying, where appropriate, the thresholds for the selection criteria;
- establishing the selection mechanism;
- inviting expressions of interest/drawing up a longlist;
- drawing up the shortlist.

Stage 3 – the award process

The third stage involves interviewing and inviting tenders, evaluating tenders, negotiating and awarding the contract and finally debriefing all tenderers.

3.2 Selecting consultants

Consultants and client advisers provide the foundation on which a successful project is constructed. Depending on the client's in-house resource, selected consultants could provide the following functions:

- design services (a single organization could be responsible for all design duties, with other designers appointed as subcontractors; alternatively different organizations could be appointed for each of the key disciplines, with the project manager responsible for managing and controlling them);
- project management (including cost management);
- value management, risk management, partnering facilitator, facilities management (may be included in project management).

The consultant's brief should describe the services that the consultant is required to carry out precisely. These are dictated by the strategy adopted and whether the services are to be provided individually or in combination.

The project sponsor must also ensure that any authority delegated to the project manager is carefully defined particularly in connection with:

- ordering variations and making changes;
- certifying interim payments;
- granting extensions of time;

- settling claims; and
- agreeing final accounts.

Developing the model for selecting consultants

Establishing VFM has as much to do with the quality of goods and services as with their price. But there must be a sound basis for evaluation and judgment.

Sir Michael Latham in his 1994 report *Constructing the Team* stated that, 'professional consultants should be selected on a basis which properly recognizes quality as well as price.' Working Group 4 of the Construction Industry Board was established to choose and endorse a quality price assessment mechanism for appointing professionals – including architects, engineers, surveyors and project managers.

The principal features of the quality/price mechanism recommended in this report are summarized as follows:

1 The quality/price mechanism should be established by a formally constituted and fully accountable tender board before tenders are invited, and all tender documentation should be designed to ensure that appropriate responses are received to which the mechanism can be applied.
2 A quality/price ratio must be agreed at the outset, representing the percentage weightings to be given to quality and price. The more complex the project, and the greater the degree of innovation and flexibility likely to be required from the consultants, the higher the ratio should be. Indicative ratios suggested for various types of projects are:

Type of project	*Indicative quality/price ratio*
Feasibility studies and investigations	85/15
Innovative projects	80/20
Complex projects	70/30
Straightforward projects	50/50
Repeat projects	20/80

3 Quality criteria should be grouped under four main headings and weighted. Recommended headings and suggested weightings are:

Quality criteria	*Suggested weighting range*
Practice or company	20–30%
Project organization	15–25%
Key project personnel	30–40%
Project execution	20–30%

4 A quality threshold needs to be established (e.g. 65 out of 100). Tenders must achieve this minimum quality score before final interviews are held and prices considered.
5 Submitted tenders are assessed for quality by marking each of the four quality criteria out of 100, multiplying each mark by the respective weighting percentage and then adding them together to give a total score out of 100.
6 Consultants passing the quality threshold (ideally only two to three) are then interviewed, their quality scores are reviewed and their prices examined and marked. The lowest compliant bid scores 100 and others score 100 minus the percentage figure by which their bids exceed the lowest price (e.g. a bid 25 per cent above the lowest bid scores 75).

Suggested weighting ranges for project-specific quality criteria are illustrated in Table 3.1.

Table 3.1 Project-specific criteria

Generic quality criterion (marked out of 100)	*Key aspects*	*Suggested weighting range*
Practice or company	Organization Financial status Professional indemnity insurance Quality assurance or equivalent system Commitment and enthusiasm Workload and resources Management systems Relevant experience Ability to innovate References	20–30%
Project organization	Organization of project team Authority levels of team members Logistics related to site, client and other consultants Planning and programming expertise	15–25%
Key project personnel	Qualifications and experience relevant to project Understanding of project brief Flair, commitment and enthusiasm Compatibility with client and other team members Communication skills References	30–40%
Project execution	Programme, method and approach Management and control procedures Resources to be applied to the project Environmental, health and safety matters	20–30%

The final quality/price assessment is achieved by multiplying the quality and price scores by the respective weightings set by the quality/price ratio and adding them together to give a total score out of 100 (e.g. if the quality/price ratio is set at 70/30, the quality score is 80 and the price score is 75, the total score is 80 x 70 per cent + 75 x 30 per cent = 78.5). The highest scoring consultant should be awarded the contract. An example of a tender assessment sheet is shown in Table 3.2.

The Construction Industry Council (a body representing all the professions) has developed a tool called *Selecting the Team* to help clients create a team able to work together successfully. It offers practical advice on how to put together a selection panel, develop a questionnaire, set the criteria for a shortlist and then evaluate the shortlisted candidates. This publication complements two other CIC partnering publications – *A Guide to Partnering Workshops* and *A Guide to Project Team Partnering*.

Basis of payment to consultants

There are three principal ways of paying for professional services (sometimes used in combination):

1 time charge
2 lump sum and
3 ad valorem – according to value

Table 3.2 Example of completed tender assessment sheet

Tender assessment sheet

Project: Halls of residence, University of Metropolis
Tenderer: bmg (Architectural services)
Assessor: Keith Potts

Project quality weighting: 65%
Project price weighting: 35%
Quality threshold: 65 (to be compared with total quality mark)

Quality threshold	*Project weighting (A)*	*Marks awarded (B, out of 100)*	*Weighted marks (AxB)*
Practice or company	25%	64	16
Project organization	15%	80	12
Key project personnel	40%	65	26
Project execution	20%	75	15
	100%	Total quality score	69
Price criteria			
Tender price	260		
Price score	100	100	100

Overall assessment

Quality weighting x quality score	= 65% x 69 = 44.9
Price weighting x price score	= 35% x 100 = 35.0
	Overall score = 79.9

Signed:
Date:

The fee structure to be adopted will depend on the degree of certainty in the scope and content of the services required. When the scope and content of the services are uncertain, for example during the appraisal of options, then reimbursement on a time basis is appropriate. However time charges provide no surety of the eventual fee cost. They tend to be an expensive way of paying for longer-term services and are more appropriate for shorter-term commissions.

Lump sum charges should only be used where the scope of all the services is defined precisely and there is little risk of significant variations in the scope of the works. A combination of lump sum charges for the more certain elements of the work and time charges for those less certain, may offer best VFM.

Ad valorem fee structures reimburse consultants in proportion (generally as a percentage) to the cost of the project.

From the client's viewpoint these may appear at times to provide an incentive for consultants to design expensive projects rather than those offering value for money. It may therefore be appropriate to introduce some form of abatement or capping mechanism to the fee structure, in order to underline the necessity of striving to contain certain costs while maintaining quality. However, great care should be taken when developing such a model in order not to penalize those who are not responsible for changes or who have carried out abortive work or had to provide additional services as a result of the changes caused by other parties.

If the consultants' fees are calculated based on the final construction cost during times of high inflation there may be an overpayment, known as an *uncovenanted gain*, as the majority of consultants' work is usually carried out during the early stages of the project.

Panel 3.1 Case study: Scottish Parliament building

On the Scottish Parliament building each consultant's fee remuneration was wholly or mainly a percentage value of the approved construction cost of the project.

In the 2004 *Audit Report* on the Scottish Parliament building the Auditor General for Scotland identified that, before they appointed consultants, the client's project management could have explored more carefully alternative fee arrangements with its consultants, including final incentives linked to delivering value for money. 'Percentage fees do not align the objectives of the client with the commercial objectives of the consulting firms because the more a project costs the more each consultant is paid'.

In the event a fee cap was agreed with cost consultants and the services engineer 12 months before completion. The final fees with the architect had not been finalized three months before completion, whilst the final payment to the construction manager was uncertain due to the qualified nature of the agreed cap with them.

Source: Audit General for Scotland, 2004

3.3 Selecting contractors by value

The principal aim of the selection process is to select a contractor who offers value for money. This will nearly always involve a process of competitive tendering. 'Value for money for a particular project means optimizing the balance between best performance or quality of service and lowest price' (OGC Successful Delivery Toolkit, 2005).

A very useful approach to tender evaluation is to use a quality/price mechanism which is based on a numerical scoring and weighting system. The advantages of this approach include:

- It formalizes what can be a very subjective process.
- It requires forethought as to what are the most important criteria for selection.
- It can be transparent.
- It can be audited.

Traditionally there have been three types of appointment procedure:

1 Open tendering: all interested parties can submit tenders in response to an advertisement in a local or national newspaper or the *Official Journal to the European Union* (OJEU) notice. Normally a small deposit is required, which is refundable on submission of a bona fide tender.

   The open tendering approach is an inefficient use of the industry's resource. It can lead to an excessive number of tenders, with the lowest tender being a highly risky choice; it is not recommended.

2 Selective, or restrictive, tendering: allows the number of organizations to be restricted by using a selection process in advance of tender invitation. Under this approach client bodies who are regular users of the industry can keep standing lists, which should be reviewed annually, for different values and types of work.

   For major one-off projects, contractors can be selected for tender using a pre-qualification questionnaire.

3 Negotiated tendering: available in two forms:

   a. Competitive – enables clients to negotiate the terms with selected bidders and may include a formal tender stage prior to negotiation.

b. Without a call for competition – used in only the most exceptional circumstances, e.g. emergency storm damage repair.

The selection process

The selection process produces a shortlist of the most suitable organizations from those that expressed an interest in carrying out the project. The selection process must be objective, fair, accountable and transparent, with the criteria for selection established before inviting expressions of interest.

The selection process consists of the following steps:

- identify the selection criteria;
- establish the weighting;
- identify the minimum thresholds for selection criteria, where appropriate;
- construct the selection mechanism;
- invite expressions of interest;
- draw up a longlist;
- draw up the shortlist.

The selection criteria for contractors should be based on attributes that fall under the following headings:

1 *The contractor's personal and financial standing*
Whether the contractor is financially stable and/or has the backing of a large group. Such assessment normally includes examination of accounts, annual reports (if a public company) or a confidential report from the company's bank.
Under this heading a company would not be suitable for selection on the following grounds: bankruptcy, failure to pay taxes, serious misrepresentation, grave misconduct or conviction of a criminal offence.

2 *Technical and organizational ability*
Whether the contractor has sufficient experience in the particular type and magnitude of works and has a satisfactory performance reputation in such areas as: available resources; design expertise; experience of partnering; supply chain management in force with subcontractors and suppliers; policy on risk management, e.g. terms of subcontracts, history of rejected claims, skill/qualifications profile of workforce (own and key subcontractors), quality management; health and safety record.

Considerable care and effort will be required to set appropriate selection criteria for individual projects in order to make sure that only suitable contractors are selected.

Table 3.3 shows an example of a selection mechanism and demonstrates how the selection criteria and the weightings applied to them are used to evaluate each organization.

The award process

The award process looks *forward* at the proposals for the specific contract, whereas the selection process looks *back* at the status and previous performance of the bidders. The award criteria must be identified before inviting tenders and must be confirmed in the *instructions to tenderers*.

Table 3.3 Example of selection mechanism for contractors

Project Title: Baywatch Holiday Village
Assessors:
Overall quality threshold: 50

Mightybuild Construction plc

FINANCIAL STANDING

Selection criteria	*Quality Threshold (QT)*	*QT Reached?*
Bankruptcy, convictions, misconduct, etc.	Clean record	YES
Profit and loss for last 3 years		YES
Public liability insurance		YES
Professional indemnity insurance (where applicable)		YES

TECHNICAL AND ORGANIZATIONAL

Selection Criteria	*Criteria weighting (a)*	*Score awarded (b)*	*Weighted score (a x b)*
Relevant technical experience	20	80	16.0
Resources relevant to the project	10	70	7.0
Relevant design experience	15	60	9.0
Past performance on teamwork/partnering	15	30	4.5
Past performance on risk/value management	10	50	5.0
Rejected claims history	10	10	1.0
Health and safety record	10	70	7.0
Quality assurance	10	60	6.0
TOTAL	100		55.5

The award process is separate and distinct from the selection process. The award must be made on a *VFM basis* (value for money, i.e. the most economically advantageous to the client) and not on lowest cost alone.

The award process comprises the following activities:

- confirm candidates;
- establish award criteria; weightings for award criteria; quality/price ratio; award mechanism; price scoring;
- evaluate quality element;
- prepare instructions to tenderers;
- invite tenders;
- evaluate *price* element;
- balance quality and price;
- notify award and debriefing.

Table 3.3 shows that Mightybuild Construction passed the initial financial standing and quality test with a score of 55.5 (above the minimum threshold of 50) – they can therefore can be considered for selection. However, it should be noted that, whilst they have a good technical and design record overall, their performance on partnering and claims is not good. In fact Mightybuild are currently involved in adjudication/litigation on 25 per cent of their existing projects; potential problems may lie ahead for the client if Mightybuild are selected!

Evaluating quality

The quality evaluation of each shortlisted firm will normally be based on a pre-tender interview, which is often preceded by the completion of a pre-interview questionnaire. The quality scores should be established before the price bids are opened. Mightybuild usually score well at such interviews; indeed, their competitors have observed that Mightybuild have a policy of sending the ‘A’ team to interviews and the ’Z’ team to carry out the project!

Topics likely to be considered within *quality* include:

- *team working arrangements*: partnering with client and subcontractors;
- *aesthetic and functional characteristics*: design, operating costs, ease of use, adaptability, innovation, maintainability;
- *proposals for managing the contract*: planning, programming, management, milestones for achieving objectives, risk identification and proposals for management, communication, quality plan;
- *project team organization*: qualifications and experience of team members, senior managers, partners, quality of senior personnel, resources;
- *technical merit*: proposed methods, approach to CDM Regulations, health and safety management, the design and construction stages, quality of documentation, standards of materials, checks and inspections;
- *services provided from external sources*: details of joint venture proposal, arrangements for subcontracting, training amongst workforce in the supply chain.

Table 3.4 indicates typical quality/price ratios for different types of project.

Evaluating the price

There are various methods of evaluating a contractor’s tender price; one method requires the following approach:

- The *mean* price of the acceptable tenders is given 50 points.
- One point is deducted from the score of each tenderer for each percentage point above the mean.
- One point is added to the score of each tenderer for each percentage point below the mean.

Unjustifiably low tenders should be rejected and not included in the assessment.

So, in the example shown in Table 3.5, the mean price is £7,717,000:

Alpha	50.00 + 6.05	= 56.05
Mightybuild	50.00 – 8.20	= 41.80
Zed Construct	50.00 + 2.16	= 52.16

Table 3.4 Typical quality/price ratios for different types of projects

Type of project	*Indicative quality/price ratio*
Innovative projects	20/80 to 40/60
Complex projects	15/85 to 35/65
Straightforward projects	10/90 to 25/75
Repeat projects	5/95 to 10/90

Table 3.5 Award mechanism

Project title: Baywatch Holiday Village
Quality/price weighting: 60:40
Assessors:

QUALITY SCORES

Quality criteria	*Criteria weight %*	*Alpha Construction*		*Mightybuild Construction*		*Zed Construct*	
		Score	*Wtd score*	*Score*	*Wtd score*	*Score*	*Wtd score*
Proposals for and understanding of project	30	60	18.00	80	24.00	70	21.00
Experience and resources of proposed project team	20	55	11.00	90	18.00	50	10.00
Project management/ team-working skills	10	70	7.00	60	6.00	50	5.00
Risk management skills and experience	10	55	5.50	70	7.00	60	6.00
Aesthetic character of proposals	15	70	10.50	70	10.50	80	12.00
Maintainability	15	50	7.50	60	9.00	70	10.50
TOTAL QUALITY			**59.50**		**74.50**		**64.50**

PRICE SCORES

	Alpha	*Mightybuild*	*Zed Construct*
Tender Price	£7,250,000	£8,350,000	£7,550,000
TOTAL PRICE (mean £7,717,000)	**56.05**	**41.80**	**52.16**

OVERALL SCORES

	Alpha	*Mightybuild*	*Zed Construct*
Quality weighting x quality score	60% x 59.50 = 35.70	60% x 74.50 = 44.70	60% x 64.50 = 38.70
Price weighting x price score	40% x 56.05 = 22.42	40% x 41.80 = 16.72	40% x 52.16 = 20.86
Overall score	58.12	61.42	59.56
Order of tenders	3	1	2

Comments: after multiplying the *quality* scores by 60 per cent and the *price* scores by 40 per cent the award mechanism shows that the contract should be awarded to Mightybuild (Table 3.5). However, in compiling the table the author identified two major areas of difficulty in developing the quality part of the model, particularly:

1 identifying the key criteria and the relevant weighting; and
2 identifying a realistic and objective score against the criteria for each contractor.

3.4 CIRIA guide, *Selecting Contractors by Value*

In 1998 the Construction Industry Research and Information Association (CIRIA) produced the definitive guide, *Selecting Contractors by Value* (Jackson-Robbins, 1998). The guide provides an overview of the key processes in selecting contractors by value.

The CIRIA guide identified the following key issues to be considered in the selection of contractors:

1 Defining value – what represents value to the client?
2 Identifying opportunities for contractors to add value – where can contractors add value to the project?
3 Developing the procurement strategy to secure value – when and how can contractors be involved?
4 Defining the selection criteria – how can potential contractors be judged?
5 Obtaining information – how can a full picture be obtained of potential contractors?
6 Making the choice – how can a balanced and accountable selection be made?

The CIRIA guide includes a toolbox comprising 12 matrices which are intended to help clients and their advisers compare the ability of potential contractors to add value to a project:

Matrix 1: technical knowledge and skill
Matrices 2–8: skill and commitment in managing: time, cost, quality, risk, health and safety, environmental issues
Matrix 9: effectiveness of contractor’s internal organization
Matrix 10: contractor’s attitude and culture
Matrix 11: quality of human resources proposed
Matrix 12: quality of supply chain management.

Each matrix contains up to six indicators against which there are definitions allowing the scorer to judge the contractor to be *poor*, *adequate*, *good or excellent*. Table 3.6 provides an example.

The total scores can be calculated against each matrix to arrive at a total weighted score in a similar way as in Table 3.2. The CIRIA toolbox removes some of the subjectivity involved in the process by giving definitions against each attribute, thus making the process more transparent and auditable.

Significantly, the author of the CIRIA guide admits that the final scores of even the most sophisticated matrix should only be used as an aid to making a judgement. The guide advises that the selection should critically assess the numerical results and if necessary test them, for example by carrying out a sensitivity analysis. Would you recommend Mightybuild?

Table 3.6 Matrix 11: Human resources – indicator 4

Company employment policy	*Regular use of agency staff*	*Staff regularly employed, with reasonable lengths of service*	*Company training policy, including staff appraisals/ development programme*	*‘Investors in People’ award, loyal and enthusiastic employees*
Overall assessment	Poor (-1)	Adequate (0)	Good (1)	Excellent (2)

Source: CIRIA, 1998

Panel 3.2 Case study: Stoke-on-Trent Cultural Quarter

The appointment of an appropriate management contractor was a key decision for this project. The Council made use of a methodology, Most Economically Advantageous Tender (MEAT) that was starting to be used in the public sector.

The MEAT methodology scores each bid against a range of qualitative and quantitative factors. The Council Officers decided that quality would account for 60% of evaluation, which would be assessed at interview and included previous management contracting experience and experience of working on theatres and concert halls. Cost would count for 40%, the calculation being based on the extent to which the bids were above or below the average cost of all the bids.

The Council invited five potential contractors to attend interviews and submit tenders – one contractor was deleted.

	Norwest Holst	*Tilbury Douglas*	*Bovis*	*Sunley Turriff*
Interview	344	380	470	362
Tender	300	225	113	163
Total	644	605	583	525
Fee	£1,264,188	£1,398,973	£1,602,924	£1,510,938

Norwest Holst secured the highest number of points: 644. However, they were ranked last in relation to quality assessment. The procurement route was non-traditional with a high degree of risk; therefore the contractor's experience of management contracting was essential. Bovis had the most experience of both management contracting and refurbishment of theatres. Norwest Holst had the least relevant experience – yet were selected.

The project cost the Council £15m more than the original budget of £22m, yielding a total spend of £37m.

Source: Audit Commission: District Auditor's Report, Cultural Quarter Stoke-on-Trent City Council, 22 January 2004. For a fuller description on this case study see Chapter 10.

The Stoke Cultural Quarter case study indicates the care which must be taken in the initial selection of contractors.

In November 2005, ICC Credit, one of the UK's leading credit reference agencies, reported that Sunley Turriff Construction Limited, based in Manchester, had gone into liquidation. The company was established in 1993. Over the 12-year period, the company went through a number of ups and downs. In 1998 the company achieved its highest turnover of £95 million. However, its profit record failed to perform as well. Over the last 7 years the company was not profitable and, in 1995, the profit slumped to a negative figure of £4.5 million and remained in the red for the rest of the company's existence (ICC Credit).

Using the selection methodology described on the Baywatch Holiday Village example Sunley Turriff would not have passed the Financial Standing section within the Quality Threshold and so would not have been included in the shortlist.

3.5 Single-stage tendering

Under the traditional approach the complete design should be undertaken by the employer's architect/engineer and a full bill of quantities prepared. These are sent, together with the drawings and specifications, to a shortlist of contractors who could be selected from the Authority's standing lists of pre-qualified contractors. The contractor with the lowest bid is normally awarded the contract.

In the 1980s and 1990s the National Joint Consultative Committee (NJCC) produced several useful procedural guides, including *Codes of Procedure for Single-Stage Selective Tendering*, *Two-Stage Tendering*, *Design & Build* and *Management Contracting*. The NJCC was disbanded in 1996 and was replaced by the Construction Industry Board (CIB) who produced a useful *Code of Practice for the Selection of Main Contractors* (CIB, 1997).

Simon Rawlinson of Davis Langdon (Rawlinson, 2008) identifies that many clients are looking to maximize the element of competition in the economic downturn by considering the single-stage strategy. However, he critically points out that the firm price is only as good as the design information upon which it based. Rawlinson (2008) further expands on the advantages and disadvantages of single-stage tendering and identifies steps that can be taken to improve the contractor's submission. Additionally he includes a brief description of two complex design and build case studies on which the single-stage tender approach was used.

David Mosey of Trowers & Hamlins later produces a strong rebuttal of the single-stage approach (Mosey, 2008), claiming that this method produces a fragmented project team, with the contractor appointed too late to influence design, programme or risk strategy and braced to claim compensation to make up for errors in its estimates. 'Properly structured two-stage tendering, using an early conditional contractor appointment, is the best means for clients to control projects and obtain added value from their contractors' (Mosey, 2008).

In December 2006, Sir Liam McCollum in the Northern Ireland High Court ruled in the *J&A Developments Ltd v Edina Manufacturing Ltd and Armoura Ltd and John Francis McBride, Peter Anthony Dolan, Gerald Coyle and Barry Gallagher T/A APD Architects and Design Partnership Third Parties* NIQB 85 (11 December 2006) case that, once incorporated in the tender documentation, the principles of the NJCC *Code of Procedure for Single-Stage Selective Tendering* became contractually binding, even though the code is, on the face of it, merely advisory in character.

The case concerned a builder (J&A Developments Ltd) who submitted the lowest tender to the client (Edina Ltd and Armoura Ltd) and refused to reduce their price to within the client's budget. The client renegotiated with the second and third lowest tender and awarded the contract to one of them. J&A claimed for a loss of profit. Sir Liam agreed that under the circumstances the NJCC Code did have binding effect and that J&A were entitled to their loss of profit, quantified at £128,000 (Chartered Institute of Loss Adjusters).

Postcript: The co-author (Keith Potts) is grateful to Chris Ritchie of Kennedys Law, Belfast for highlighting this case.

3.6 Two-stage tendering

Two-stage tendering is a procedure typically used to secure the early appointment of a contractor on the basis of an agreement to undertake pre-construction services, the intention being that the parties enter into a lump sum contract or cost reimbursable contract with a target price after further negotiation. The main benefits of this approach are early completion and the potential to include the contractor's buildability expertise within the design. Additionally this approach allows the client to have a greater involvement in the pre-selection and appointment of subcontractors.

The two-stage process:

1 pre-qualification: main contractor tenderers;
2 compile first stage tender: based on programme; method statement; pre-construction fee; preliminaries; percentages for overheads and profit; initial pricing of packages;
3 identification of preferred contractor: pre-contract services agreement;
4 pre-qualification: tender of subcontract packages;
5 subcontractor selection by employer and contractor (allows for novation of client-appointed specialists);
6 compile second-stage tender: first-stage contractor; agreement of subcontract terms; risk allowances;
7 agreement of second-stage lump sum tender;
8 award of main contract: commencement of works and subcontractor appointment.

The preferred contractor will, typically, provide the pre-contract services on either a cost-reimbursable basis or for a fixed fee, and essentially undertakes a consultancy role, working alongside the design professionals appointed by the employer. During the pre-construction services period the preferred contractor will tender the early and long-lead work packages and agree a programme and cost plan with the employer. It is now common practice for the tendering of works to be carried out by the contractor during this period on an open book basis (Davis and Dornan, 2008).

The second stage, which is typically managed as negotiation between employer and the preferred contractor, is based on the agreed mechanism within the pre-construction agreement for conversion into a lump sum or target cost contract and relies on competition between second-tier contractors for work packages.

Two-stage tendering should, in theory, be well suited to design and build projects. However, whilst this approach should give the client additional control over the design development and transfer of risk to the contractor, it normally comes at a premium price. For a fuller commentary on two-stage tendering see Simon Rawlinson's article in *Building* 12 May 2006.

> An economic market forecast by Davis Langdon in *Building* magazine reported that in London 'Contractors are unwilling to take unattractive procurement routes. It is difficult to attract interest in single-stage design and build projects with contractors more interested in two-stage design and build or traditional routes. Furthermore, two-stage tenders have increasingly become contractors' preferred approach for complex projects and some projects cannot be let by any other means'.
>
> (Fordham, 2007)

3.7 FIDIC tendering procedures

The FIDIC document *Tendering Procedure*, second edition (FIDIC, 1994) presents a systematic approach for tendering and awarding of contracts for international construction projects. Experience has shown that pre-qualification is desirable since it enables the employer/engineer to establish the competence of companies subsequently invited to tender.

Tendering Procedure shows the following flowchart of activities:

1.0 establishment of project strategy
2.1 preparation of pre-qualification documents
2.2 invitation to pre-qualify

2.3 issue and submission of pre-qualification documents
2.4 analysis of pre-qualification applications
2.5 selection of tenderers
2.6 notification of applicants
3.1 preparation of tender documents
3.2 issue of tender documents
3.3 visit to site by tenderers
3.4 tenderers' queries
3.5 addenda to tender documents
3.6 submission and receipt of tenders
4.1 opening of tenders
5.1 review of tenders
5.2 tenders containing deviations
5.3 adjudication of tenders
5.4 rejection of all tenders
6.0 award of contract
6.1 issue letter of acceptance
6.2 performance security
6.3 preparation of contract agreement
6.4 notification of unsuccessful tenderers.

Under Section 5.3, adjudication of tenders, *Tendering Procedure* identifies that the evaluation of tenders are generally considered to have three components:

Technical evaluation
Conformity with specification and drawings; comparison of any proposed alternatives (if allowable) with the requirements of the tender documents; design aspects for which the contractor is responsible; methods of construction and temporary works; environmental considerations; quality assurance; programme.

Panel 3.3 FIDIC Tendering Procedure

The FIDIC document *Tendering Procedure* gives guidelines on the analysis of pre-qualification applications – the evaluations should determine, for each company or joint venture:

- structure and organization;
- experience in both the type of work and the country or region in which it is to be undertaken;
- available resources, in terms of management capability, technical staff, construction and fabrication facilities, maintenance and training facilities, or other relevant factors;
- quality assurance procedures and environmental policy;
- extent to which any work would be likely to be subcontracted;
- financial stability and resources necessary to execute the project;
- general suitability, taking into account any potential language difficulties;
- litigation or arbitration history.

Source: FIDIC (1994)

Financial evaluation
Capital cost; discounted cash flow and net present value (NPV); programme of payments; financing arrangements; currencies; securities; interest rates; down payments/retentions; daywork rates; contract price adjustment proposals.

General contractual and administrative evaluation
Conformity with instructions to tenderers; completeness of tenders; validity of tenders; exclusions and deviations – stated or implied; insurance; experience of key staff; shipping, customs, transport; working hours; labour build-up, run down and source.

It is noted that the FIDIC contract highlights the importance of assessing tenders on a net present value basis. The technique is also recommended by the World Bank yet it is rarely encountered

Panel 3.4 Case study: tender assessment – international mega project based on FIDIC

The assessment of tenders was carried out in two stages. The first stage involved a coarse assessment of all tenders to identify the tenders to be considered in depth. The second stage involved a detailed appraisal and examination of the most favoured tenders together with negotiation with tenderers, as appropriate, leading to final recommendation.

The tender assessments were carried out by groups reporting to the Chairman and Executive. The activities involved included:

Finance department
Examine financial package; check front loading; bring all tenders back to net present value utilizing the Interim Payment Schedule included in the tender; arithmetical check of BofQs; check alternative offers; identify most favourable in financial terms.

Contracts/legal department
Examine the covering letter and all qualifying statements; indicate cost and time implications of qualifications.

Programming department
Check that the tenderer's programme adheres to schedules of milestones and critical dates identified in the contract documentation.

Consultants/civil engineering department
Examine alternative design offers and recommend any which warrant further consideration and advise on any planning implication; examine method statement to highlight any anomalies and areas of non-acceptance; prepare detailed cost comparison to enable cost centres and activity bills to be compared with employer's estimate.

Utilities and civil planning
Evaluate the implications of the tenderer's submission on traffic, land access and utility diversions.

At the second-stage assessment a detailed study would be undertaken and questions of clarification would be developed. Following the issue of the questions to the tenderers and receipt of the answers all outstanding matters would be clarified. The confirmation wrap-up letters would be incorporated into the contract.

in standard UK contracts. This powerful tool enables an equitable comparison to be made of all the tenderers' forecasted project cash flows on a present-day cost basis. The challenge for the client's commercial advisers is devising a tendering system that allows an NPV comparison to be made.

3.8 Conclusions

We have now examined the procedures for selection of both consultants and contractors in the UK and overseas. In the UK, as part of the VFM process demanded by the Government, there has been a shift by public sector clients to selection based not only on lowest price but also embracing *quality* issues.

Over the past decade many significant guides have been published by the Construction Industry Council and CIRIA in order to assist clients and their consultants in developing best practice. However, the Baywatch hypothetical case study and the Stoke-on-Trent Cultural Quarter case study demonstrate that, even when *quality* issues are incorporated into the selection process, major problems can still arise.

3.9 Questions

Question 1

The University of Metropolis wishes to appoint the client's project manager with full responsibility for controlling and managing the time, cost and quality on the new £25 million Learning Centre and Teaching facility.

The Executive of the University understands that the construction industry is now committed to providing best value for its clients and is keen that this philosophy is adopted by all its consultants.

Describe the pre-qualification selection process and identify the criteria for the shortlist to tender.

Question 2

Access the OJEC website (www.ojec.com) and answer the following:

1 What does OJEU mean?
2 Which projects are covered by its regulations?
3 What are the public procurement thresholds?
4 What criteria are used to evaluate tenders?
5 What process is followed?

Question 3

In June 1998 the Foreign and Commonwealth Office (FCO) signed a contract for the construction, operation and financing of a new Embassy in Berlin with a German supplier called Arteos which had been formed by a consortium comprising Bilfinger + Berger, one of the three biggest German construction companies, and Johnson Controls, a large American-based facilities management provider. The construction was completed in 2000.

Review the techniques used in the selection of Arteos on this PFI project.

Source: www.nao.org.uk/idoc.ashx?docId=922F1C63-85E2-40B9-B194-4541EEF1ECCD&version=-1 – accessed 12 September 2012.

3.10 References/further reading

Auditor General for Scotland (2004) *Management of the Holyrood Building Project*, Audit Scotland.

Chartered Institute of Loss Adjusters: www.cila.co.uk/files/tendercodes.doc – cited 17 April 2009.

CIB (1997) *Code of Practice for the Selection of Main Contractors*, Working Group 3.

CIRIA (1998) *Selecting Contractors by Value*, Construction Industry Research & Information Association.

Construction Industry Board (1996) *Selecting Consultants for the Team: Balancing quality and price*, CIB.

Construction Industry Council (1994) *Procurement of Professional Services*. *Guidelines for the value assessment of competitive tenders*, CIC.

Construction Industry Council (2002) A Guide to Project Team Partnering, CIC

Construction Industry Council (2005) *Selecting the Team*, CIC.

Construction Industry Council (2005) *A Guide to Partnering Workshops*, CIC

Davis, C. and Dornan, P. (2008) 'The rise of two-stage tendering', *The International Construction Law Review*, Pt 4, pp. 511–517.

Fordham, P. (2007) 'Economics: market forecast', *Building*, 2 February, pp. 64–65.

FIDIC (1994) *Tendering Procedure*, 2nd edition, FIDIC, Switzerland.

Holt, G.D., Olomolaiye, P.O. and Harris, F.C. (1995) 'A review of contractor selection practice in the UK construction industry', *Building and Environment*, Vol. 30, No. 4, pp. 553–561.

Holt, G.D. (1998) 'Which contractor selection methodology', *International Journal of Project Management*, Vol. 16, No. 3, pp. 153–164.

ICC Credit: www-icc-credit.co.uk – accessed January 2007.

Jackson-Robbins, A. (1998) *Selecting Contractors by Value*, Construction Industry Research and Information Association.

Mosey, D. (2008) 'It's just too sad to be single', *Building*, 12 December, p. 47.

NAO (2000) Report by the Comptroller and Auditor General: The Foreign and Commonwealth Office, *The New British Embassy in Berlin*, HC 585 Session 1999–2000, The Stationery Office, London.

NJCC (1994) *Codes of Procedure for Single Stage Selective Tendering*, National Joint Consultative Committee.

OGC (2005) Successful Delivery Toolkit, Office of Government Commerce, Available at: http://webarchive.nationalarchives.gov.uk/20100503135839/http:/www.ogc.gov.uk/documents/cp0043.pdf (cited 23 May 2013)

Rawlinson, S. (2006) 'Two-stage tendering', *Building*, 12 May, pp. 62–65.

Rawlinson, S. (2008) 'Procurement single-stage tendering', *Building*, 21 November, pp. 68–71.

4 Pre-contract cost management

4.1 Introduction

Cost management is the process that is necessary to ensure that the planned development of a design and procurement of a project is such that the price for its construction provides value for money and is within the limits anticipated by the client.

Construction is a major capital expenditure which clients do not commence until they are certain that there is a benefit. This benefit may be for society in the case of public projects, with justification based on a cost-benefit analysis, or purely based on financial considerations in the case of private projects.

Most clients are working within tight, predefined budgets, which are often part of a larger overall scheme. If the budget is exceeded or the quality not met the scheme could fail. Pre-contract estimating sets the original budget – forecasting the likely expenditure to the client. This budget should be used positively to ensure that the design stays within the scope of the original scheme.

When developing an estimate the following factors need to be considered:

- land acquisition, including legal fees;
- client's own organization costs allocated to the project (this obviously varies but can be as much as 10 per cent of the overall project budget);
- site investigation (frequently underrated and underbudgeted, resulting in unnecessary extra costs and time – this could be as much as 1 per cent of budget);
- enabling works, de-contamination;
- insurances (many major clients prefer to insure against the risks and take out a project insurance policy covering both themselves and the contractor – this may be up to 1 per cent of the budget);
- consultants' fees, including design (on large transportation and infrastructure projects this can be as much as 15 per cent to 20 per cent of the budget);
- construction costs (these typically account for between 70 per cent and 80 per cent of the project sum, excluding land);
- value added tax (currently charged at 20 per cent);
- contingency and risks (this covers for the unknown and may be between 20 per cent and 25 per cent or, if the project is of long duration, the contingency factor could be double or triple these amounts);

- financing and legal costs (financing costs can be substantial, depending on the financing method chosen and typical bank rate – these could amount to anything between 7 per cent and 20 per cent; lawyers are expensive, at anything up to £500 per hour and more).

Cost control has to be exercised before any commitment is made. To do otherwise sees cost control become a procedure of cost-monitoring only. Pre-contract financial control therefore should be a proper mix between design cost control and cost-monitoring but with the emphasis on positive cost control rather than passive monitoring. An essential tool for financial control is the cost plan.

However, in practice the difficulties of estimate production are exacerbated when the project involves major uncertainties: perhaps because no similar work has been tackled before, or because the scope of the work is poorly defined (Swinnerton, 1995). The Scottish Parliament building is a prime example, being a unique building with a poorly defined brief – initial budget of £40 million, with final cost reported at £431 million.

After investigating 258 international transportation infrastructure projects worth US$90 billion, Flyvbjerg *et al*. (2002) consider that there is overwhelming statistical evidence that the cost estimates used to decide whether such projects should be built are often misleading and are best explained by strategic misrepresentation or lies.

We conclude that the cost estimates used in public debates, media coverage, and decision-making for transportation infrastructure development are highly, systematically, and significantly deceptive. So are the cost-benefit analyses into which cost estimates are routinely fed to calculate the viability and ranking of projects. The misrepresentation of costs is likely to lead to the miscalculation of scarce resources, which in turn, will produce losers among those financing and using infrastructure be they taxpayers or private investors.

Flyvbjerg *et al*. (2003) also identify that improvements to cost estimates could be made by implementing four basic instruments of accountability: (1) increased transparency including stakeholder involvement; (2) the use of performance specifications instead of technical solutions; (3) explicit formulation of the regulatory regimes that apply to development and implementation; and (4) the involvement of private risk capital in public projects.

4.2 Cost estimating on engineering, manufacturing and process industry projects

Estimates of the cost and time are prepared and revised at many stages throughout the project cycle. These are all predictions and should not be considered 100 per cent accurate. The degree of realism and confidence achieved will depend on the level of definition of the work and the extent of the risk and uncertainty. Consequently, as the design develops, the accuracy of the estimate should improve.

The Joint Development Board's (JDB's) publication, *Industrial Engineering Projects*, demonstrates this principle of estimating accuracy clearly in connection with capital projects in engineering, manufacturing and process industries (JDB, 1997). The JDB is sponsored by the Royal Institution of Chartered Surveyors and the Association of Cost Engineers and is charged with raising the profile of project and commercial management in the engineering industry.

The JDB document identifies four main types of estimate, which could be produced by the owner or contractor, each with a different level of accuracy and each used at different stages throughout the project cycle. Each of these is discussed below.

Order of magnitude estimate

This order of magnitude or *ballpark* is produced for the rapid evaluation of commercial possibilities and economic viability of a project. Since little detail will normally be available, the estimate will normally be based on data from a similar previous project updated for time, location, changes in market conditions, current design requirements and relative capacity.

In the absence of data from a near duplicate project, the estimator will rely on published or historical data from a number of existing projects, usually related to the overall size or capacity of the project or facility concerned, adjusted as necessary. An order of magnitude estimate will typically have an accuracy of -25 per cent to +50 per cent (JDB, 1997).

Typical examples of this type of estimating include:

- cost per megawatt capacity of power stations;
- cost per kilometre of highway;
- cost per tonne of product output for process plants;
- cost per car park space (multi-storey car park), pupil (school), beds (hospital), etc.

The key issue to consider when using this approach is comparing like with like. Are the standards the same in the previous projects; does the price include infrastructure; are professional fees and financing costs included, etc? Despite these concerns, an order of magnitude estimate can be useful, particularly at the conceptual stages of projects when information is very limited and alternatives have to be ranked quickly (Norman, 1994).

This approach is probably realistic for all complex major projects, including civil engineering and building. It is based on the concept that the degree of accuracy of the estimate is only as good as the level of detail available. In practice clients often demand certainty of outcome from inception, requiring the design team to successfully manage the development of the design within the initial budget.

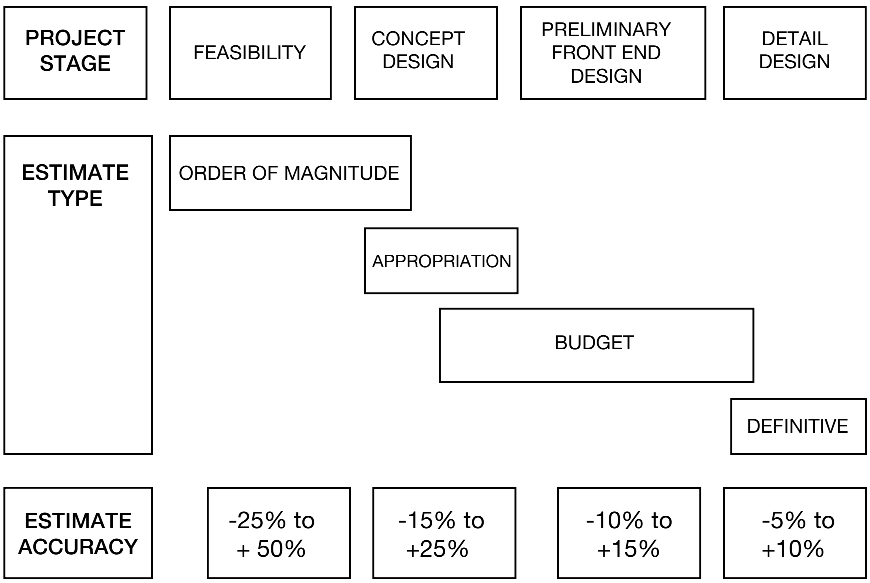


Figure 4.1 Estimating accuracy in industrial engineering projects (JDB, 1997)

Appropriation estimate

In the engineering and process industries the appropriation estimate is sometimes referred to as the Class III estimate as it uses information developed to a level of definition described as Class III. At this stage the designers will have identified the major equipment and determined their required outputs. This will enable the estimator to make enquiries of potential suppliers regarding the availability and price of key components. The appropriation estimate will typically have an accuracy of -15 per cent to +25 per cent (JDB, 1997).

Budget estimate

In the engineering and process industries the budget estimate is sometimes referred to as the Class II estimate and is produced once the conceptual design has been completed. The budget estimate will typically have an accuracy of -10 per cent to +15 per cent (JDB, 1997). In those same industries information available at this stage will allow for approximate quantities to be established and guide prices to be obtained from potential vendors.

Definitive estimate

In the engineering and process industries the final estimate, which is produced immediately following commitment to the major capital expenditure, is the definitive or Class I estimate with an accuracy of between -5 per cent to + 10 per cent (JDB, 1997).

This estimate will typically contain the level of detail used in the execution of projects and the preparation of bids. It will be used in the maintenance of close control over the cost of the work or for allocation of resources into work packages.

The order of magnitude estimate takes a *top down* approach, probably based on the final cost of previous projects. In contrast the definitive estimate takes a *bottom up* approach; the estimate is built up from specific project information and therefore has less need for risk and uncertainty allowances.

4.3 Cost estimating on civil engineering projects

In carrying out cost management there should be a clearly defined route from feasibility stage through to the placement of a contract. There should be break points, or Gateways, when the client can take the decision whether to proceed or not. This is in line with the recommendations by the erstwhile Office of Government Commerce in their Gateway Review Process.

One of the benefits of cost management in the pre-contract stage, especially in multi-contract projects, is that it helps the project team to better establish the appropriate contract strategy. That is, which work should be placed in which contract and possibly the form of contract that should be adopted for particular contracts. Cost management can also help identify possible programme restraints both in contract preparation and execution.

The preparation of the first estimate would be based on a variety of techniques, for example historic data or approximate quantities. Major projects often have substantial elements that are unique and for which there is no relevant historic data. In these cases it is necessary to analyse the project in as many individual work sections as can be identified, if possible to prepare indicative quantities and consider the resources necessary to carry out the work. During this indicative stage it is wise to contact potential contractors and manufacturers especially with regard to order of cost estimates for specialist sections.

Other matters that have an effect on cost and need to be addressed at this time include: location of project and access thereto, especially with regard to heavy and large loads; availability of labour and the possible need for residential hostels or other accommodation for workmen; off-site construction; and temporary works. It will also be necessary to consider allowances for design development, allowances for consultants' fees and client's costs, land acquisition costs and general contingencies.

When the client has accepted the first estimate and instructs that the project proceeds to the next stage then this becomes the first cost plan against which further design developments and changes are monitored.

During the process of design development the main duties of the quantity surveyor as part of the cost management team are:

- to check and report the cost of design solutions as they are established or refined by the engineers;
- to prepare comparative estimates of various design solutions or alternatives and advise the engineer accordingly;
- as changes are introduced into the project, to estimate the cost effect of the change and to report;
- to prepare a pre-tender estimate based on a bill of quantities or priced activities;
- to prepare a financial appraisal.

The monthly issue of the updated cost plan is the vehicle whereby the cost management team is made aware of the current estimated cost of the project. In its simplest form a pre-contract cost plan will set out in tabular form each and every work section, the approved estimate for that section, the estimate for the previous and the current month for the section and a note of the changes that have taken place in the month. The total of all the sections provides the estimated cost of the project.

There should be a continuous dialogue between the designers and the quantity surveyor; ideally both should work together in the same office during the critical stages of design development. Normally, there are so many changes within a month during design development that these are better listed as an appendix to the cost plan. One national client insists that a separate appendix to the cost plan lists all potential changes and these have to be approved by his project manager before changes can be included in the cost plan. In this way the cost plan represents committed cost only (Shrimpton, 1988).

The extent of detail in the preparation and updating of cost plans is such that it is best handled on a database for transfer to a spreadsheet.

The accepted estimate in the form of priced activities or bill of quantities becomes the basis for the first post-contract cost plan. This then acts as the client's design datum for cost management and reporting in the construction stage.

Highway works

An approximate estimate of the cost of constructing major highway works is usually required at an early stage in the project cycle in order to determine if the scheme is reasonable and will fit in with government funding allowance. At this early stage the proposed project will be analysed in fundamental elements. The road construction will be estimated at £x per linear metre for three-lane, dual or single carriageway – this price will normally include drainage, lighting and signage.

The estimate will be based on an analysis of previous similar tenders using the highway consultant's own data or data from personal contacts, or following up leads in Government White Papers or in the *New Civil Engineer*. Adjustments need to be made for inflation and market forces using the Department of Transport's *Road Construction Price Index*, which is published quarterly and shows trends in national prices.

Additional items to be considered include earthworks, statutory undertakers' equipment to be moved, townscaping and landscaping, telephones, closed circuit TV, etc. Bridges are kept separate and are again estimated based on the consultant's own cost data taking into account the number of spans, type of construction, length, width of carriageway, etc.

The Highways Agency (HA), acting as an Executive Agency for the Department of Transport, has radically changed its procurement policies following the recommendations made in Egan's *Rethinking Construction*.

Since the mid-1990s the Highways Agency has undertaken most major projects using design and build (D&B) contracts with most risks transferred to achieve greater certainty of spend. The scope for contractor innovation has been limited because they have not been appointed until after the statutory planning stages that establish many constraints.

In addition, improved price certainty has been sought by transferring risks, without giving full recognition to a contractor's ability to assess and manage the risks. The Highways Agency now recognizes that this approach does not always support partnership working if commercial pressures come to the fore. Improved value for money can be achieved by allocating risks appropriately, and price certainty delivered by managing the risks in partnership, supported by incentives.

The earlier appointment of a contractor offers considerable scope for better value, but it is important to get the right timing. The earlier it is, the more scope there is for the contractor to contribute expertise and innovation, but the time period to construction should not be too long.

The use of project-partnering arrangements on the HA's major projects in recent years has been beneficial in achieving mutual objectives for the particular projects. However, the procurement of major projects on an individual scheme basis means that the partnerships, and the invested knowledge and experience of team members, can be lost to the client if there is

Panel 4.1 Highway scheme estimates

In 2006 *The Times* reported that highway schemes to ease congestion are being stalled and many could be scrapped. According to the article, one third of planned improvement schemes have been delayed up to 5 years.

> The Highways Agency said that the nature of the programme meant that some schemes could fall behind or progress quickly. But construction companies blame Treasury rules for budgeting, which force the Highways Agency to include a margin of error of up to 45 per cent.

A Highways Agency spokesman said that the Government was committed to the programme of improvements and that all the roads would be built. The agency said that it was working with contractors to reduce costs. Where that was not possible, increases would be met from a special reserve.

Source: Jameson and Nugent (2006)

Author's comment: this approach seems to be in line with the JDB recommendations on order of magnitude estimates at feasibility stage in the range of -25% to + 50% accuracy.

no continuity of work. The lack of continuity also makes it difficult for suppliers to plan their resources and does not encourage the training and development of the workforce. The HA now recognizes that this could be resolved by applying long-term relationships to the delivery of major projects.

In March 2007 the Nichols Group produced a *Review of Highways Agency's Major Roads Programme* (Nichols, 2007). Within this report, four areas of the Highway's Agency's capability were reviewed: estimating, risk management, method of procurement and delivery capability.

The Nichols Report identified that half the increase in estimates was due to excessive inflation in the sector, with the other half equally divided between inadequate initial estimates, scope changes and time delays. There had been consistent underestimating of increasing ancillary costs, including land, third party costs (such as Network Rail, Environment Agency and Statutory Undertakers) and preliminaries (such as contractor's site costs and traffic operations requirements).

The Nichols Report also identified that risk management was not working well within the HA.

> Root causes are the focus on risk events, which ignores significant sources of uncertainty and the way uncertainty accumulates; reliance on single point estimates, without defining the plausible range of values which could arise; and the adoption of provisions and contingencies which are not transparent.

The Highways Agency decided to embrace best partnering practice as recommended in Latham and Egan using the New Engineering Contract. After progressively trying design, build, finance and operate (DBFO) and design and build (D&B), the HA adopted Early Contractor Involvement (ECI). ECI is a partnering approach in which the contractor is appointed at an early stage of project development to assist in planning, assessing buildability and cost estimating. In the HA, this is immediately after OGC Gateway 2, in advance of route development and the statutory process. The contractor is then incentivized to design and construct the scheme within an agreed target price, based on a pain/gain formula.

The current procurement strategy of the HA (Highways Agency, 2009) now offers what is described as a segregation model with a range of contract types including ECI and Managing Agent Contractor (MAC), to maximize the scope for delivering value. This reflects their commitment towards early involvement and long-term relational contracting.

This change of approach will have a significant impact on the cost control process throughout the pre-tender period. Critically, the design team, including the contractor and supply chain, will be working to establish innovative designs within the targets set for key components.

4.4 Cost estimating on building projects

After World War II, during a period of national shortages and austerity, there was a huge demand for school buildings which led to the introduction of strict cost limits on school places by the UK Government. These pressures on public sector finances in turn led to the development during the late 1950s of a completely new method of design cost control known as elemental cost analysis and cost planning.

Hertfordshire County Council was one of the pioneers in the 1950s and 1960s, making important contributions to innovative school design on the CLASP modular school building projects and the development of cost planning. CLASP (Consortium of Local Authority Special Programme) is a modular steel-framed, flat-roofed, pre-cast concrete building system developed to meet the demand for school buildings of that time. Saint (1987) describes how this early Hertfordshire team of architects continually searched for improvements involving a continuous cycle of design, production, feedback and development. There was close involvement with a wide variety of component manufacturers, including of sanitary equipment, floor tiles, warm air heating systems, lighting, school furniture, etc. in order to encourage the development of modern economic designs.

However, it was James Nisbet at the Architects and Buildings Branch in the Ministry of Education who first developed and described the technique of elemental cost analysis and cost planning with the publication of Building Bulletin No. 4, *Cost Study*, in 1951. This technique required the architects to 'design to a cost' in contrast to the approximate quantities method of approximate estimating which essentially was 'costing a design' with very little control. The elemental cost analysis approach thus enabled the client to obtain a more reliable pre-tender estimate and gave the design team a template in order to control the cost during the design development stages.

On 30 October 1953 *The Builder* published a long letter from James Nisbet in which he clearly spelt out the opportunities for the quantity surveyor. 'This type of cost control requires close collaboration with the architect at an early stage of his design, when the quantity surveyor will be called upon to display a more detailed knowledge of costs than has been usual in the past.' 'Cost planning therefore opens up a vast new field to the quantity surveyor where he can play a more valuable part in the design of buildings.'

These latter comments are reinforced with James Nisbet's observations made at the RIBA Cost Control Conference in 1959: 'The surveyor's present skill is closely related to the down to earth world of measurement and builders' prices but cost control will bring him into a creative world that could become the major part of his expertise' (*Architects' Journal*, January 1959: 186). He recommends that 'the cost plan must be prepared *jointly* by the architect and quantity surveyor' and speculates that 'such a close association could, in the long run, lead to an amalgamation of architects and quantity surveyors in one firm' (Nisbet, 1959: 23, 25).

Substantial support and encouragement in the development of this new discipline was provided by the architectural profession throughout the 1950s through the forum of the *Architects' Journal* with case study cost analyses and expert comment and RIBA's organization of a major conference on the theme of *Architectural Economics* in 1956. Later, in 1962, the Cost Research Panel of the RICS created the Building Cost Information Service (BCIS) to collate cost data for the preparation of such cost plans.

The technique is now well established in the building sector and has been further developed by the BCIS to include a national database of over 16,000 elemental cost analyses, which can be accessed online. Such information can be used to aid the pre-contract estimating process in the building sector as well as helping to ensure value for money by aiding the designer to ensure the most appropriate distribution of costs within the project.

Cost management is the total process, which ensures that the contract sum is within the client's approved budget or cost limit. It is the process of helping the design team design to a cost rather than the quantity surveyor costing a design.

The basis of the design cost control using the cost planning technique is the analysis of existing projects into functional elements in order to provide a means of comparison between projects planned with data from existing projects. A building element is defined as part of a building performing a function regardless of its specification. Elemental analysis allows the comparison of the costs of the same element between two or more buildings.

As the element under consideration is performing the same function, then an objective assessment can be made as to why there may be differences in costs between the same elements in different buildings. There are four main reasons why differences in costs occur:

- differences in time (inflation)
- quantitative differences
- qualitative differences
- differences in location.

On a major project it is necessary to consider individual buildings or parts of buildings. A major shopping centre may be split into common basement, finished malls, unfinished shells, hotel and car parking. The parts of the whole may be physically linked and difficult to separate, but separation will ease estimating and control. The costs of the identifiable parts can then be compared against other schemes. A composite rate per square metre is meaningless when you mix the cost of finished atrium malls with unfinished shells.

As well as separating out parts of the building that serve different functions it is important to separate for phasing. Many major projects have to be built around existing structures, which increases the cost because of temporary works as well as inflation.

The client's and project's status with regard to value added tax (VAT) will also need to be established. In the UK VAT is currently payable on building work other than constructing new dwellings and certain buildings used solely for residential or non-business charitable purposes and also on all consultants and professional fees. The current VAT rate as from 4 January 2011 is 20 per cent.

For further information on the application of VAT to construction works in the UK visit the HM Revenue & Customs website. It is customary to exclude this amount from estimates and tenders, a practice that is well understood in the construction industry. However this must be pointed out to any client who otherwise may think that the estimate is their total liability (Ferry and Brandon, 1999).

Design stages

The reference to Design Stages is to the RIBA Plan of Work 2007 (amended 2009) (taken from the RIBA *Handbook of Architectural Practice and Management*), which identifies and describes the main stages of the project cycle under the traditional procurement route through which a project design typically passes. Table 4.1 shows the cost control tasks and deliverable reports required from the quantity surveyor within this process model. It is acknowledged that a new plan of work is scheduled for release (in 2013) by the RIBA to reflect recommendations of the UK Government Construction Strategy and address inherent shortcomings of the current Plan of Work. The stages of this new Plan of Work however generally map directly onto the existing framework and therefore the tasks of the quantity surveyor as per Table 4.1 will still remain very much relevant under the new framework.

It is recommended that value management and risk management are also carried out throughout the design process. These might affect both the client's requirements and the chosen design solution and changes would, therefore, affect the budget and cost plan.

If at any time during the design process it becomes apparent that the agreed budget is likely to be exceeded without the brief being changed, the client should be informed and instructions requested. Likewise, if it becomes apparent that the whole of the agreed budget will not be required, the client should be informed.

In 2009 the RICS introduced the *New Rules of Measurement (NRM): Order of Cost Estimating and Elemental Cost Planning*. At the elemental level the NRM structure is the same as the functional building element structure of the Standard Form of Cost Analysis (SFCA). The NRM expands upon this and details how cost plans should be calculated and presented as the design develops. Joe Martin at the BCIS considers that 'It should improve consistency in the tendering process on projects where measurement is not provided, e.g. in design and build' (Martin, 2009).

Budget estimating techniques

On projects where non-traditional procurement routes are used, the responsibility for developing the cost plan may change but the stages suggested here remain appropriate. For example, on

Table 4.1 Cost control tasks and deliverable reports

RIBA Plan of Work 2007 stages		*Quantity surveyor's key cost management tasks*	*RIBA Plan of Work 2013*
Preparation	A Appraisal	Assist the architect in developing the business case and executing the feasibility studies Determine the budget (NRM – order of cost estimate)	1 Preparation
	B Design brief	Assist the architect in identification of procurement method and procedures	
Design	C Concept	Prepare preliminary cost plan (NRM – formal cost plan 1)	2 Concept design
	D Design development	Carry out cost checks on structural and building system services and finalize cost plan (NRM – formal cost plan 2)	3 Developed design
	E Technical design	Carry out cost checks (NRM – formal cost plan 3)	4 Technical design
Pre-construction	F Production information	Review information provided by specialists and carry out cost checks (NRM – pre-tender estimate)	
	G Tender documentation		
	H Tender action	Appraise tenders, submit recommendations to the client and review cost plan	5 Specialist design
Construction	J Mobilization		6 Construction (off-site and on-site)
	K Construction to practical completion	Submit monthly report to client identifying changes to budget Obtain approval of changes from client prior to instruction	
Use	L Post-practical completion	Settle final account	7 Use and aftercare

Source: Adapted from RIBA Plan of Work 2007 and 2013

design and build (D&B) schemes, the client's quantity surveyor will be responsible for the cost plan at design brief and concept stage and the D&B contractor's quantity surveyor will be responsible for developing the cost plan with the contractor's design team to produce the tender. However, the principles of budget, cost plan, cost checks and reconciliation should be adhered to whenever possible.

There are four main ways to estimate the cost of a building during the design stage, which are dependent on the quantity and quality of the information available at the time the estimate is required:

- function or performance-related
- size related
- elemental cost analyses
- unit rates.

As a general principle, estimates prepared on minimal information and those taking a very short time to prepare will be less accurate than those based on the use of substantial information requiring substantial time to prepare.

The term *cost modelling* is often used to describe the function of cost estimating. Any form of cost prediction can be described as a cost model, whether it is based on functional, performance-related, elemental cost analysis or detailed rates calculated by contractors when pricing tenders. However, cost modelling usually generally implies the use of computer aids in order to allow multiple iterations to be rapidly performed in order to select the most appropriate solution to achieve value for money.

Functional or performance-related estimating

A functional or performance-related estimate typically requires one quantity and one rate and is related to the client's basic requirement. Typical examples include:

- 1,000-bed hotel
- 2,000-pupil school
- 1,500-bed hospital.

For example, a hotelier will know that a hotel will cost £75,000 per bed to build and will earn them £75 per bed per night. They can use this information to calculate the relative efficiencies of two proposed hotel options of completely different sizes.

An estimate based on this technique is very simplistic and crude, but of course quick. It does not take into account plan shape, number of floors, ground conditions, etc. It is considered extremely risky to use this technique except at the very earliest stages of inception. Often statistical techniques are employed in an attempt to improve the accuracy and reliability of the estimate.

Using this approach it would have been possible to identify a *ballpark* figure for the anticipated cost of the new Wembley Stadium at an early stage in the project cycle based on the cost per seat (see Table 4.2).

It is interesting that an independent value for money study by surveyors Cyril Sweet in April 2002 described the Wembley Stadium and identified some of the key features of this design and construction contract with Multiplex as:

> Value for money both in terms of the market price for the scheme as designed, and in terms of comparison with stadia of similar standing**.**

Table 4.2 Major stadiums, cost-per-seat comparisons

Stadium name	*Wembley*	*Stade de France*	*Stadium Australia*	*Munich (new stadium)*	*Sapporo Dome (Japan)*	*Washington State*
Location	London, UK	Saint Denis, France	Sydney, Australia	Germany	Sapporo, Japan	Washington, USA
Capacity (seats)	90,000	80,000	80,000	66,000	42,122	72,000
Accommodation area (sq m)	173,000	70,000	100,000	na	53,800	na
Area per seat (sq m)	1.92	0.88	1.25	na	1.28	na
Total cost (£m)	£352.6m	£266.6m	£278.9m	£248.2m	£246.0m	£359.6
Cost per seat	£3,918	£3,332	£3,486	£3,761	£5,839	£4,995

Source: *Wembley National Stadium Project: Into Injury Time, Sixth Report of Session 2001–02* produced by House of Commons Culture, Media and Sport Committee: www.publications.parliament.uk/pa/cm200102/cmselect/cmcumeds/843/843.pdf – cited 16 October 2012)

This does not signify that it is the cheapest price, but that it falls within the broad cost parameters for a project of this type and scale.

We consider that the level of the Multiplex price reflects the specific aspects of the proposed Wembley contract. Onerous conditions of contract, developed to provide greater security of outturn price for WNSL (the client).

A significant amount of additional accommodation, provided to generate income, a need arising from the requirement for the stadium to be financially self sustainable. High design standards required by the lottery funding agreement. Overall capacity of 90,000 seats, which are proportionately more expensive than those in a lower capacity stadium.

(Cyril Sweet, 2002)

Size-related estimating

These techniques are invariably based on gross floor area (GFA) approaches, where the total floor area of the required building is calculated and then multiplied by an appropriate unit rate per square metre of floor area. In former times volumetric approaches were used, but this technique has broadly fallen out of favour as large errors can arise.

More detailed approaches can be applied by the use of differential rates for different areas within the building to give a greater degree of accuracy. A major limitation of these techniques is that they take no account of the geometry of the building.

Elemental cost analysis estimating

This technique relies on the selection of one or more suitable cost analyses and adjusting them in time, quantity, quality and location in order to provide an estimate of the proposed building. It is a technique which is used as the means to establish the cost plan which should confirm the budget set at the feasibility stage and to establish a suitable cost distribution within the various elements.

Panel 4.2 The Building Cost Information Service of the RICS

The nationally available BCIS provides two types of elemental cost analyses:

1. Concise cost analysis, which gives only a breakdown into broad elements such as substructure, superstructure, services, etc.
2. Detailed cost analysis in a standard format – fully describing each project thus:
   a) information on the project, including description, site and market conditions, number and prices of tenders, contract period, form of contract;
   b) elemental costs – showing element total cost, cost per square metre of gross floor area, element unit quantity, element unit rate, with two sets of figures for the preliminaries shown separately and apportioned;
   c) specification and design notes;
   d) plan and elevation.

The elemental cost data from previous projects is accessible to subscribing members of the BCIS online (http://service.bcis.co.uk). Thus, even in the absence of designer's drawings, the client's cost adviser is able to create on the computer a pre-contract cost model using the data from several similar previous projects.

Invariably an outline cost plan is first produced using the cost per square metre of each functional element in order to allocate elemental cost limits. When the design has developed further the elemental unit quantities are calculated in order to establish elemental cost targets for inclusion in the detailed cost plan.

As the design evolves more information becomes available. The element unit rate can be modified as described below. Most elements have different specifications, with varying rates that need to be isolated. For example, a factory unit may have a mainly unfurnished warehouse, some offices and a toilet block.

The element unit rate calculation arrives at the same cost but assumes an identical mix of specification to arrive at an aggregate rate. It is not easy to fully appreciate an aggregate rate, as it bears no relation to the specification rates. Any change in the ratios of the varying specification could have a significant cost effect. The parts of elements are referred to as components and are added together to create the elemental sum (see Table 4.3).

Cost-checking

In order to confirm the accuracy of the cost plan, which in itself will have confirmed the budget set at the feasibility stage, cost-checking is deployed. Cost-checking is the execution of the cost control component in the design process. It ensures that the information as a basis for the tendering can be prepared such that the lowest tender will confidently equate closely with the budget set at the feasibility stage.

Milestone reports

If all the documentation is formatted in the same way it can be compared and reconciled. One way to achieve this is to use milestone reports. This is a table that summarizes and reconciles between each milestone. A milestone report is normally a report such as:

- original budget
- cost plans, e.g. 1 to 10
- pre-tender estimates
- contract sum
- financial statement, e.g. 1 to 50
- final account.

Table 4.3 Establishment of elemental cost targets for inclusion in cost plan

Element 43: Floor finishes				
Area	*Specification*	*Quantity (m2)*	*Rate*	*Cost (£)*
OUTLINE COST PLAN				
All areas	Typical mix	10,000	£7.30	73,000
DETAILED COST PLAN				
Warehouse	Floor hardener	9,000	£2.00	18,000
Office	Carpet	900	£50.00	45,000
Toilets	Ceramic tiles	100	£100.00	10,000
		10,000		73,000

The main group costs, such as total finishes, are tabled together with the total cost, area, cost per square metre and a comment on any major changes to brief. The costs can be plotted on a graph. After several projects the client's cost consultant can analyse their performance to see if they need to adjust their level of optimism or pessimism.

4.5 General comments

The client obviously remembers the first figure reported to them. When the original feasibility study is performed the budget is often fixed; it is therefore essential that all cost-reporting reconciles back to the original budget. All estimates should explain to the client and the design team what is included in the budget. It should be a discussion document for design optimization.

As the design develops it is inevitable that some over-specification in individual elements will occur, sometimes increasing the total cost beyond the total budget. The elemental breakdown can highlight the offending elements by showing an excessive percentage of the total.

Normally the individual percentages of each elemental cost for a particular type of building produce a typical *pattern*. It is important to match the percentages, or pattern, with the norm for that type of building. Mere consideration of the total cost per square metre can be misleading as there can be two high and two low elements, which may cancel each other out and yet still require detailed examination.

4.6 Action after receipt of tenders

Action after receipt of tenders is that required at the tender action stage (Design Stage H) in analysing each tender and updating information for the client and consultant.

Panel 4.3 Pre-contract cost control on public building projects – lessons to be learned

- Recognize cost as a design factor.
- Design to a cost target.
- Develop a realistic first estimate based on stringent Government cost limits.
- Develop a cost plan based on an elemental cost analysis approach, cost-checking throughout the design process.
- The architect and quantity surveyor should work together as a team (preferably in the same office) with close involvement of the building services consultant.
- On schools projects consider the use of standard modular grids, standard components, light and dry systems of construction and off-site prefabrication.
- Continually search for improvement, including liaison with component manufacturers.
- Use value management/value engineering techniques on the project.
- Liaise with the Building Research Establishment.
- Utilize a central control unit to circulate best practice guides and information on successful projects to all local authorities.
- Share best practice through case studies and annual conferences.
- Do not indulge in costly architectural styles.

(Potts, 2010)

In most cases, sound cost planning will produce tenders within budget. If, due to market conditions or late changes in designs and specification, adjustments need to be made to a tender, information on potential savings will need to be identified by the design team. If there are significant changes from the initial tender documents, consideration should be given to the need for seeking revised tenders.

Cost planning has evolved significantly over the years. Cost plans can now embody replacement costs, operation and maintenance costs, whole-life costs, Standard Assessment Procedure (SAP) energy ratings and the BRE's Environmental Assessment Method (BREEAM). The move from 'costing a design' to 'designing to a cost' and the development of cost planning has enabled quantity surveyors to add a value-added service to their clients, whilst the concept of elements has been incorporated into the development of life-cycle costing and value management.

4.7 Conclusions

This chapter has briefly reviewed the key concepts of pre-contract cost management in the industrial engineering, civil engineering and building sectors in order to identify a suitable approach for construction works. Many similarities in the approach and techniques in the three sectors have been identified.

The cost manager's systems should provide clients and project managers with the maximum possible advance warning of likely expenditure so that timely and appropriate actions may be considered.

It is necessary to identify what items are included in the estimate and which are excluded. Forecasts should not be single figures, implying a degree of accuracy that does not exist; they should be a range of figures within stated parameters. Ideally each estimate should be a logical development of its predecessor, reflecting the increased level of detail available.

In the periods between revisions of estimates and cost plans, the development of designs and programmes and the progress of procurement and commitment must be controlled.

A major factor in the management of costs is the identification and management of the risks. Risks are associated with the unknown. Therefore, as a project progresses from inception, through design, construction and use, the unknown elements should diminish and the risk allowance can be reduced accordingly.

4.8 Questions

Question 1

Describe and discuss the range of cost models and show how they are useful at different stages in the design process.

Question 2

Discuss the steps that can be taken to ensure that cost planning and control keep the final cost of a building project within cost target.

Question 3

The primary function of producing estimates of the cost of construction works is to be able to advise clients of anticipated development costs. Discuss the various methods of providing such pre-contract estimates in relation to a proposed marina development.

4.9 References/further reading

Ashworth, A. (2004) *Cost Studies of Buildings*, 4th edition, Prentice Hall.

Bathhurst, P.E. and Butler, D.A. (1980) *Building Cost Control Techniques and Economics*, Heinemann.

Ferry, D.J. et al. (1999) *Cost Planning of Buildings*, 7th edition, Blackwell Science.

Flanagan, R. and Tate, B. (1997) *Cost Control in Building Design*, Blackwell Science.

Flyvbjerg, B., Holm, M.S. and Buhl, S. (2002) 'Underestimating costs in public works: Error or lie?', *Journal of American Planning Association*, Vol. 68, No. 3, pp. 279–295.

Flyvbjerg, B., Bruzelius, N. and Rothengatter, W. (2003) *Megaprojects and Risk; An anatomy of ambition*, Cambridge University Press.

Highways Agency (2009) *Procurement Strategy 2009: Delivering sustainable value through supply chain management*: http://assets.highways.gov.uk/about-us/corporate-documents-procurement-strategy/Procurement_Strategy_2009-10.pdf – accessed 20 September 2012.

HM Revenue and Customs: www.hmrc.gov.uk.

House of Commons Culture, Media and Sport Committee (2002) *Wembley National Stadium Project: Into Injury Time, Sixth Report of Session 2001–02*: www.publications.parliament.uk/pa/cm200102/cmselect/cmcumeds/843/843.pdf – cited 16 October 2012.

Jameson, A. and Nugent, H. (2006) 'Delays ahead as road costs soar', *The Times*, 23 January 2006, p. 3.

Joint Development Board (1997) *Industrial Engineering Projects: Practice and procedures for capital projects in engineering, manufacturing and process industries*, E & FN Spon.

Martin, J. (2009) 'Supporting the NRM', *RICS Construction Journal*, July–August.

Morton, R. and Jaggar, D. (1995) *Design and Economics of Building*, E & FN Spon.

NAO (2009) Performance of PFI Construction, A review by the private finance practice, National Audit Office.

Nichols, M. (2007) *Report to Secretary of State for Transportation: Review of Highways Agency's Major Roads Programme*, Nichols Group: www.dft.gov.uk/pgr/roads/nicholsreport/nicholsreport.pdf – accessed 22 April 2009.

Nisbet, J. (1959) The Role of the Quantity Surveyor during the Design Stage, *RIBA Journal*, July 1959.

Nisbet, J. (1989) *Called to Account: Quantity surveying 1936–1986*, Stoke Publications.

Norman, A. (1994) *Cost Estimating*, notes presented at the UMIST Project Management Course, UMIST.

Potts, K. (2010) 'The first estimate should equal the final account – quantity surveying and the development of elemental cost analysis and cost planning', *RICS COBRA Conference 2010*, 2–3 September, Dauphine Université, Paris.

RIBA (2013 forthcoming) *Plan of Work*: www.architecture.com/Files/RIBAProfessionalServices/Practice/FrontlineLetters/RIBAPlanofWork2013ConsultationDocument.pdf – accessed 15 October 2012.

RICS (1992) *Cost Management in Engineering Construction Projects: Guidance notes*, Surveyors Holdings Limited.

RICS (1998) *The Surveyors' Construction Handbook*, Surveyors Holdings Limited.

Saint, A. (1987) *Towards a Social Architecture: The role of school building in post-war England*, Yale University Press, New Haven and London.

Seeley, I.H. (1996) *Building Economics: Appraisal and control of building design, cost and efficiency*, Macmillan.

Shrimpton, F.S. (1988) 'Cost management and reporting in civil engineering', *RICS/ICE Discussion Meeting*, RICS Quantity Surveyors Division.

Swinnerton, D. (1995) 'Estimating techniques and their application', *Project*, April pp. 11–14.

5 Cost management on PFI projects

5.1 Introduction

Privatized infrastructure projects have been around for at least 200 years. In the eighteenth century one of the first concessions to be granted was given to the Perrier brothers to provide drinking water to the city of Paris. The Trans-Siberian Railway and the Suez Canal were thought to have been the first Build, Own, Operate and Transfer (BOOT) projects in the modern world (Merna and Njiru, 2002). The great Victorian contractor Weetman Pearson not only built railways, power stations and ports in Britain, Mexico and Chile but also promoted the companies, raised the capital and ran the operations for a number of years.

The idea behind the BOOT philosophy is that there is an increasing worldwide perception that the electorate requires improvements in the quality and availability of its public services, particularly infrastructure projects – but is not prepared to pay extra tax to fund them. A solution is to get the private sector to pay for these facilities (as well as designing, building and operating them) and in return allow the companies involved to take the bulk of the revenue produced.

The term Build-Operate-Transfer (BOT) was first introduced in the early 1980s by Turkey's then Prime Minister. Under this arrangement the private organizations undertake to build and operate a project normally undertaken by Government. Ownership normally reverts to Government after a fixed concession period, normally between 10 and 50 years. The revenues generated by the project are the main source of repaying the debt. The projects are normally structured to have limited or no recourse to the project sponsors, contractors or to the Government – projects being undertaken by a self-contained concession company or special purpose vehicle.

This approach is particularly attractive for Governments in the rapidly developing countries in the Pacific Rim, e.g. in Thailand and Malaysia, which see the BOT approach as a means of reducing public sector borrowing and, at the same time, promoting direct foreign investment in their country's infrastructure or industrial projects. Examples of such projects include power stations, toll roads, toll bridges and even pipeline systems for oil and gas.

The proactive involvement of the home Government is usually critical to the success of the project. Robert Tiong's important research in the early 1990s identified that sponsoring Governments adopted a range of strategies in order to support these major infrastructure projects. These included giving concession periods of up to 55 years, offering support loans, giving concessions to operate existing facilities, facilitating foreign exchange guarantees and interest rate guarantees, etc. (Tiong, 1990).

The first BOT project in the UK was the Channel Tunnel linking the UK and France and constructed by a consortium of five British contractors, five French contractors and five banks. This was followed by other infrastructure projects including the Skye Bridge, the Second Severn Crossing, the Dartford Bridge, the London City Airport and the Manchester Metrolink.

Research by Cheung *et al*. (2010) investigated the suitability of procuring large public works in Hong Kong through the Public Private Partnership (PPP) approach. Hong Kong has a long history of using PPP on public projects, including the Cross Harbour Tunnel which was delivered using a BOT approach in the late 1960s. Recently a number of mega PPP projects have been proposed by the Hong Kong Government, including the 30-kilometre-long Hong Kong to Macau bridge. The researchers identified the positive and negative factors in using the PPP approach and compared perceptions in Hong Kong, Australia and the UK.

From their survey the researchers identified that the top positive factors for using the PPP approach in Hong Kong and Australia were similar and fundamentally focused on improved efficiency. These factors were that PPP: (1) provided an integrated solution for public infrastructure/services; (2) facilitated creative and innovate approaches; and (3) solved the problems of public sector budget restraint/saved time in delivering the project. In contrast, respondents to a similar previous survey in the UK (Li, 2003) identified the following economic factors as being more important: (1) risk transfer to the private partner; (2) solution to the problem of public sector budget restraint; and (3) non-recourse or limited recourse to public funding.

5.2 Structure of BOT projects

The main parties involved in a BOT project are:

- the host Government – often the host Government provides critical financial support without which the project would not become a reality;
- the project sponsors – normally a joint venture comprising contractors/ banks/entrepreneurs;
- the banks – these may include major world banks, e.g. Asian Development Bank, European Investment Bank, as well as major national banks;
- the shareholders – this includes pension fund holders and major investors;
- the contractors – often multinational joint ventures.

The typical five phases of a BOT project, with the roles and responsibilities of the project sponsors identified, are:

1. pre-investment: acting as consultants, the project sponsors carry out the feasibility study;
2. implementation: acting as consultants, the project sponsors carry out the engineering/ building design; as project sponsors they negotiate favourable concession agreements from Government; and as project promoters they raise equity and borrow finance during the implementation phase;
3. construction: the project sponsors act as the contractor to build the facility, usually on a fixed-price turnkey basis, during the construction phase;
4. operation: the project sponsors act as the operator and owner of the facility, using the project revenues to repay the loans during the operation phase;
5. transfer: transfer of ownership to the Government.

5.3 Case study: Nottingham Express Transit (NET) light rail

In 1990 the Nottingham City Council and Nottinghamshire County Council formed a private company limited by shares under the name of Greater Nottingham Rapid Transit (GNRT) to undertake the construction and operation of the LRT system.

The 1994 Act of Parliament (GNLRT Act) was passed granting the City and County Councils the powers to develop and operate an LRT system, to authorize the construction of the works and acquisition of land required, and to transfer the undertaking to GNRT Limited or any other organization.

In 1997 Arrow Light Rail was selected as the preferred bidder. Arrow Light Rail is an SPV (special purpose vehicle) company formed to design, build, fund, operate and maintain Line One of the Nottingham Express Transit.

The promoter is Nottingham Express Transit (NET), the private company formed by Nottingham City Council and Nottingham County Council (GNRT under the Parliamentary Act).

The concessionaire is Arrow Light Rail, comprising six partners each bringing their own particular skills and expertise to the organization. These partners are:

1 Bombardier (formerly Adtranz) – one of the leading providers of total rail systems and tailor-made solutions for rail transport services worldwide;
2 Carillion Private Finance (CPF) – part of Carillion plc. CPF is a UK leader in private finance, primarily in health, prisons and transport sectors;
3 Transdev – the leading operator of integrated urban transport systems in Europe and operating over 70 public transport networks in France, including modern tramways;
4 Nottingham City Transport (NCT) – the leading bus operating company in the Nottingham area;
5 Innisfree – the leading private equity investor in UK Private Finance Initiative and Public Private Partnership infrastructure projects and a 30 per cent shareholder of Arrow;
6 CDC Projects – the major French public sector financial institution, a 20 per cent shareholder of Arrow.

Figure 5.1 shows the PFI organizational structure on stage 1 of the Nottingham Tramway. The contractor is Bombardier Carillion Consortium (BCC), a segregated consortium in which the two members take responsibility for delivery of their respective scopes of work and are jointly and severally bound to supply the entire scope of works to the client – Arrow Light Rail.

The operator is the Nottingham Tram Company, a special purpose company owned by Transdev and NCT, which took over the project on completion.

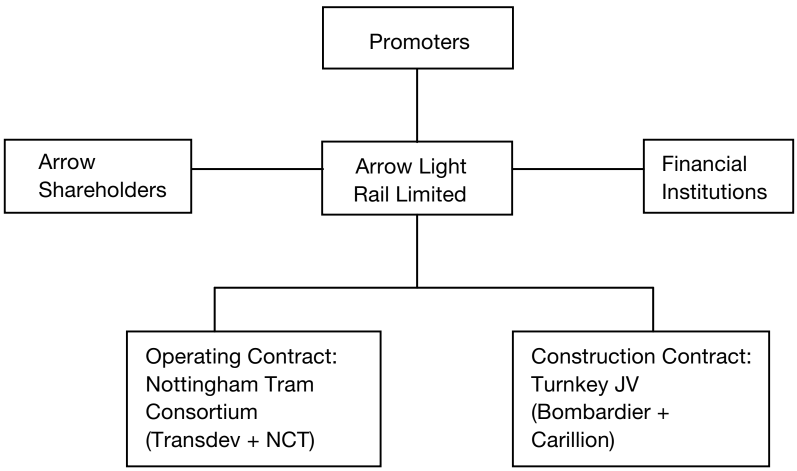


Figure 5.1 PFI organization on Nottingham Tramway

Arrow's £220 million funding of the project is met by bank loans, sponsor equity and grants. The loans will be paid back during the operating period from performance-related payments from the promoters and revenue from fares.

The promoter awards a concession to the concessionaire, who in turn procures design and construction from the contractor, and operations from the operator. The principal documents are as follows:

- Concession Agreement and Schedules – specify the rights and obligations of the promoter and the concessionaire;
- Turnkey Contract and Schedules – specify the rights and obligations of the concessionaire and the contractor;
- Railtrack Agreements – specify the rights and obligations of the promoter, the concessionaire, the contractor and Railtrack for the Railtrack Enabling Works.

Both members of the Bombardier Carillion Consortium are bound by the Consortium Agreement, which defines their respective scopes of work and responsibilities within the consortium.

Some 10 years in the planning, NET was a key part of Greater Nottingham's integrated transport strategy, to improve access to the city centre and reduce traffic congestion and pollution. Line One was anticipated to take 2 million car journeys per year off the roads and was also expected to bring economic regeneration and environmental benefits to the area. The project finished six months late, but the public sector was protected by a robust PFI structure; however, the turnkey contractors, mainly civil engineering, lost money on the project.

NET Line One was opened by Transport Minister Alistair Darling in March 2004 and showed strong patronage, with 8.5 million and 9.8 million passengers, respectively in its first 2 years of operation. This trend has continued to date with current passenger numbers standing at 9.7 million (gov.uk website). Passenger surveys published in 2011 reveal up to 94 per cent satisfaction with the service and 88 per cent support for planned new lines south and west of the city.

It is significant to observe that the shareholder composition of the consortium has changed substantially as follows: Bombardier (12.5 per cent), NCT (14.28 per cent), Transdev (12.5 per cent), Innisfree (36.43 per cent), and Galaxy SARL (24.29 per cent) (HM Treasury).

5.4 Factors leading to success on BOT projects

The following factors have been identified by the United Nations Development Unit as important for the success of BOT projects (UNIDO, 1996):

- The project must be financially sound, feasible and affordable.
- The country risks must be manageable.
- There must be strong government support.
- The project must rank high on the host Government's list of infrastructure projects.
- The legal framework must be stable.
- The administrative framework must be efficient.
- The bidding procedures must be fair and transparent.
- BOT transactions should be structured so as to be concludable within a reasonable time and at a reasonable cost.
- The sponsors must be experienced and reliable.
- The sponsors must have sufficient financial strength.
- The construction contractor must have sufficient experience and resources.
- The project risks must be allocated rationally among the parties.

- The financial structure must provide the lenders with adequate security.
- The foreign exchange and inflation issues must be solved.
- The BOT contractual framework must be coordinated and must reflect the basic economics of the project.
- The public and the private sectors need to cooperate on a win-win basis.

Building a BOT toll road in a developed country might be an attractive proposition to a potential sponsor. However, in contrast, building such a road in a developing country might not be so attractive due to the economic and political situation and potential risks involved.

5.5 Risks and securities

The United Nations Development Unit (UNIDO, 1996) has identified the range of potential risks on major international BOT projects which could include:

- political risks, including changes in taxation, import restrictions or even cancellation of the concession;
- a country's commercial risks, including foreign exchange, inflation and interest rates;
- a country's legal risks, including changes in law and regulations;
- development risks, including bidding, planning and approval;
- construction risks, including delay, cost overrun, *force majeure*, loss or damage to work and liability;
- operating risks, including technical, demand, supply, cost escalation and management risks.

The Channel Tunnel project highlighted the risks to investors involved in BOT projects. The project opened more than 1 year late and cost at least three times the initial budget of £3.5 billion. In contrast, the £80 million QE2 bridge on the Thames crossing at Dartford was completed on time and within budget and will show a generous return for the investors; it is anticipated that the toll revenue in the last year before handover to the Government will equate to the total initial cost.

Given the complexity of BOT schemes and the magnitude of the funds required, it is important for project sponsors to identify, evaluate and allocate the main risks in a BOT project. Indeed, the analysis and allocation of risk is central to the financial structuring of a BOT project. In the first instance, the objective must be to minimize the risks associated with the project, for example by adequate geological, technical and market studies. Thereafter, the process is one of insuring, controlling and apportioning risks according to the parties' willingness to bear them.

The key to successful BOT project financing is structuring the project finance with as little recourse as possible to the sponsors or Government, while at the same time providing sufficient guarantees and undertakings so that lenders will be satisfied with the credit risk.

PFI projects have significant benefits for clients: not only is the project considered off the balance sheet but all the risks should be transferred to others. However, the termination of the PFI contract for the National Physical Laboratory (NPL) demonstrated that sometimes the risks may be too great for the private sector to carry.

In 1998 Laser, a SPV jointly owned by Serco Group plc and John Laing plc, signed a 25-year PFI contract under which Laser would build and manage new facilities for NPL, comprising over 400 laboratories. Laser awarded John Laing a fixed-price contract to design and build the new facilities. However, intractable problems occurred in designing 30 specialist laboratories which required stringent temperature and/or sub-audible noise controls facilities which considerably delayed the project.

Ultimately John Laing plc was unable to carry the massive financial burden, with losses estimated at £67 million; John Laing Construction was sold and the remaining company restructured. In turn, Serco recognized that it could not complete the project and the PFI agreement was terminated in 2004 (National Audit Office).

Postscript: the project was completed by the client, the Department of Trade and Industry, in 2007.

5.6 Case study: Sydney SuperDome, Australia

In the last two decades the BOOT strategy has become popular in Australia, with examples such as the Sydney Harbour Tunnel, the Stadium Australia in Sydney, the M2, M4 and M5 toll ways in New South Wales and the Ord River Hydro-Electric Scheme in Western Australia.

The Sydney SuperDome is a 70,000 m^2 multi-use indoor arena with seating capacity for 20,000 spectators. It was built at a cost of A$280 million (£115 million) over 25 months as part of the 2000 Olympic Games infrastructure programme, with a 30-year operation concession period. The SuperDome, which is the largest indoor venue in Australia, can be used for gymnastics, tennis, basketball and ice hockey and also for concerts and exhibitions. The SuperDome was designed and constructed by Abigroup together with the Japanese big-five contractor, Obayashi. Figure 5.2 shows diagrammatically the simplified corporate structure, clearly identifying the main parties to the project.

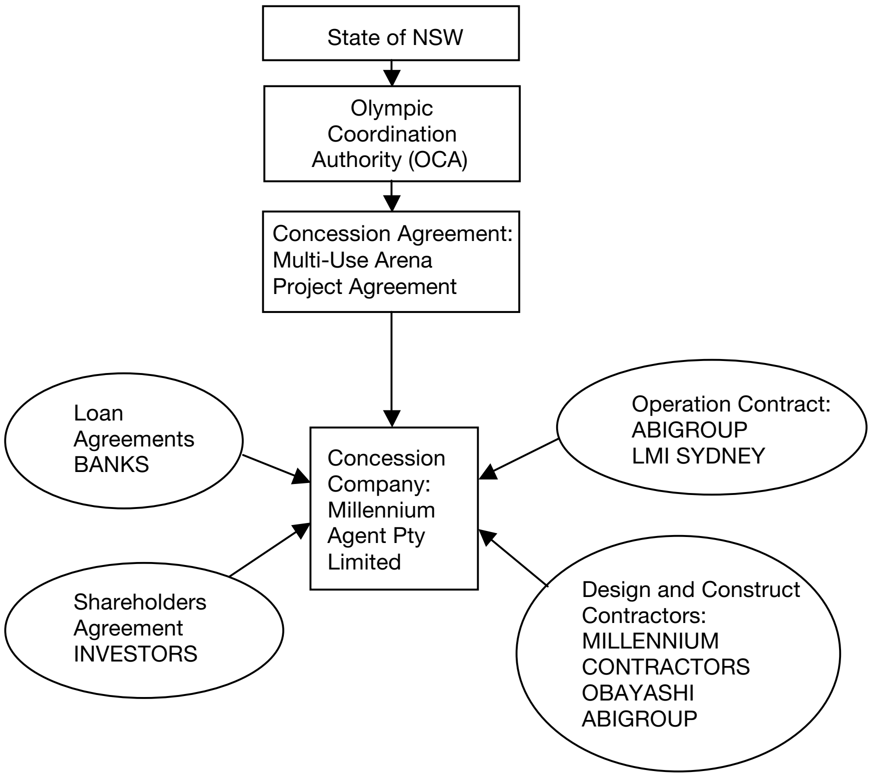


Figure 5.2 Simplified SuperDome corporate structure

The Government contributed 72 per cent towards the cost of the Arena alone, with the Millennium Consortium contributing the balance. The Government also paid the consortium for the construction of an adjacent car park and landscaping.

The Multi-Use Arena Project Agreement obliged Millennium Agent to:

- finance, plan, design, construct and commission the Arena;
- plan, design, construct and commission the adjacent car park and public domain areas;
- procure the operation, maintenance and repair of the Arena during the lease until 2031;
- make the Arena available for the Olympic Games;
- yield up possession of the Arena to the OCA in 2031 (Jefferies, 2006).

The Sydney SuperDome is a success story and is setting the benchmark for future Public Private Partnerships initiated by the Australian New South Wales Government. In 2006 it was renamed the Acer Arena (Acer Arena website).

5.7 The Private Finance Initiative

The Private Finance Initiative was launched in November 1992 by the then Chancellor of the Exchequer, Norman Lamont. It came against the backdrop of a major programme of privatization during the 1980s under the leadership of the Prime Minister, Margaret Thatcher.

The PFI is a form of PPP that marries a public procurement programme, where the public sector purchases capital items from the private sector, to an extension of contracting-out, where public services are contracted from the private sector. Under the PFI structure, revenue is received from the Government. In contrast, PPP projects are stand-alone and receive no government support.

In 1994, the then Conservative Government introduced the requirement for all central ministry departments to check whether every project they planned was capable of being procured under PFI. With the change of Government in May 1997 the Labour Government conducted a thorough review of the experience of PFI in the previous 5 years. The results of this review – the Bates Review – endorsed the use of PFI and led to a substantially improved process and simplified market (CIC, 1998).

Since 1996, PFI has accounted for around 10–15 per cent of all the UK's gross public investment, with the health and education sectors contributing the greatest number of projects. However the largest capital value projects are in the transport and defence sectors, with the £10 billion Channel Tunnel completed in 1994 and the £17 billion maintenance and upgrading of two-thirds of the London Underground by Metronet.

In July 2007 Metronet went into administration, claiming that the 30-year project was already overspent by £1.2 billion in the first 7.5 years due to London Underground repeatedly asking for work outside the original scope. Metronet's five shareholders, WS Atkins, Balfour Beatty, EDF Energy, Bombardier and Thames Water had already written off considerable sums from their company balance sheets. This case study clearly identifies that major PPP/PFI projects involve potential massive risks for private companies and their shareholders and may not be appropriate for all public projects.

As of November 2011, more than 712 PFI deals had been awarded by the UK Government, including expenditure on schools replacement and refurbishment, prisons, hospitals, new or refurbished health facilities, transport projects including roads bridges, and waste and water projects, with over 150 local authorities involved in PFI projects (HM Treasury, 2012).

Five key lessons concerning PFI projects have been identified in the relentless search for improvement in public services (CBI, 2007):

1 Integrating service and design leads to a whole-life approach.
2 Allocating risks creates incentives for better delivery.
3 Increasing transparency and accountability has wider benefits for government financing.
4 Improving customer and staff satisfaction is key.
5 Opportunities are created to prioritize environmental sustainability.

Although it is well established that PFI has a strong record of achieving the above outcomes and delivering projects on time (69 per cent of projects between 2003 and 2008 were delivered on time, compared to 30 per cent on non-PFI projects) and on budget (65 per cent compared to 27 per cent on non-PFI projects) (cf. National Audit Office, 2009; HM Treasury, 2006), the UK Government's commitment to using PFI as a procurement option has wavered somewhat, and this has led to a review of PFI and introduction of an alternative delivery model that is potentially cheaper and strikes a better balance of risk between private and public sectors (HM Treasury, 2011).

This review was driven by numerous complaints about PFI. First, the high cost of bidding (estimated at £11.5 million for hospitals and £2.4 million on schools projects) and the diminishing number of firms who are prepared to do so. Second, the protracted procurement process (taking up to 9 years and 5 years in the cases of the M25 motorway widening and Paddington Health Campus Scheme, respectively) (National Audit Office, 2011). Another issue of great controversy is the cost of services and its variability across departments and councils. Jesse Norman (Conservative Member of Parliament for Hereford and South Herefordshire, UK) reports in *The Times* (7 May 2012, p. 20) on excesses in the cost of procuring PFI projects, highlighting the £1 billion and £1.5 billion unnecessary cost of the M25 motorway and AirTanker refuelling contracts, respectively, as evidence of the waste. Indeed Daniel Martin (Whitehall Correspondent for the *Daily Mail* in the UK) had also previously reported widespread abuse, with some PFI hospitals for instance being saddled with bills of up to £13,704 for installation of 3 lights in a garden, £8,450 for a dishwasher and £75 for an air freshener (23 December 2011, p. 6).

The new delivery model being introduced to address these concerns, dubbed 'Private Finance 2' (PFII), offers: (1) a greater proportion of government ownership of schemes (up to 49 per cent); (2) public sector representation on project boards; (3) expedited procurement processes to be completed within 18 months; (4) centralized procurement teams within government departments; (5) more transparency of private sector profits, with annual publication of financial performance; (6) profit-sharing with the public sector; (7) reduction in debt-funding from the typical 90 per cent to 80 per cent; and (8) the removal of facilities management contracts from the private finance model (Evans, 2012).

These principles are yet to be operationalized in new schemes, the first of which were named as a £325 million hospital in Birmingham and accommodation for the armed forces (Cross, 2012). It is therefore not possible to provide a detailed analysis of how PFII works in practice. Instead, a detailed review of the traditional PFI approach is provided next to afford the reader an opportunity to see where differences will exist under the new private finance model, and also because some of its essential principles will still be relevant under the new model and will continue to influence the role of the cost manager.

Structure of PFI projects

The aim of the PFI initiative was to bring private sector skills into projects that would have previously been wholly or mainly provided by the public sector. The underlying principle behind PFI has many dimensions. The obvious one is the pure PFI case where a facility and service is provided at minimal cost to the public sector. Second, it is the public sector's exploitation of the private sector's ability to design and manage more efficiently. The public sector is characterized by substantial cost overruns and poor management skills; utilizing PFI and passing over control may eliminate some of these inefficiencies.

The choice of PFI as the most appropriate route for procurement in the UK is governed by HM Treasury rules for developing an outline business case. The Government department has to support an application for funding with appropriate feasibility studies. In addition the department has to demonstrate that significant benefit would be derived from this type of contract over any alternatives. This includes cost savings, but is principally governed by the benefits of transferring inherent risks to the private sector.

In PFI accommodation projects, such as hospitals or prisons, the construction element typically represents around 25 to 30 per cent of the total value of the contract. But other project costs, such as maintenance, will be influenced by the quality of the construction work.

Figure 5.3 shows the commercial structure of a PFI project with the three main parties: the Government customer with the business case; the operation carried out using a special purpose vehicle; and the provider of finance.

The key role in any PFI project is the special purpose vehicle. An SPV is the legal entity, essentially a shell organization, which is created by shareholders in a bidding company or consortium. The SPV is designed to fund the project and contract with the public sector client for the purpose of delivering the PFI service. Depending on what is included in the contract the SPV is likely to include the equity provider, the contractor and a facilities management provider. During the selection process the SPV will need to provide detailed financial models showing how, amongst other things, they intend to fund a project over the lifetime of the project.

The concessionaire is the company, which has been awarded the contract by the public sector client to provide the PFI service. The concessionaire company will either be an SPV established by a bidding firm for the sole purpose of the specific project or an existing company, which will be taking the liabilities of the PFI project 'on balance sheet'. The concessionaire is responsible for the design, construction, financing and operation of the built facility required to provide the PFI service.

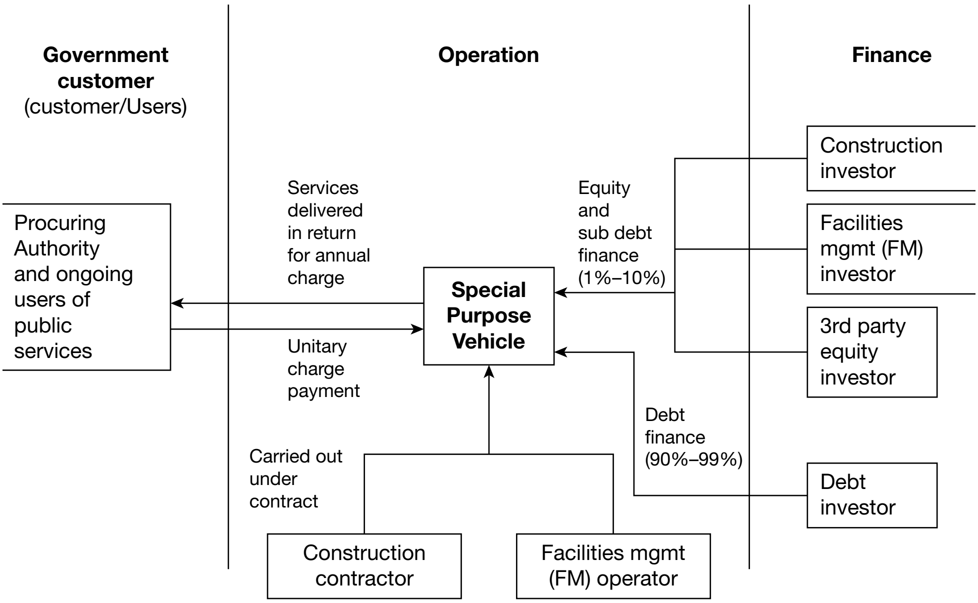


Figure 5.3 A typical commercial structure of a PFI project

Types of PFI strategies

The Treasury has described three different types of PFI strategies:

1 Financially free-standing projects
In these projects the private sector undertakes the design, building, finance, operation and maintenance of the completed asset. The project may involve building a new asset or taking over the operation and maintenance of an asset. Examples include the Skye Bridge, the A50 Stoke–Derby link road and the M40 widening. The concessionaire's revenue is generated from the collection of tolls (real or shadow – based on monitored usage).
2 Services sold to the public sector
In this type of PFI project, the cost of the project is met wholly or mainly by charges from the private sector service provider to the public sector body, which let the contract. Examples include privately financed prisons and hospitals. In the case of prisons, the Prison Service does not lease the prison accommodation; rather, it pays for a complete service provided to the inmates.
3 Joint ventures
The cost of joint ventures is met partly from public funds and partly from private funds, with overall control of the project resting with the private sector. Examples of such projects include the Channel Tunnel Rail Link and the Croydon Tramlink. This type of project requires a value-for-money test conforming to the following criteria:

- private sector partner chosen in competition;
- joint venture control held by private sector;
- a clear definition of government contribution and its limitations;
- clear agreement on risk and reward allocation, defined and agreed in advance.

Government contributions can take various forms and include equity, concession loans and asset transfer. Typically, government contributes through aiding initial planning or granting subsidies.

The PFI process

The four 'p's (4ps) (Public Private Partnership Programme) is a local government central body set up to assist local authorities to develop and procure projects through public-private partnerships and the PFI. The 4ps offers comprehensive procurement support to local authorities including hands-on project support, gateway reviews, skills development and know-how procurement guidance in the form of procurement packs, case studies and extranets.

The 4ps publication, *A Map of the PFI Process: Using the Competitive Dialogue*, provides an overview of the process as a whole and a short introduction to each of the identified stages (Local Partnerships website). The guide states that the PFI transforms local authorities from being the owners and operators of assets, to the purchasers of services.

Once the need for the service/facility is identified, procurement options are considered and investment appraisal exercises undertaken. The conclusions of the detailed options appraisal exercises should be documented in an Outline Business Case (OBC).

From the appraisal of a number of possible project and procurement options, a preferred service delivery option, the *Reference Project*, will be identified; this is the benchmark solution against which bids are subsequently identified. The same project option procured through a traditional route is known as the Public Sector Comparator (PSC) and provides a benchmark against which the value for money of the PFI can be assessed at the OBC stage.

The output specification, developed as part of the suite of bid documents provided to bidders, is arguably the most important document in the procurement of a PFI project. It sets out what is expected of the SPV, written in terms of outputs or outcomes. This means specifying what the authority expects to see as a result of the project rather than how it expects that result to be achieved, thus encouraging innovation.

The payment mechanism has two main elements: availability standards and performance standards. The availability standards define when the asset is considered *available for use*. The performance standards cover any standards not covered by the availability standards: in general the service and maintenance standards.

The authority pays a monthly or yearly *unitary charge* to the SPV. The charge is calculated based on the availability and performance of the facilities and associated services, and deductions are made for poor performance. In order to determine the unitary charge prior to submitting their tender for the project, the sponsors would have to estimate:

- the capital costs of the project;
- the likely financing costs and, hence, debt service responsibilities of the contractor;
- the operating costs of the project for 25–30 years (including subcontractor costs, administrative costs, employment costs, insurance costs, tax liabilities and other costs, expenses and fees);
- any other costs, expenses and risks inherent in the project;
- surplus by way of dividends or interest on subordinated loans.

At the end of the contract term the authority might have the right to acquire the building at a specified value or to walk away if it has no further need for the asset. Alternatively there might be provision to retender the service, with the building being made available to the successful bidder. Whether the SPV gets paid for the asset will depend on the approach to residual value and whether this is reflected in the charges.

Contract management under PFI

The Invitation to Tender should include a draft of the PFI Contract – called the Model Contract. This sets out the terms on which the local authority expects bidders to submit a Standard Bid. The HM Treasury *Standardisation of PFI Contracts* and the service-specific model contracts included in 4ps *Procurement Packs* (where relevant) should be used to develop the Model Contract.

Contract management is the process of managing and administrating the PFI/PPP contract, from the time it has been agreed at contract award, through to the end of the concession period. The 4ps publication, *A Guide to Contract Management for PFI and PPP Projects* (Local Partnerships website) identifies that there are four components of contract management:

1 Setting up the contract management team: determines when the contract management team should be set up, the structure, the attributes and training needs.
2 Managing relationships: establishes relationships, communication routes and systems, and the active support and enhancement of them throughout the life of the project.
3 Managing service performance: assesses whether the services being delivered by the service provider meet the required standards and whether remedial measures are effective.
4 Contract administration: ensures obligations and responsibilities defined under the contract are met, ensuring under performance, risks, payment of the unitary charge, reporting and

change are all managed effectively so that value for money and continuous improvement are achieved.

The 4ps guide also includes a map of contract management involvement throughout the project development and procurement stages.

5.8 Alternative PPP models – local asset-backed vehicles (LABVs)

As efficiency and value for money became increasingly critical and the failings of wholesale outsourcing under PFI became increasingly evident, local asset-backed vehicles (LABVs) emerged as an alternative model for combining public sector assets with private sector expertise and finance as a means of driving development and investment.

Structure of LABVs

In its most basic form, a corporate entity is created in which public and private sectors are equal shareholders. The public sector transfers assets typically in the form of real estate (that is to be managed or developed) to this new entity, and the private sector matches the value of those assets with cash. The cash is then invested to add value to the estate through the provision of infrastructure or other development works. Profits arising from operation or onward sale of such ventures are then shared equally between the public and private sector partners. A typical LABV structure is depicted in Figure 5.4.

The LABV typically has a term of 10–20 years and employs professionals including a construction team, often via tendering on the open market, to deliver the infrastructure or carry out the development works.

According to Grace and Ludiman (2007) who reviewed its potential for accelerating regeneration in cities in a research article published in the *Journal of Urban Regeneration and Renewal*, several regional development agencies in the UK have taken advantage of this model to drive regeneration in their regions, and increasingly local authorities are also adopting this model. Some of these are documented in the RICS review of LABVs (RICS, 2012). One of these examples is previewed in Panel 5.1.

Further elaboration of LABVs and their variants as well as outlines of other PPP models can be found in Grace and Ludiman (2007), Harrison and Marshall (2007), RICS (2012), Thomson (2012) and Out-Law.com.

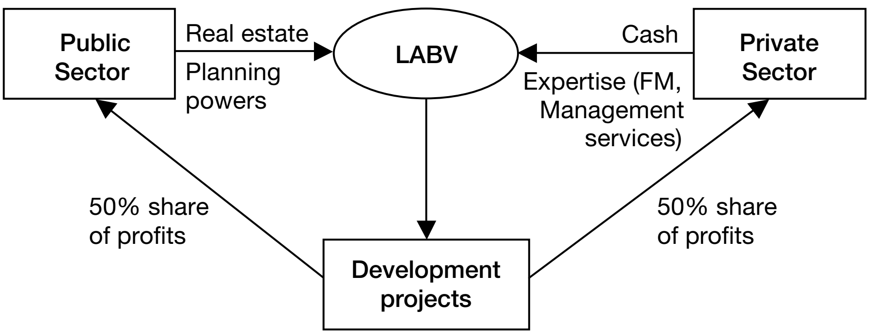


Figure 5.4 Typical LABV structure (adapted from RICS, 2012 and Grace and Ludiman, 2007)

Panel 5.1 Aylesbury Vale District Council LABV

Aylesbury Vale District Council (AVDC) required significant investment for its commercial and retail portfolio that comprised 292 units, generating rental income of £3.6 million per annum. It also had opportunities to redevelop some sites for more commercial uses.

In 2009 it established a joint venture with Akeman Partnership (Strutt & Parker and Guildhouse) called Aylesbury Vale Estate (AVE) in a 50:50 split with a minimum term of 20 years. Its primary aim was to enable the portfolio to be commercially managed and redeveloped to attract new businesses to the area. Akeman Partnership was selected through an OJEU competitive dialogue process.

AVDC transferred an estate portfolio including industrial premises, town centre sites, surface car parks, shops, sports grounds and facilities, community buildings and operational properties such as waste recycling yards at market value to AVE. This was matched by working capital and investment from Akeman.

Since its formation AVE has successfully delivered a number of the Council's key objectives through repositioning and growing the portfolio and enhancing income streams through operational savings and voids reduction, disposal of non-performing assets, acquisition of a shopping centre in a prime location, affordable housing scheme developments and development of a new trade park.

Income from this portfolio through rent and strategic disposals is used to service interest (risk adjusted rate of return) payments on the loan notes issued to the partners for their transfers/investments into the partnership.

The success of this LABV, alongside others, shows that there is a viable alternative development model to PFI.

Sources: www.propertyweek.com/news/aylesbury-vale-starts-asset-backed-vehicle/3151189.article – accessed 12 December 2012; www.gldhse.com/development_aylesbury.htm – accessed 12 December 2012; Aylesbury Vale Estates LLP Business Plan Update 2011.

5.9 The role of the cost consultant in PFI/PPP projects

As previously established, the cost consultant has a significant role to play under the three procurement systems: traditional, design and build and the management approach. Their expertise has developed based on a sound appreciation of construction technology, measurement and estimating, legal and contractual issues, budgeting, cost planning and control systems, change and claims management. A challenge for the profession is to provide services that add value under the PFI procurement route.

During the early stages of the project the client may rely on external advisors to supplement the skills and knowledge bases of the in-house personnel. This is particularly relevant if the client is new to PFI or if in-house resources are being utilized on other projects.

There are three main categories of professionals involved in PFI/PPP projects: financial, legal and technical. The financial advice is usually undertaken by personnel from the major banks and specialist PFI advisors. Likewise, legal advice is usually undertaken by leading lawyers. The technical team includes traditional construction-related specialisms and facilities management disciplines.

Table 5.1 Roles of cost manager and project manager on BOT/PFI projects

Client		*Cost management*	*Project management*
Public sector	Project sponsor	Construction cost advice Public sector rules/OGC gateway advisory and review Business case, public sector comparator advice FM cost advice Procurement strategy Commercial negotiations Tender analysis Risk advice Capital tax advice/VAT Life-cycle cost advice Output specification development Technical evaluation	Bid process management OJEC procedures Advisor team management Construction advice Long-term contract management
Independent	Sponsor and bidder	Independent certifier	Independent certifier
Private sector	Bidder	Construction cost manager FM cost manager Risk manager Capital tax advisor FM consultancy Life-cycle cost manager	PM for SPV SPV bid manager Construction cost manager
	Financier	Technical advisor	Technical advisor

Source: adapted from Hedgecox, *Costing out PFI/PPP*
www.publicservice.co.uk/pdf/pfi/spring2001/p168.pdf – cited 27 November 2012

The process of appointing external consultants will be dependent upon public sector procurement procedures appropriate to the market sector. Clients traditionally appoint advisors independently, but a turnkey appointment may also be used as consultants gain experience of working effectively with each other.

The structure of a PFI project is complex and involves many different parties. Eaton and Akbiyikli (2005) identify that this should create the following advantages for quantity surveyors: their services are required by more parties; added value services are now required and quantity surveyors' services are needed for longer duration. The range of clients that could potentially be serviced by quantity surveyors, include the public sponsor, the SPV, the design and construction companies, the operation and maintenance companies, and the various financial institutions providing equity, commercial loans and debt finance.

The structure for the construction phase of a contract is typically representative of traditional procurement – usually based on the design and build approach. The operational phase will reflect typical facilities management contract structures.

Additionally cost managers have established themselves as independent certifiers – crucially being involved at the sign-off of the project for occupation or use by the client body. Table 5.1 indicates the range of roles undertaken by construction cost and project managers on PFI/PPP projects.

Under the PFI structure the quantity surveyor needs to develop expertise in relatively new areas of knowledge, including: checking the sustainability of the design, validating the acceptability of innovative solutions, developing more expertise in risk management, developing payment systems linked to performance measurement, executing audit procedures and undertaking life-cycle and operational cost management.

5.10 Case study: Stoke-on-Trent schools, UK

In 1997 many of the schools in Stoke-on-Trent were in a dilapidated state and not fit for modern teaching and learning practice. The schools included buildings dating back to the nineteenth century, some of which had not been upgraded or refurbished for 50 years. Furthermore, the annual budget for maintenance of all the schools was £120,000: totally inadequate when one large replacement boiler would cost £80,000. The City Council's annual expenditure was already stretched to its absolute limit, so a radical, brave new way of thinking was required.

In November 2000, after 3 years of intense planning and negotiation, one of the first PFI partnership charters in the UK was signed to cover the refurbishment and maintenance for 25 years of all Stoke-on-Trent's 122 schools. This 5-year capital expenditure scheme was very much a pioneer in PFI school projects. There was no precedence to follow and no standard contracts were available at the time. It is noted that the Treasury Task Force later issued guidance for standardizing the terms of PFI contracts.

The project cycle followed the 4ps process with independent Gateway Reviews at key points, all as the OGC Gateway Process model (National Archives). The different procurement options were considered before selecting the PFI approach. Feasibility studies were undertaken using the Public Sector Comparators as the benchmark. Output specifications were developed embracing such issues as minimum temperature in classrooms. Sophisticated financial models, which included sinking funds and risk allowances, were developed and rigorously tested.

The winning bid was received from a special purpose company called Transform Schools (Stoke), comprising shareholders Balfour Beatty Capital Projects (50 per cent) and Innisfree (50 per cent). The project is unique in being the largest bundled refurbishment scheme ever attempted in England and is valued at £153 million, of which £80 million is for building nine new schools and refurbishing the rest of the portfolio. One of the principal reasons that Balfour Beatty succeeded in securing the contract was its innovative proposal to replace nine schools rather than refurbish them.

Once the SPV was chosen there was a 12-month intense period of activity in which the architects Aedas worked with the school governors to develop acceptable designs. The construction contracts were let on a design and build basis.

The PFI Board, comprising city councillors, representatives from the Department for Education and Skills (DfES) and 4ps, together with the authority's project director, met on a monthly basis. The PFI team comprising the authority's project director, lawyers, financiers and the technical team met on a two-weekly basis. Some meetings comprised over 40 participants, so one of the biggest challenges facing the project team was capturing all the knowledge and expertise and incorporating the feedback into the project.

The key lessons learned from this project include:

- a real belief in the partnering ethos by all the parties. There were difficult problems to resolve throughout the negotiation period but the parties kept talking until these were finally resolved. The original contract, with nine new schools, was extended to a total of 17 new schools; 15 were built by the SPV contractor and two by other contractors;
- detailed identification and evaluation of the main risks throughout the 25-year period to be passed to the SPV. In this contract the additional risks were estimated at 17 per cent.

Some risks were considered unreasonable for the SPV to carry and were retained by the authority, e.g. vandalism in school time;

- the importance of teamwork with the complete integration of the key stakeholders in an open forum;
- attention to detail in the innovative contract, which included:
- a clause requiring the contractor to demonstrate a 20 per cent saving in energy consumption in each school in the first 5 years by 2006 and a further 5 per cent saving by 2010;
- an agreement on the refinancing provision, with the authority retaining 25 per cent of any profits; this was a particularly difficult point for the negotiation team, with the SPV wanting to retain the whole benefit whilst the authority wished to take a 50:50 split;
- the client's involvement in securing a quality design; for example they could comment at the point of handover and the contractor might be required to make changes at their own expense if not acceptable;
- a stipulation that at the end of the 25-year period the estate should be in a position where there would be no major repair necessary for the next 5 years;
- change or variation clauses allowing the authority to bring in other contractors to do the work if the SPV contractor's price for the variation was considered too high.

This pioneering PFI project not only provided one of the best portfolios of school buildings in England but also resulted in other positive features, including: employment of 500 from the local labour force during construction; apprentices taken on by the SPV contractors; and sponsorship of a local community football team. Most significantly there has been a dramatic reduction in school vandalism and a raising of student and teaching staff morale. It is anticipated that the improved buildings will also result in improved student performance in the years to come.

The main parties involved in this pioneering project were:

- Client: *Financial Advisor*, ABROS; *Legal Advisor*, Eversheds; *Technical Advisors*, Gleeds and the Building Research Establishment.
- SPV: *Financial Advisor*, HSBC Plc; *Legal Advisor*, Clifford Chance, Tods Murray; *Technical Advisors*, Summers Inman (life cycle assessments, technical assessments), Hurst Setter (health and safety), Capita (M&E and structural), Walker Cotter (planning supervisor) and Atkins Faithfull & Gould (monitoring engineer/technical advisor to the lending banks).
- *Service Provider*: Transform Schools (Stoke) Limited; *Shareholders (providing the equity)*: Balfour Beatty Capital Projects, 50 per cent and Innisfree, 50 per cent; *Funders (providing the senior debt funding)*: Lloyds TSB and Dexia Public Finance Bank.
- *Subcontractor 1*: Stoke Schools JV comprising Balfour Kilpatrick Limited (Design & Build) and Balfour Beatty (Design & Build); *Subcontractor 2*: Haden Building Management Limited (Hard FM).

(*transformschools.co.uk*; Balfour Beatty; interview with the authority's project director, Mike Inman, 12 July 2007)

5.11 Conclusions

There is strong evidence that PFI projects are far better at keeping to time and budget than other forms of procurement. In spite of the reformation of the existing financial model, it is clear that PFI is here to stay in the UK in one form or another. The PFI arrangement is also attractive to Governments worldwide, as it allows them to keep public borrowing down as the projects are funded throughout their usable life cycle. However, the evidence on quality of service and to some extent design is mixed.

To date, it would appear that the most successful projects have been of the financially freestanding variety, e.g. the Dartford Crossing. However, there was widespread frustration at the lack of projects financially closed, particularly in the health sector. Likewise, in the highway sector there has been frustration at the time and cost involved in the Design, Build, Finance and Operate (DBFO) market. It is not uncommon for DBFOs to take nearly 2 years from receipt of tender documents to financial close and for the bidding process to cost more than £3 million.

Initially local authorities had an ambivalent attitude towards the initiative but have now embraced it wholly, particularly for the provision of schools. These projects create opportunities for smaller contractors executing the building work as subcontractors.

In practice, construction cost managers and project managers have established themselves as key participants within PFI/PPP projects in a number of areas. As well as performing advisory roles for public sector clients, cost and project managers are called upon to assist with the other key parties to a PFI/PPP transaction, namely the bidders and the financiers. Construction cost managers and project managers have a significant role to play in this challenging environment not only in the UK but also internationally in countries such as South Africa and Australia.

5.12 Questions

Question 1

The proposal is to widen the M6 motorway between Birmingham and Manchester – a distance of 80 miles – from 3 lanes each way to 5 lanes each way. Bids are invited from international consortia to execute the project under a PFI arrangement.

Identify the main risks for the public sponsors, the SPV, the lenders and the contractors under the following headings:

1 social
2 legal
3 economic
4 environmental
5 political
6 technological.

For a solution, see Figure 6.2, p. 68 in Eaton and Akbiyikli's *A Report on PFI and the Delivery of Public Services: Quantifying quality*', RICS (2005).

Question 2

Compare and contrast the key differences between traditional public sector procurement and PFI (for a solution, see CIC, 1998 p. 10).

Question 3

Identify the key issues and the lessons to be learned on the PFI case study *The Redevelopment of the Cruciform Building, University College London*:

www.hefce.ac.uk/Pubs/hefce/1999/99_43.htm – cited 17 June 2012.

Question 4

The NAO has produced over 72 reports on PFI/PPP projects. Make a 10-minute presentation to your peers on the key findings and recommendations of one report: www.nao.org.uk/publications.aspx?y=All&s=4205&c=All&t=488 – cited 15 June 2012.

Question 5

Eaton and Akbiyikli's research at the University of Salford "A report on PFI and the delivery of public services: Quantifying Quality", contains eight case studies. Make a 10-minute presentation to your peers on the key findings and recommendations of one case study: http://usir.salford.ac.uk/433/1/QuantifyingQualityPFI_Report.pdf – cited 17 June 2012.

Question 6

The Commission for Architecture and the Built Environment's (CABE) *Client Guide: Achieving well designed schools through PFI*, gives a good overview of the design process under a PFI project. Make a 10-minute presentation to your peers on the recommendations from one chapter (Chapters 2 to 7):

http://webarchive.nationalarchives.gov.uk/20110118095356/http:/www.cabe.org.uk/files/achieving-well-designed-schools-through-pfi.pdf – cited 17 June 2012.

5.13 References/further reading

Acer Arena: www.acerarena.com.au – cited 24 March 2007.

Akintoye, A., Beck, M. and Hardcastle, C. (eds) (2003) *Public-Private Partnerships: Managing risks and opportunities*, Blackwell Publishing.

Balfour Beatty: www.balfourbeatty.com – cited 23 March 2007.

Boussabaine, A. (2006) *Cost Planning of PFI and PPP Building Projects*, Taylor & Francis.

CBI (2007) *Building on Success: The Way Forward for PFI*, Confederation of British Industry.

Cheung, E., Chan, A.P.C. and Kajewski, S. (2010) 'Suitability of procuring large public works by PPP in Hong Kong', *Engineering Construction & Architectural Management*, Vol. 17, No. 3, pp. 292–308.

Construction Industry Council (CIC) (1998) *Constructors' Key Guide to PFI*, Thomas Telford.

Cross, L. (2012) 'New PFI: First projects revealed', *Construction News*, 4 December.

Dinesen, B. and Thompson, J. (2003) *PFI/PPP Projects – Are They Working?*, Major Projects Association.

Eaton, D. and Akbiyikli, R. (2005) *A Report on PFI and the Delivery of Public Services: Quantifying quality*, RICS: http://usir.salford.ac.uk/433/1/QuantifyingQualityPFI_Report.pdf – cited 17 June 2012.

Evans, R. (2012) 'George Osborne to announce new private finance initiative: Details in autumn statement', *Construction News*, 4 December.

gov.uk: www.dft.gov.uk/statistics/series/light-rail-and-tram – accessed 29 May 2012.

Grace, G. and Ludiman, A. (2007) 'Local asset backed vehicles: The potential for exponential growth as the delivery vehicle of choice for physical regeneration', *Journal of Urban Regeneration and Renewal*, Vol. 1, No. 4, pp. 341–353.

Grimsey, D. and Graham, R. (1997) 'PFI in the NHS', *Engineering, Construction and Architectural Management*, Vol. 4, No. 3, pp. 215–231.

Harrison, B. and Marshall, A (2007) *City Solutions: Delivering local growth – local asset-backed vehicles*, PricewaterhouseCoopers/Centre for Cities.

Hawash, K. and Barnes, M. (1997) 'The potential for adopting the NEC's family of contracts on PFI projects', *Engineering, Construction and Architectural Management*, Vol. 4, No. 3, pp. 203–214.

Hickman, D. (2000) *PFI and Construction Contracts*, Chandos Publishing.

HM Treasury (2006) *PFI: Strengthening long-term partnerships*, HMSO: www.hm-treasury.gov.uk/media/1E1/33/bud06_pfi_618.pdf – accessed 6 December 2006.

HM Treasury (2011) *Government Plans To Reform PFI Model*: www.hm-treasury.gov.uk/press_128_11.htm – accessed 31 May 2012.
HM Treasury (2012) PFI data: www.hm-treasury.gov.uk/ppp_pfi_stats.htm – accessed 30 May 2012.
HM Treasury: www.hm-treasury.gov.uk/d/pfi_equityholders.xls – accessed 29 May 2012.
Jefferies, M. (2006) 'Critical success factors of public private sector partnerships: A case study of the Sydney SuperDome', *Engineering, Construction and Architectural Management*, Vol. 13, No. 5, pp. 451–462.
Jefferies, M., Gameson, R. and Rowlinson, S. (2002) 'Critical success factors of the OOT procurement system: Reflections from the Stadium Australia case study', *Engineering, Construction & Architectural Management*, Vol. 9, No. 4, pp. 352–361.
Kumaraswamy, M.M. and Zhang, X.Q. (2001) 'Governmental role in BOT-led infrastructure development', *International Journal of Project Management*, pp. 195–205.
Li, B. (2003) *Risk Management of Construction Public Private Partnership Projects*, PhD thesis, Glasgow Caledonian University, UK.
Local Partnerships: www.localpartnerships.org.uk – cited 6 May 2012.
Merna, T. and Njiru, C. (2002) *Financing Infrastructure Projects*, Thomas Telford.
NAO (2009) Performance of PFI Construction, A review by the private finance practice, National Audit Office.
National Archives: http://webarchive.nationalarchives.gov.uk/20100503135839/http:/www.ogc.gov.uk/what_is_ogc_gateway_review.asp – cited 6 May 2012.
National Audit Office (2003) *PFI: Construction Performance*, Report by the Comptroller and Auditor General HC371 Session 2002–2003, 5 February.
National Audit Office (2011) Report by the Comptroller and Auditor General HC920 Session 2010–2012.
National Audit Office: www.nao.org.uk/publications – cited 20 May 2007.
Out-Law.com: www.out-law.com/en/topics/property/structured-real-estate/local-asset-backed-vehicles – accessed 12 December 2012.
Owen, G. and Merna, T. (1997) 'The Private Finance Initiative', *Engineering, Construction and Architectural Management*, Vol. 4, No. 3, pp. 161–162.
Payne, H. (1997) 'Key legal issues in projects procured under the private finance initiative', *Engineering, Construction and Architectural Management*, Vol. 4, No. 3, pp. 195–202.
RICS (2003) *Project Management and the Private Finance Initiative*, RICS: www.observatory.gr/files/meletes/Project%20management%20and%20the%20PFI.pdf – cited 18 June 2012.
RICS (2012) *Local Asset Backed Vehicles: A success story or unproven concept?*, RICS.
Thomson, A. (2012) 'Regeneration revisited', *Public Finance*, http://opinion.publicfinance.co.uk – accessed 12 December 2012.
Tiong, R.L.K. (1990) 'Comparative study of BOT projects', *ASCE Journal of Management and Engineering*, Vol. 6, No. 1, January, pp. 107–122.
Transform Schools: www.transformschools.co.uk – cited 13 July 2007**.**
United Nations Industrial Development Organisation (UNIDO) (1996) *Guidelines for Infrastructure Development Through Build-Operate-Transfer (BOT) Projects*, UNIDO, Vienna.
Walker, C. and Smith, A. (1995) *Privatized Infrastructure: The build, operate and transfer approach*, Thomas Telford.
World Bank Infrastructure Governance Roundtable United Kingdom PPP Forum: www.worldbank.org/transport/learning – cited 23 March 2007.

Websites

http://en.wikipedia.org/wiki/Private_Finance_Initiative – cited 24 May 2007.
www.localpartnerships.org.uk.

6 Contractor's estimating and tendering

6.1 Introduction

In the *Code of Estimating Practice* the Chartered Institute of Building defines estimating as 'the technical process of predicting costs of construction' and tendering as 'a separate and subsequent commercial function based on the estimate' (CIOB, 2009). At first sight the production of an estimate might appear to be a precise technical and analytical process. However, in reality it is often a subjective process based on knowledge and experience of the key participants.

The estimating process is very important as it enables construction companies to determine their direct costs and to provide a *bottom-line* cost below which it would not be economical for them to carry out the work (Smith, 1995). Overestimated costs result in a higher tender price and rejection by the client. Likewise, an underestimated cost could lead to a situation where a contractor incurs losses. If the contractor is selected, then the estimate should also provide the basis for project budgeting and control.

The submission of successful tenders is obviously crucial to the very existence of contractors. Yet a fundamental truth of competitive tendering, particularly on major works, is that the lowest tenderer is often one who has most seriously underestimated the risks, which obviously could have drastic consequences, particularly in times of recession when margins are slim to say the least.

A study by Al-Harbi *et al*. (1994) identified that the main problems facing estimators in Saudi Arabia while compiling tenders for building works included: tough competition, short contract period, incomplete drawings and specification, incomplete project scope definition, unforeseeable changes in material prices, changes in owners' requirements, current workload, errors in judgment, inadequate production time data, lack of historical data for similar jobs and lack of experience of similar projects. These items indicate the challenges faced by estimators no matter where the work is carried out.

Further research on the factors influencing project cost estimating practice in the UK (Akintoye, 2000) identified several key issues, including: complexity of the project, scale and scope of construction, market condition, method of construction, site constraints, client's financial position, buildability and location of the project. It is believed that these factors have a direct effect on the productivity levels on site and the overall performance of the project.

Additional research by Akintoye and Fitzgerald (2000) identified that the most significant factors resulting in inaccurate estimates included: insufficient time for tender preparation; poor tender documentation; insufficient analysis of the documentation by the estimating team;

low level of involvement from the site team that will be responsible for construction; poor communication between the estimating and construction teams and lack of review of cost estimates by company management. Tendering for work in an area of which contractors have little knowledge is also a significant reason leading to inaccurate estimating (Carr, 1989). Thus, when tendering for work overseas, UK contractors sometimes form joint ventures with home-based contractors.

Smith (1995) identified three main factors which could lead to inaccurate estimates: inappropriate assessment of risk, inappropriate contract strategies and human characteristics of the individual estimator.

Despite these challenges, however, there can be scope for innovation when tendering. It is not unknown, on major civil engineering projects, for the award to be made to the contractor who has devised a more economic design than the one proposed by the engineer for part or even the whole of the works. Furthermore, contractors have been awarded contracts even though their tenders were not the lowest; this may be due to a highly original method statement and design solution for the temporary works. On major international infrastructure projects it is not unknown for the major *big six* Japanese contractors to offer the client a deferred payment scheme. Japanese firms will often bid low and provide an excellent service in the hope of establishing a new, long-term, loyal customer.

Detailed investigation and pre-planning is essential as considerable site overhead costs can be saved by early completion of the project; these costs include salaries of site staff, accommodation, site services and standing construction equipment.

However, before any estimates can be submitted, the first step for contractors is to get onto the tender lists. This could be done on an *ad hoc* basis or preferably in accordance with a longer-term strategic marketing plan. This plan, which could be a 5-year plan, should be based on an analysis of the past and consideration of the future trends within the market, and should be re-examined on an annual basis and modified accordingly.

6.2 Stage 1 – decision to tender

The first stage in the tendering process is the decision to tender. The purpose of the initial overall appraisal is to highlight any high values or any particular problems that may require specialist attention; it can also identify possible alternative methods of construction or temporary works.

Panel 6.1 Case study: Cessnock Dock Railway, Glasgow

Winning contracts through innovation is not a new concept. In 1893 the original Robert McAlpine won a contract for the Cessnock Dock Railway in Glasgow with a tender far below any other. Everyone agreed that it would be impossible for him to do the work for the tender as he had no means of transporting the substantial amount of excavated material from the project to the sea where it was required to be dumped.

Excavations on the job were made in plastic clay, in shale and in sand. A brick-making plant was constructed and, in the event, every brick used in the project was made from the excavated material and millions of bricks were sold. Roads were constructed to the sandpits and McAlpine not only had the sand hauled away for him but was paid a fair price.

Source: J. Saxon Childers, 1925

As soon as the tender documents are received the estimator should quickly skim through the documents in order to establish the following:

- amount and type of work involved in the project and whether the company has any competitive advantage;
- the approximate value of the project together with a review of the major resources required, particularly construction equipment, staff, key subcontractors and suppliers;
- the programme requirements, i.e. completion dates, sectional completion and critical milestone dates – will these require excessive overtime?;
- the Form of Contract, Specification, Method of Measurement and if any amendments have been made to standard documents;
- the time and resources required for preparation of the tender;
- whether any contractor's design is required and whether the main contractor is required to accept liability for any subcontractors' design. The contractor should be provided with a design brief and a performance specification clearly identifying their design responsibility;
- possible alternative methods of construction (where the contractor's expertise leads them to consider that a more economical design could be used, e.g. precast piles in lieu of cast in situ);
- design for temporary works (including support structures/cofferdams/temporary bridges/river diversions/special shuttering/scaffolding/ground water control systems, etc.);
- whether the risks are acceptable. These could include: weather conditions /flooding/suitability of materials – particularly filling material from quarries/reliability of subcontractors/non-recoverable costs, e.g. excesses on insurance claims/outputs allowed, namely productivity/cost increases/terms and conditions in contract/ability to meet specification for price allowed/availability of labour/plant) and whether the tender is of particular interest;
- contract requirements for performance bonds, warranties and parent company guarantees. For example, under clause 10 – 'Performance security' of the *ICE Conditions of Contract*, 7th edition, the contractor may be required to obtain and provide the employer with such security in a sum not exceeding 10 per cent of the tender total;
- insurance requirements and excesses (these must be checked against company policies);
- funding requirements for the project. It will be necessary to plot income against expenditure using the programme of works and the BofQ/priced activity schedule – payments in arrears and retentions, both from the employer and to suppliers and subcontractors, must be considered.

Upon completion of the review the estimator should complete a pre-tender data sheet, grade the tender based on the interest to the company and recommend whether or not to tender (see CIOB, 2009). If a contractor decides not to tender, the documents should be returned to the employer; however, in practice this rarely occurs.

Öztaç and Ökmen (2004) note the importance of identifying the risks at the pre-tender stage and developing a risk management strategy. They describe a case study involving a new police station in Turkey based on a fixed-price design and build approach in which the inexperienced contractor agreed to execute the project in a timescale that was 30 days shorter than a realistic timescale, with resultant losses.

The technical process of predicting the net cost of the works is carried out by a team comprising the estimator, planning engineer, materials estimator and estimating technician, together with possible contributions from temporary works designers and an experienced construction manager if the work is of a specialist or complex nature. At the end of the process the team will produce the *cost estimate*. The *estimate* is the prediction of the cost to the contractor. The *tender* is the price submitted by the contractor to the employer.

6.3 Stage 2 – determining the basis of the tender

During this stage the estimator, prior to the preparation of the cost estimate, will disseminate and assemble the key information and generally become familiar with the documents. Unlike pricing a bill of quantities in the building sector, a civil engineering BofQ/priced activities can be priced only when read in conjunction with the engineer's drawings and the specification. Projects carried out for water authorities and railway or road transport authorities are normally in accordance with standard sector specifications.

Enquiries will be sent to subcontractors and major materials suppliers, the latter often based on the quantities calculated by the contractor's quantity surveyor from drawings. The contractor should also check that the major quantities in the BofQ are correct; if any are found to be incorrect, this factor will be considered later at the commercial appreciation stage. The contractors' and subcontractors' estimator should be familiar with the measurement rules specified within the contract method of measurement. For example, under Class E 'Earthworks' of CESMM4 the excavation is computed net using dimensions from the drawings. Significantly, coverage rule C1 states: *Items for excavation shall be deemed to include upholding sides of excavation, additional excavation for working space and removal of dead services*. Thus the contractor/subcontractor should include for all these items in their excavation rates as they will not be measured separately. The bills of quantities are not a guarantee of the final quantities, only an estimate. The quantities are usually subject to remeasurement on completion based on the latest engineer's drawings or on records taken on site, e.g. excavated rock quantities.

However, the most important part of this stage is for the team to determine the *construction method* and sequence upon which the tender is based, together with an *outline programme of the works*, two items that are inseparable.

The construction method will often be dependent on the design of the temporary works necessary to enable the permanent works to be constructed. Temporary works are normally designed in-house by the contractor but, in the case of scaffolding and falsework, design may be supplied by specialist contractors.

Temporary works may have considerable time and cost implications, and can include cofferdams and temporary bridges on river-works, temporary piling and jetties on marine projects, overhead gantries on elevated motorways, dewatering systems and grout curtains on deep basements, etc.

The contractor may further be required to design part of the works to meet a performance specification, for example concrete specified to strength or piling to a load-carrying capacity; this design would often be undertaken by specialist suppliers or subcontractors.

A further involvement of the contractor's design department may be in identifying more economic alternative design solutions for sections of the permanent works. This is often done in the hope of sharing the saving involved, which could be considerable.

The programme could be in the form of a bar chart or in the case of major works based on a network showing the critical path produced utilizing computer software. The programme will be used by the successful contractor as a control document for monitoring progress and calculating the effects of delay and disruption to the flow of the works.

The programme is particularly important as 15–40 per cent of the cost of civil engineering work is time-related, and many items such as site overheads are computed directly from it. Furthermore, as most contractors will be bidding using the same quotations from subcontractors, hirers of construction equipment and materials suppliers, obtaining a saving in time is one of the few ways in which the contractor can show a substantial saving to the project cost.

The NEC3 Guidance Notes (NEC, 2005) state:

> Provision is made in the Contract Data for a programme either to be identified in the Contract Data part two at the Contract Date or to be submitted by the Contractor within a period stated in the Contract Data part one. . . . Employers may wish to have programmes submitted with tenders in order to judge whether a tenderer has fully understood his obligations and whether he is likely to carry out work within the stated time, using the methods and resources he proposes. Any doubts on these matters can then be resolved after submission of tenders.

(Asking contractors to submit programmes and method statements with their tender has potential risks for clients, as highlighted in the legal case *Yorkshire Water Authority v Sir Alfred McAlpine & Son (Northern) Ltd* 1985 32 BLR 114.)

During this stage the estimator will need to identify any inherent restrictions (e.g. delivery of bulk materials by rail or water) and any items on long delivery (e.g. special equipment). They will further need to consider alternative methods of construction, sequence of construction and the level of utilization of resources.

In accordance with the requirements of the standard conditions of contract, the contractor is deemed to have inspected the site and examined its surroundings. The contractor may also visit the engineer's office and the local authority in order to examine core samples, location of existing services, traffic requirements and any other relevant information available. If the contractor is to be responsible for the design of a significant part of the works, then the contractor may need to carry out further site investigations. However, it is the employer who should identify how this can be done most efficiently.

Following the site visit a comprehensive standard pro-forma checklist will normally be prepared listing such items as: access to site, site security, provision of services, soil and groundwater information, nature of excavation fill and disposal, nearest tipping facilities, availability of labour, construction equipment and materials, site organization and layout, land purchase for borrow pits, etc.

A method statement is prepared in conjunction with the programme, setting out the quantities of work, method of executing the work, the sequence of operations, the resources, i.e. labour gangs and construction equipment required, the anticipated productivity output levels and overall

METHOD STATEMENT
Contract: New Reservoir, Bryn Gwynant — **Sheet No:**
Tender No: — **Prepared by:**
Date:

No.	OPERATION	QUANTITY	METHOD	SEQUENCE OF OPERATIONS	PLANT AND LABOUR	OUTPUT	DURATION
1.	Strip topsoil	7,500 m^3	Excavate using loading shovel and transport to temporary tip using dump trucks		Loading shovel and three dump-trucks	50 m^3/hr	15 days
2.	Drainage to dam	300 m	Excavate using backactor, load, transport to temporary tip using dump trucks	Excavate, load trench support, lay pipes, backfill	Backactor + three dump trucks	Based on 3 gangs 15 m per day	20 days

Figure 6.1 Typical method statement

durations, which should be the same activity durations shown on the programme. The method statement is a key document in the preparation of the tender and should consider the site visit report, the geotechnical report, the sequence and methods for the main operations of work, subcontracted work, bulk quantities, schedule of labour and construction equipment and any temporary works required. At the same time separate histograms could be produced showing the key construction equipment, staff and site supervision and labour requirements.

The Construction (Design and Management) Regulations 2007 (CDM 2007) also require the principal contractor before the start of the construction phase to prepare a construction phase plan which is sufficient to ensure that the construction phase is planned, managed and monitored in a way which enables the construction work to be started so far as reasonably practicable without risk to health and safety. This plan may be required as part of the tender. The CDM 2007 Regulations also require the principal contractor to ensure that the construction phase plan identifies the risks to health and safety arising from the construction works and includes suitable and sufficient measures to address such risks.

Stage 2 can thus be summarized as follows:

- Examine key documents: drawings/specification /BofQ (Works Information, Site Information, Contract Data).
- Send enquiries to major subcontractors and materials suppliers.
- Check major quantities in the Bill of Quantities.
- Determine the method of construction and the outline programme of the works.
- Examine more economic alternative designs, design temporary works and any necessary permanent works.
- Identify inherent restrictions, e.g. access to site/transport.
- Visit engineer's office – examine core samples.
- Visit site – compile site visit report. A typical site visit would ensure that the following items were identified:
    - project particulars – contact details;
    - site position – distance from office and plant depot, public transport facilities, adjacent buildings, hazards;
    - site conditions – ground conditions, water level, security, space for accommodation, working space;
    - access – traffic restrictions, temporary roads required;
    - local facilities – availability of services, overhead and underground services, location of nearest tipping, availability of fill material/aggregates;
    - local contacts – availability of labour, subcontractors;
    - other contractors working on or adjacent to the site; and
    - sketches/photographs.

6.4 Stage 3 – preparation of cost estimate

During this stage the estimator will assemble information on the net cost of the works, including calculating: the current rates for labour, materials and construction equipment; the unit or activity rates; the preliminaries or general items; and finally the summaries.

Current rates for labour, materials and construction equipment

The rates for labour will be the *all-in* rates, i.e. the contractor's total cost per hour of employing the different categories of labour. These hourly rates are calculated based on the basic rates as the national working rule agreement with the defined allowances for special skills together with bonus payments, holiday pay, CITB levy, employers' insurance, etc. An example of the detailed build-up of the 'all-in' labour rate is shown in the latest copy of *Spon's Price Book for Civil Engineering Works*.

The rates for material should cover transport to site, offloading/storage, unavoidable double handling and waste. Prices for bulk materials must be scrutinized in order to ensure that they meet the specification and testing/sampling requirements; delivery must also meet the demands of the programme.

The construction equipment rates should cover transport to site, erection/dismantling, operators, maintenance and fuel. Major static items of construction equipment such as tower cranes are normally priced separately in the general items or method-related charges section, whilst other items are often included in the individual rates.

Unit rates for each item in the BofQ/ activity schedule

The three main estimating techniques used by contractors when pricing major construction works are detailed below.

Unit rate estimating

Unit rate estimating, which is the standard procedure in the sector, involves pricing individual rates in the BofQ which has been prepared in accordance with a method of measurement, e.g. SMM7. The unit rates are calculated using one of the following methods:

- historical rates based on productivity data from similar projects;
- historical rates based on data in standard price books, e.g. Spon's, Wessex, Laxtons, *Hutchins UK Building Costs Blackbook*;
- *built-up* rates from an analysis of labour, materials and construction equipment for each item and costed at current rates.

There are several possible disadvantages of using the unit rate method for estimating major works. The system does not demand an examination of the programme or the method statement and does not encourage an analysis of the real costs and major cost risks in undertaking the work. Furthermore, the precision and level of detail in pricing each item can give a false sense of confidence in the resulting estimate.

Generally, it is not recommended that the data from standard price books are used in the estimating of major civil engineering works, either at tender or when variations are required. The reason for this is the possible differences in ground conditions, method statements, temporary works, availability of construction equipment, location of the project and the time of year in which the work is executed, etc. Each project should be considered on its own merits and the cost estimate based on first principles using the operational method.

Operational estimating

Operational estimating, which is the recommended method for estimating civil engineering works, requires the estimator to build up the cost of an operation based on first principles, i.e. the total cost of the construction equipment, labour and permanent/ temporary materials. This method of estimating links well with the planning process as it embraces the total anticipated time that the construction equipment and labour gang are involved in the operation, including all idle time.

Harrison (1994), identifies that operational estimating is particularly relevant where specialist equipment with high transport costs is required and where gangs with specialized experience cannot easily be utilized on other operations when not fully engaged in their own work, for example on piling, excavation and concrete work. Harrison (1994) includes a good example showing the calculation of four major excavation items based on the same labour and plant rates. Method A, based on the operational approach, equates to £15,250 whilst Method B, based on a build-up of the individual items, equates to only £13,329. The main difference is that the operational approach was calculated based on a programme time in weeks, whilst the individual items were calculated based on a theoretical production output per hour.

If a BofQ approach is used, the total cost of the operation is then divided by the total quantity in the BofQ to arrive at an appropriate rate. A significant advantage of this approach is that it provides a complete integration between the estimate and the programme, which in turn enables a project cash flow to be produced. Furthermore, the pricing of operations, or activities, is obviously compatible with the NEC ECC *priced activities* approach. The process involves:

- compiling a method statement showing sequence, timing and resources required;
- refining the method statement to show an *earliest completion* programme with no limit on resources;
- adjusting the programme by *smoothing* or *levelling* the resources in order to produce the most economic programme to meet the time constraints;
- applying current unit costs: fixed, quantity proportional and time-related.

Work package		**Activity (duration)**		**Quantity**
Imported natural material other than topsoil or rock; granular graded material; filling, general 250mm thick		**F100** **11 days**		**5,000 m^2**
Charges				**Value**
Operational charge 5,000 m^2 x 250 mm depth of fill = 1,250 m^3 Base on all-in output 0.07 hr/m^3 Then overall time is: 1,250m^3 x 0.07 = 87.5 hr ÷ 8 hrs/day = 10.9 days (say 11 days) 11 days x 8 hours x £61				5,368.00
Resources allocated Hourly cost JCB JS150 30 Roller 15 Labourer x 2 16 ----- £61/hour				
Materials schedule				
Description	**Qty**	**Unit**	**Rate (£)**	
Type 1 Granular material	1,250 m^3 Waste 10%	m^3	25.00	31,250.00 3,125.00
				39,743.00

Figure 6.2 Example of a priced activity: filling 250mm thick

Establishing realistic productivity levels for labour and construction equipment on major operations can prove difficult, particularly on overseas work. However, the operational estimating approach enables the estimating team to better appreciate the major risks and uncertainties in the work.

Man-hours estimating

Man-hours estimating is most suitable for work which has significant labour content and/or for which extensive reliable productivity data exists for the different trades/specialisms involved. Typical applications include:

- design work and drawing production, both engineering and architectural;
- installation of process plants and offshore modules.

This method of estimating is frequently used by the major mechanical and electrical contractors as well as by the large American contractors e.g. Bechtel. It should be used in conjunction with a construction programme/schedule in order to highlight any restrictions, e.g. availability of heavy-lifting equipment, which may affect labour hours expended in fabrication yards or on site.

Example: operational method of estimating

The question relates to the construction of a reinforced concrete basement (size 50 m x 30 m x 10 m deep) built below ground on a greenfield site.

The contractor's estimator is required to calculate an appropriate BofQ rate for the following.

E326	Excavation for foundations, material other than topsoil, rock or artificial hard material maximum depth 5–10 m	15,000 m^3.

Approach: Consider two alternative construction methods:

Method A: Open cut with battered sides (assume total volume of excavation equals 2.5 x net volume) – the open cut method will require additional working space to allow for erect and strip shutter to the outer face.

Method B: Steel cofferdam built around net perimeter of basement.

Assume the following net costs (based on quotations from subcontractors):
Excavation open cut: £10 per m^3
Disposal on site: £1 per m^3
Bring back and fill: £2 per m^3.

Excavation restricted within cofferdam: £25 per m^3
Sheet piling (assume 15 m deep): £35 per m^2
Mobilization/demobilization piling rig: £5,000 each way
Extract cofferdam piling: £5,000
Site overheads: 10 per cent, head office overheads and profit: 12 per cent.

Solution

Costs of Method A (open cut)

Figure 6.3 Method A (open cut)

Excavating in open cut	15,000 x 2.5 m^3 = 37,500 m^3 @ £10/m^3	£ 375,000
Disposal on site	37,500 – 15,000 = 22,500 m^3 @ £1/m^3	£ 22,500
Bring back and fill	22,500 m^3 @ £2/m^3	£ 45,000
	Total net cost	£ 442,500

It is up to the contractor to select the most economic method of working. The additional excavation required is dependent on the nature of the ground and the natural slope of inclination – generally the harder the material, the steeper the slope.

Costs of Method B (steel cofferdam)

Sheet piling – mobilization/demob	2 x £5,000	£ 10,000
Sheet piling	160 x 15 = 2,400 m^2 @ £35/m^2	£ 84,000
Excavate within cofferdam	15,000 m^3 @ £25/m^3	£375,000
Extract cofferdam		£ 5,000
Total net cost		£474,000

Thus, based on the above, the estimator would choose the open cut method.

Net cost of open cut method	£442,500
+ 10 per cent site overheads	£ 44,250
	£486,750
+ 12 per cent head office overheads and profit	£ 58,410
	£545,160

So, the rate to be included in the BofQ should be £545,160/15,000 m^3 = £36.34/m^3.

Figure 6.4 Method B (steel cofferdam)

Subcontractors

The management of subcontractors can make or break a contract, as typically subcontractors comprise over 75 per cent of the total work executed. Few contractors have the necessary continuity in projects to justify purchasing specialist plant or have the expertise necessary to execute all the work, e.g. specialist piling or diaphragm walling, hence the use of subcontractors. Indeed, over the years the role of the main contractor has shifted from a traditional works contractor towards the management of works packages.

However, it is still a prudent policy for main contractors to price as much of the basic subcontract work as if it were being carried out by their own resources. This should ensure that the work is adequately priced and reduce the risk to the main contractor. Laryea (2009) describes in detail the actual process used by two major civil engineering contractors when dealing with subcontractors and suppliers as part of the bidding process. Brook (2008: 117) further notes that

> For design and build projects, there are additional responsibilities for sub-contractors, not least the development of the concept design and completion of working drawings. Sub-contractors are expected to submit with their tender, risks that have been identified and priced in their offer. It is important that the main contractor ensures that there is no duplication of risk allowances in the tender.

The construction industry has traditionally had an uneasy relationship with its subcontractors, often going back to subcontractors in order to gain price reductions or increased discounts after tender award. Furthermore, main contractors choose to dump as much risk as possible onto subcontractors through the use of penal clauses in the subcontract documents. However the more enlightened clients are now adopting a partnering approach with integrated project teams and fair conditions of contract, e.g. the NEC ECC subcontract form.

> Enlightened contractors could conduct a buildability review with the specialist designers in order to identify more economic/practical/safe methods of working. The developed improvements might or might not be declared at tender, depending on the particular terms of the contract. For example, under a target cost contract it may be advisable to leave the identification of these savings until the construction stage.

General items (preliminaries)

The general items or preliminaries represent the cost of operating the site and will need to be calculated separately. These items can be included on a time-related or a fixed-price basis. Typical general items on a major civil engineering project might include:

- site staff, including project manager, agents, engineers, foremen, quantity surveyors, office manager, store keeper, clerks, secretarial;
- head office staff allocated to project, e.g. designers, health and safety;
- company cars;
- site offices, mess huts, toilets, running costs;
- transport for construction equipment;
- general site labour;
- services connections and running costs;
- haul roads;
- temporary fencing;

- construction equipment purchases, including personnel carriers, land rovers, compressors, pumps, cranes, miscellaneous;
- scaffolding and hoists;
- access for subcontractors;
- small tools;
- plant consumables, including fuel and fuel distribution;
- contract works insurances;
- setting up compounds;
- security;
- signboards;
- road cleaning facilities;
- computing equipment;
- office stationery, etc.

If the contractor is successful and is awarded the contract, then detailed records will need to be kept for these preliminaries items. If any extension of time claims are made, these items will form the basis of the *site overheads* component within a prolongation claim.

Preparation of summaries, tender summary, analysis sheets, special conditions

This section is basically the bringing together of the different elements that make up the estimate.

Stage 3 (preparation of the cost estimate) can be summarized as follows:

- Calculate current cost rates for labour/materials/plant.
- Calculate unit rates for each item using one of the following methods:
  1. operational method (based on method statement and construction programme – consider total resources i.e. teams of operatives and equipment);
  2. unit rates (normal approach in the building sector);
  3. man-hours estimating (used by US contractors on petrochemical projects – based on work-study feedback).
- Analyse and check subcontractors' quotations.
- Price preliminaries.
- Prepare summary sheets.

6.5 Stage 4 – commercial appreciation

Tender committee meeting – part 1

Following the production of the cost estimate a small management team, comprising the chief estimator and proposed contracts manager, will make a separate comprehensive evaluation of the estimate to ensure that the bid is both feasible and commercially competitive.

The first task of the senior management team at this tender committee meeting is to review the estimate taking into account the construction method and programme, the technical and commercial risks, the contract cash flow and finance, the potential for use of own construction equipment, the competition, the economic climate and the commercial opportunities. Research by Laryea and Hughes (2009) identified strong evidence of amendments made by clients to standard forms of contracts, forcing contractors to respond with qualified tenders.

On contracts involving major earthworks the risk can be considerable, particularly in connection with borrow pits and quarries, as the material to be extracted may subsequently be rejected as unsuitable by the engineer or the local authority may refuse a planning application for the extraction.

Weather conditions can also be influential with continuous wet weather likely to cause a prolonged shutdown of all major earthmoving operations, the costs of which may not be recoverable under the contract.

Other risks include reliability of subcontractors – failure to perform or bankruptcy is at the contractor's risk; increases for inflation, e.g. steel and fuel; availability of suitable labour – specialist labour may need to be brought in from elsewhere within the UK or from overseas; terms and conditions in suppliers or construction equipment contracts; estimator's productivity allowance; premiums on insurances. Laryea and Hughes (2008: 916), based on in-depth interviews with five major UK contractors, identified 'payment', 'design' and 'ground conditions' as the most significant risks.

> The other risks mentioned were weather, contract conditions, the job itself, project location, access, project complexity, innovation in design, state of the economy, local government issues, relationship with government councils and agencies, changes in officials, shocks in world financial markets, politics, shortages in world supply of common construction materials and impact of booming economies. Most of the contractors thought that designs were becoming more complicated because of technology. Therefore, some of them perform a design audit for every bid and would even invite a third party to review the design in order to ascertain its compliance with building regulations and standards and advise on buildability.

Laryea and Hughes (2008) also identified that contractors add a risk margin of 2 per cent to most fixed-price contracts, but it could go as high as 10 per cent, 20 per cent or even 25 per cent, depending on the size of the job and the problems highlighted.

A further consideration will be the method of calculation of fluctuations in costs which will be set out in a schedule or an appendix to the form of contract. Fluctuations in cost can be 'full', 'limited' or none at all. Depending on the option chosen, a reasonable allowance will be made to the estimate to cover potential fluctuations. Note that the NEC3 contract contains Secondary Option Clause X1: Price adjustment for inflation.

The team will also consider the commercial opportunities, particularly the method of billing and whether the major quantities are under- or over-measured or any items omitted entirely, any differences between the specification, drawings or BofQ, the lack of drawings or poor design and the contractor's alternatives.

This stage can be summarized as follows. Apply appropriate adjustments to the estimate following review of:

- method statement;
- programme;
- technical, design and commercial risks (NEC3 has introduced the concept of a risk register which allows contractors to identify which items they have/have not allowed for);
- cash flow and finance;
- use of own construction equipment;
- competition;
- commercial opportunities;
- economic climate;
- fluctuations.

6.6 Stage 5 – conversion of estimate to tender

Tender committee meeting – part 2

The second task of the senior management team at the tender committee meeting is to convert the estimate into the tender bid. The following items are considered and agreed upon:

- the financial adjustment to be made following the commercial review;
- the allowances for discounts on subcontractors and suppliers;
- late quotations; these could be included as an *adjustment* item at the end of the tender;
- the contribution for head office overheads – usually 4–8 per cent;
- profit, normally on what the market can stand;
- qualifications to the bid, if any.

Regarding head office overheads, an addition needs to be made to the net estimate to cover all costs incurred in operating the central services provided by head office. Apart from general management and accountancy, this will normally include the departments dealing with: estimating, planning and design, purchasing, surveying, insurance, wages and bonus and site safety. A typical percentage would be between 4 and 8 per cent (Davis Langdon, 2007). Contractors are obviously under constant pressure to recover their annual head office overheads within future awarded contracts. A shortfall in the annual work obtained would mean a shortfall in the recovery of head office overheads.

Obviously the level of profit is governed by the degree of competition applicable to the job – which in turn is a reflection of the industry's current workload. Again, the appropriate addition is highly variable, but for the purposes of a preliminary estimate an addition of 2–5 per cent onto net turnover is suggested (Davis Langdon, 2007).

At the conclusion of the meeting the estimator will be required to convert the cost estimate to the tender bid.

Prime Cost (the cost of doing the work in the field including all operatives below foreman level, materials, plant and sub-contractors) and the final tender is called *the spread*, which can amount to 25 per cent of the tender. This amount can be allocated to the tender in a number of ways:

- evenly on all rates;
- differentially, e.g. front-end loading on early items;
- as a lump sum in the preliminaries.

Value added tax (VAT)

Value added tax is excluded from the contractor's estimating and tendering process. The conditions of contract normally make VAT the subject of a separate invoicing procedure between the contractor and the employer.

VAT will be chargeable at the standard rate, currently 20 per cent, on supplies of services in the course of:

- the construction of a non-domestic building;
- the construction or demolition of a civil engineering work;
- the demolition of any building; and
- the approved alteration of a non-domestic protected building.

The exceptions to this rule are primarily for dwellings and some residential and charity buildings. Zero rating and a lower rating (5 per cent) tend to apply only where there is a defined social or political objective.

6.7 Stage 6 – submission of tender

Finally, the tender should be submitted to the client in the form specified in the invitation letter, arriving at the correct address at the right time. The contractor should keep all copies of the tender documents, marking drawings 'used for tender'.

6.8 Questions

Question 1

Why would a promoter wish to make amendments to the standard contract documents?

Question 2

Why would an estimator go to the trouble of checking the major quantities?

Question 3

Labour costs are estimated based on an *all-in* rate. What is meant by an 'all-in' rate and how is it calculated?

Question 4

How would the contractor's estimator calculate a due allowance for waste on materials and how accurate is this likely to be?

Question 5

What are the main elements of cost that must be taken into account in a tender for civil engineering works and how would the estimator assess each item?

Question 6

A project for which you are preparing a tender requires considerable deep excavation for which you propose allowing the use of temporary sheet piling. However, you are aware that battered side slopes may be a suitable alternative at a similar cost.

How would you insert the costs in the tender BofQ/activity schedule?

Question 7

Describe the steps you would take as a contractor to ensure that, before submitting a tender you had obtained for yourself all the necessary information as to site conditions, risks, contingencies and all other circumstances influencing or affecting your tender, as required under the NEC ECC contract.

6.9 References/further reading

Akintoye, A. (2000) 'Analysis of factors influencing project cost estimating practice', *Construction Management and Economics*, Vol. 18, pp. 77–89.

Akintoye, A. and Fitzgerald, E. (2000) 'A survey of current cost estimating practices in the UK', *Construction Management and Economics*, Vol. 18, pp. 161–172.

Al-Harbi, K.M., Johnson, D.W. and Fayadh, H. (1994) 'Building construction detailed estimating practices in Saudi Arabia', *Journal of Construction Engineering and Management*, Vol. 120, pp. 774–784.

Brook, M. (2008) *Estimating and Tendering for Construction Work*, Butterworth Heinemann.

Carr, R.I. (1989) 'Cost estimating principles', *Journal of Construction Engineering and Management*, Vol. 115, pp. 545–551.

Chartered Institute of Building (CIOB) (2009) *Code of Estimating Practice*, 7th edition, Wiley-Blackwell.

Davis Langdon (ed.) (2007) *Spon's Civil Engineering and Highway Works Price Book*, Taylor & Francis.

Harrison, R.S. (1994) 'Operational estimating', *Construction Papers No. 33*, The Chartered Institute of Building.

Laryea, S. (2009) 'Subcontract and supply enquiries in the tender process of contractors', *Construction Management and Economics*, Vol. 27, December, pp. 1219–1230.

Laryea, S. and Hughes, W. (2008) 'How contractors price risks in bids: Theory and practice', *Construction Management and Economics*, Vol. 26, September, pp. 911–924.

Laryea, S. and Hughes, W. (2009) 'Commercial reviews in the tender process of contractors', *Engineering, Construction and Architectural Management*, Vol. 16, No. 6, pp. 558–572.

McCaffer, R. and Baldwin, A. (1991) *Estimating and Tendering for Civil Engineering Works*, BSP Professional.

NEC (2005) *Guidance Notes for the Engineering and Construction Contract, An NEC Document*, June, Thomas Telford.

Öztaç, A. and Ökmen, Ö. (2004) 'Risk analysis in fixed-price design-build construction projects', *Building and Environment*, Vol. 39, 229–237.

Saxon Childers, J. (1925) *Robert McAlpine: A biography*, University Press Oxford.

Seeley, I.H. (1993) *Civil Engineering Contract Administration and Control*, 2nd edition, Macmillan Press.

Smith, N.J. (1995) *Project Cost Estimating*, Thomas Telford.

7 Value management

7.1 Introduction

The value process originated during World War II within the General Electric Company (GEC) in the USA. GEC were faced with an increase in demand but had a shortage of key materials. Larry Miles of GEC, instead of asking, 'How can we find alternative materials?', asked, 'What function does this component perform and how else can we perform that function?' This innovative approach led the company to use substituted materials for many of its products. They found, surprisingly, that the cost of the product was often reduced, but the product improved; care and attention to function provided *better value for money*.

A spin-off of this approach was the elimination of cost, which did not contribute to performance – this was known as value analysis. Over the next 10 years this was further developed by GEC and became known as value engineering (VE). Value management (VM) developed from VE and is now a requirement on many public and private projects in the USA and Australia.

It was only in the late 1980s that VM began to be used in the UK. The author (Potts) first came across the use of VM on the £50 million International Convention Centre in Birmingham; this 4-year project was completed in 1991. Two years into the construction period an American VM consultant was engaged to execute value engineering exercises; however, by this time it was too late to effect any meaningful changes. In reality, there are various triggers for a VM exercise, which are usually workshop based, e.g. new legislation, new opportunities for a commercial product, solution of a social problem or simply overspend on the budget.

In the UK, the public sector has been slow to take up VM but, with the introduction of *Best Value* and *Prime Contracting*, there has been an uptake in interest. However, the ultimate challenge is to integrate risk management and value management into a single framework that evolves throughout the life of the project.

7.2 What is value management?

Value management is the wider term used in the UK to describe the overall structured team-based approach to a construction project. It addresses the value process during the concept, definition, implementation and operation phases of a project. It encompasses a set of systematic and logical procedures and techniques to enhance project value throughout the life of the facility.

Value management embraces the whole value process and includes value planning, value engineering and value reviewing.

The basic steps are as follows:

- to determine the functional requirements of the project or any of its constituent parts;
- to identify the alternatives; and
- to examine the cost and value of each alternative to enable the *best value selection*.

(See Figure 7.1.)

Terminology

Confusion has arisen in the definitions of value, depending on geographic location.

VM/VE, value planning and value auditing are often interchangeable. The following definitions are proffered:

Value: value is the level of importance that is placed upon a function, item or solution.
Value management (VM): VM is a systematic and creative procedure operating on the relevant aspects of the value process through the life of the project or facility.
Function: a mode of action or activity by which a thing fulfils its purpose. Understanding the concept of function is important as this can provide the catalyst to introducing innovative solutions. For example, consider the function of an internal wall, it can: separate space, secure space, maintain privacy, support heating systems, support fittings and fixtures, transfer load, reduce noise, etc. If we merely required to separate floor space we could use a row of potted plants or different floor material.

Figure 7.2 shows the introduction of the parties into the project cycle under the traditional procurement route. This highlights the importance of involving all the key parties early in the

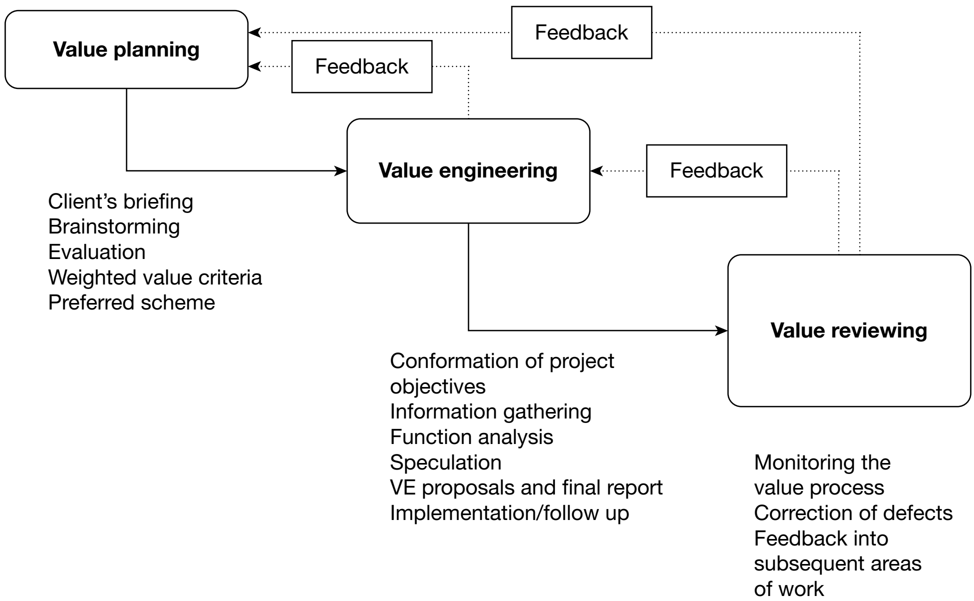


Figure 7.1 The value management process (ICE, 1996)

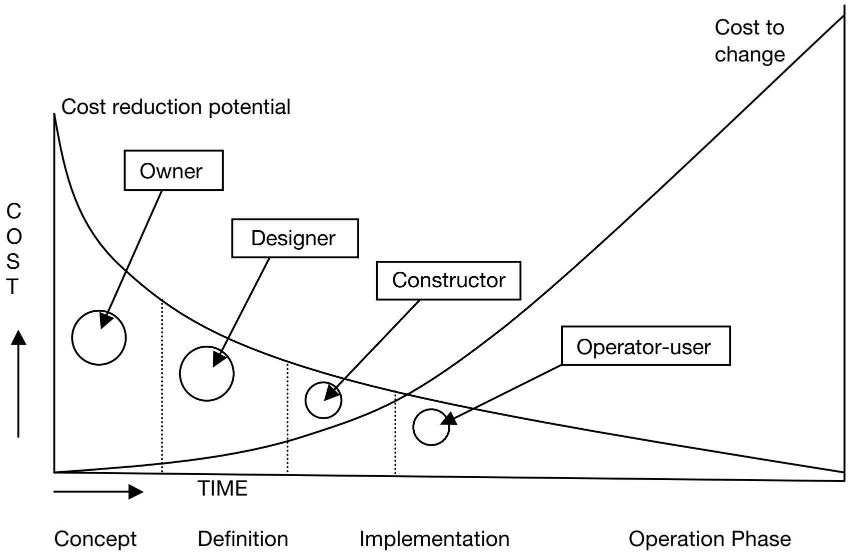


Figure 7.2 Stakeholders' impact on project cost (ICE, 1996)

process under a partnering agreement or better still a long-term alliance. Studies at the early stages of a project are much more effective and of shorter duration than those conducted later on. This is because the opportunities for making changes reduce as the project progresses and the cost of making such changes increases. Indeed, once the concept has been frozen, about 80 per cent of the total cost has been committed – even though no design exists.

All client bodies operate a capital approval process that calls for certain criteria to be met before passing from one stage to the next – known as approval gateways. Each approval gateway presents a natural opportunity to conduct a value management study to verify that the scheme, as it has evolved so far, represents optimum value to the client. It is unusual to conduct a formal study at all of these gateways – usually two, or at most three, are sufficient.

The first stage in any project is to establish that a project is the most appropriate way in which to deliver the benefits which are sought. Is it likely to be viable? Do the conditions exist to enable the project to stand a chance of success? Is it affordable? Answering these sorts of questions is the main purpose of Gateway 0 in the OGC's Gateway Review Process. Value management can make a significant contribution at this stage. Table 7.1 identifies the key questions which should be asked at each stage of the VM study throughout the project cycle.

7.3 Value planning (VP)

VP is applied during the concept phase of a project. VP is used during the development of the brief to ensure that value is planned into the whole project from its inception. Several outline designs will be assessed to select a preferred option that best meets the functional and other requirements.

At this stage the value criteria are identified and concept proposals are put forward to satisfy the client's needs and wants. The needs are those items which are fundamentally necessary for the operation of the project, while the wants are items which the client would like to have, but are not essential. Best value is provided by delivering a solution which delivers all the needs and as many of the wants as possible, within the permitted budget.

Table 7.1 Typical questions to be asked at each stage of the VM study on a new urban highway project

Stage in project	*Questions to be asked*	*Comments*
Concept	What is the problem?	Road congestion, lack of decent infrastructure
	Is this the right project to deliver the benefits?	Yes
	Does this meet our business criteria?	Part of Government / local transport plan
Feasibility	Which is the best option?	Route B
	Does this solution satisfy our need?	Yes, least demolition of existing housing
Design	Does the solution fulfil all requirements?	Best compromise solution
	Is it good value for money?	As good as possible
	Can it be built?	Yes
Construct	Are the components cost effective?	Detailed VE exercise required on road surface, bridge and tunnel construction
Use	Did we achieve the expected benefits?	Improved transport links now helping to regenerate city
	Are there lessons to be learnt for our next project?	Develop-design-build partnering approach; always expect the unexpected!

Source: Adapted based on Dallas (1998)

In order to achieve maximum benefit from the effort applied by the individuals, it is common practice to apply the principle of the Pareto rule (80 per cent of the value lies in 20 per cent of the items).

7.4 Metropolis United's new football stadium

Second division Metropolis United are keen to move from their cramped town centre stadium to a greenfield site on the edge of town. The directors of the club realize that they require a 30,000 all-seater stadium if they are to compete in the top division.

The client's project manager suggests that a value management exercise would enable the directors and the council officers, representing the local council who are partly funding the project, to identify the priorities for the club. Unfortunately there is little involvement of other key stakeholders – the fans, the manager and the players! The mechanism for incorporating best value into the project design is through the use of VP workshops. The first step of the workshop is to gather information concerning the project – generally through a briefing with the client.

In the first stage of VP, at the concept stage, a *value hierarchy* (see Figure 7.3) is developed. It aims to establish a shared perception of the design objectives and attributes.

In the second stage of VP *a value tree* is drawn up (see Figure 7.4) based on a simplified hierarchy. Although capital cost will be one of the attributes used to evaluate design options, it is preferable to omit it from the value hierarchy and deal with it separately at the end of the analysis.

The logic of the diagram emanates from the how–why approach. In essence, by providing all the criteria on the right-hand side of the diagram, one will have provided all primary requirements on the left-hand side of the diagram. These criteria can then be weighted according to their degree of importance to the client.

In the second VP stage, the project solutions would have been proposed which met these criteria; usually this exercise takes the form of a brainstorming session where creative thinking

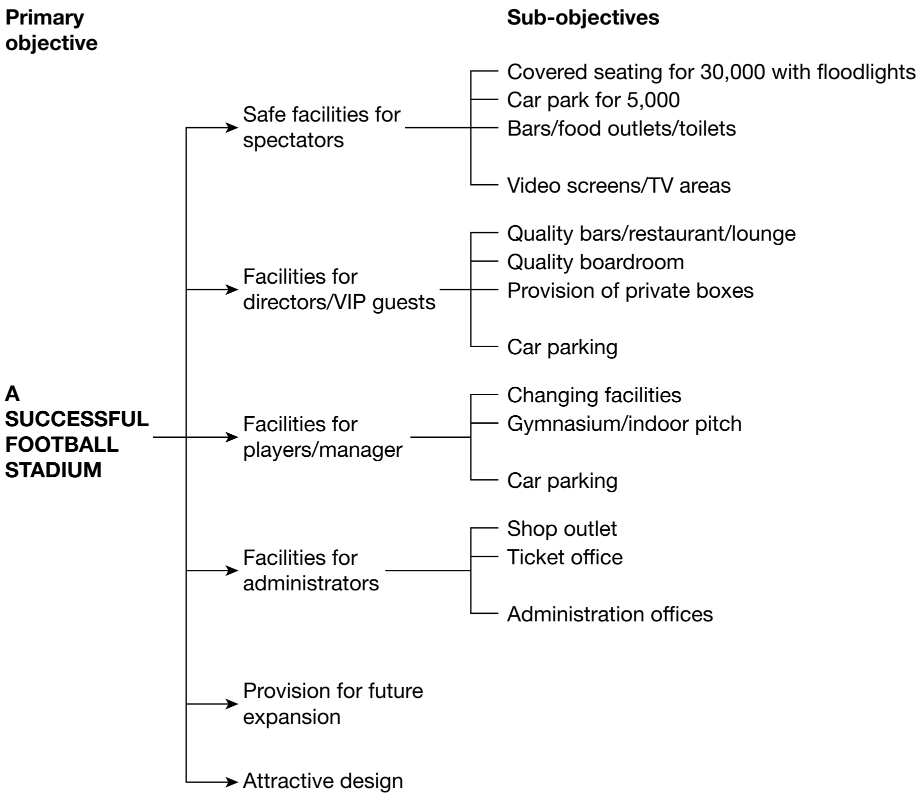


Figure 7.3 Value hierarchy at concept stage for new football stadium (Developed based on CIRIA, 1996**)**

and synergy between experienced participants leads to effective solutions to meet the value criteria.

After some considerable deliberation, the client representatives compile a weighted value tree (with the highest attribute scoring 50 and the lowest scoring 10). Naturally the directors of the club, who are providing their own financial support to keep the club in existence, consider that the facilities for directors and visiting VIPs are paramount; these attributes are therefore scored with a high 40 or 50. Attractive design is considered low priority for these self-made businessmen and is marked at 20.

The sum of the initial scores is 540. Each of the weightings of the six secondary objectives is then calculated. Thus *safe facilities for spectators* equates to 130 (40+30+30+30), which, divided by the total score of 540, equals a weighting of 0.24 or 24 per cent of the total.

In the next stage the possible design solutions submitted by the design and build contractors would be evaluated and ranked. The allocation of importance weightings to the value hierarchy forms the basis for the next stage of the second workshop, which is deciding which of the available designs provide the best value. Evaluation involves assessing each option against each of the identified attributes, and this is best done in the form of a *decision matrix* (see Figure 7.5). Finally, the team would make recommendations to the client.

Design option B shows the highest score with 54.0, with the highest score for *facilities for directors* but the lowest score for *safe facilities for spectators*. Design C shows a marginally lower overall score than B but with improved *spectator facilities* and a lower score for the *directors' facilities*.

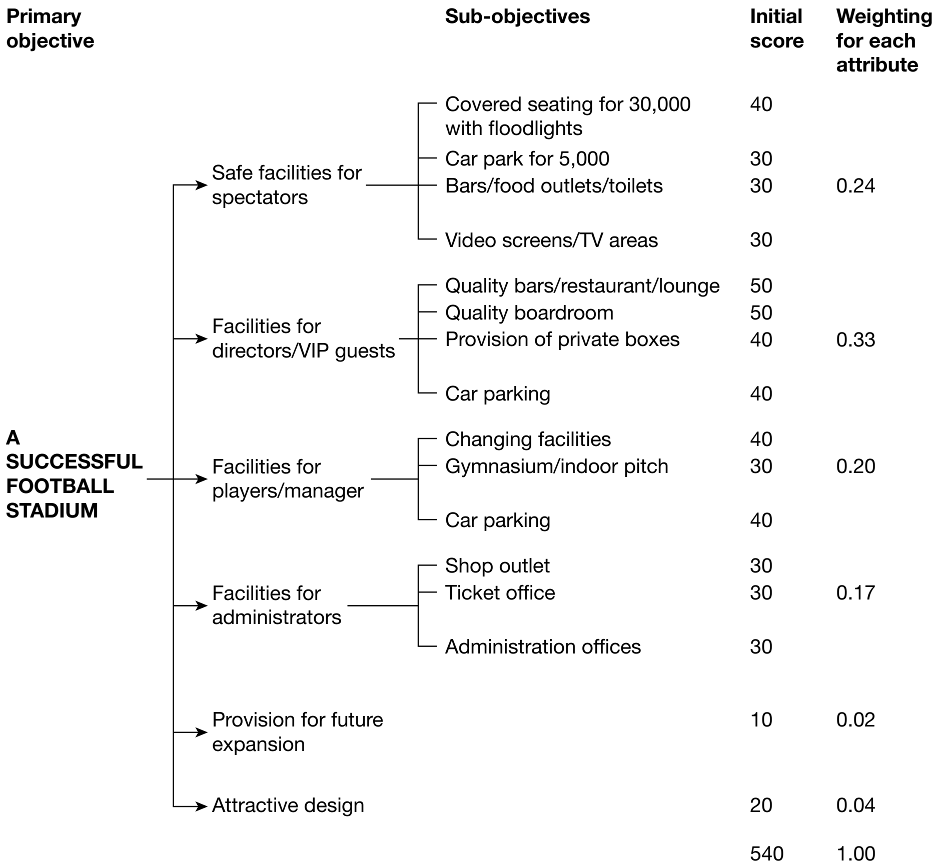


Figure 7.4 Simplified value tree at feasibility stage with importance weightings (Developed based on CIRIA, 1996)

ATTRIBUTES	Safe facilities for spectators	Facilities for directors	Facilities for players	Facilities for administrators	Provision for future expansion	Attractive design	Total weighted score
Weight of importance	0.24	0.33	0.20	0.17	0.02	0.04	
DESIGN OPTION A	70	20	10	20	40	60	
Weighted score for OPTION A	16.8	6.6	2.0	3.4	0.80	2.4	32.0
DESIGN OPTION B	40	80	20	60	70	60	
Weighted score for OPTION B	9.6	26.4	4.0	10.2	1.4	2.4	54.0
DESIGN OPTION C	50	50	80	40	10	40	
Weighted score for OPTION C	12.0	16.5	16.0	6.8	0.2	1.6	53.1

Figure 7.5 Decision matrix – shows the process of comparing the total scores of the various design options (Developed based on CIRIA, 1996)

This exercise is typical of the possible dilemmas facing clients and their advisors. This is not a science, more an art. It is extremely difficult to score each of the sub-objectives, and choosing between one contractor's design and another again becomes subjective. In the event design option B is chosen!

7.5 Value engineering (VE)

VE is applied during the definition stage and, as required, in the implementation phases of a project. VE investigates and analyses in order to identify the required function and then compares and selects from the various options to produce the owner's best value requirements.

During the VE phase any unnecessary cost is eliminated from the proposed design.

This is usually undertaken in the VE workshop, where a separate review team from that which developed the outline design reviews the work to date. Since this review is generally undertaken at approximately the 30 per cent stage, there is still a good opportunity to adjust the design before it proceeds to the definitive and detailed design stage.

The basic premise of VE is that a certain amount of unnecessary cost is inherent in every design. It is usually only possible to eliminate this by identifying another option, which provides the same function at less cost.

Specific causes of unnecessary cost include the following:

- cost of unnecessary attributes (attributes which provide no useful function);
- cost of unnecessary specification (due to needlessly expensive materials/components);
- unnecessary cost of poor buildability (failure to consider construction implications during design);
- unnecessary life-cycle cost (failure to consider future operational costs);
- unnecessary opportunity cost (the cost of losing potential revenue).

The VE workshop follows the broad principles of the VP workshop. The information phase usually involves a debriefing from the original design team to the VE team, who then consider, in the functional analysis, the function of each part of the proposed works. In the speculation phase, they have a brainstorming session and consider alternative methods of providing the same function.

Panel 7.1 Value engineering techniques

The different ways of delivering a client's requirements offer further potential for adding value to a project. With engineering services, examples of innovation that can have a significant effect on the overall project outcome include the use of ground water cooling or gas-fired air handling units.

Innovative solutions such as this need to be adopted at the earliest possible stage of a project. When the value engineering approach is applied at a later stage, it is difficult to introduce radical changes. However, opportunities to add value still exist, such as the use of manufacturer's standard components rather than bespoke products.

Source: Davis Langdon website; for a description of small-scale renewable energy systems see *Building,* 28 October 2005, pp. 54–57

There follows an evaluation phase in which the proposed alternative solutions to providing the function are analysed to determine the viability of each one. Where a suitably viable alternative is possible at a significantly reduced cost, it is included in the proposal phase.

Ideally every design decision should be subject to VE, but 80 per cent of cost is often contained in 20 per cent of the design decisions. On building projects, services in particular account for a very large percentage of the overall cost (28–40 per cent). This element can be further broken down into mechanical services (17–28 per cent), electrical services (6–13 per cent) and lifts (0–3 per cent). On road projects the three highest cost elements are typically earthworks (28–31 per cent), structures (18–32 per cent) and sub-base and surfacing (21–28 per cent) (CIRIA, 1996).

7.6 Value reviewing (VR)

VR is applied at planned stages to check and record the effectiveness of the value process and its management.

The Value Manager usually has a responsibility to review the value process throughout the project to ensure that the value identified in the VP and VE are actually provided within the executed works.

When to apply value management

Timing is of the essence. Figure7.2 illustrates the substantial scope to reduce cost, and hence improve value, in the project definition and early design phases. This scope diminishes to a point when the cost of change exceeds the saving.

Any construction project should only be commissioned following a careful analysis of need. Failure to carry out this analysis will cause problems at subsequent design and construction stages.

Many projects suffer from poor definition through lack of time and thought at the earliest stages. This is likely to result in cost and time overruns, claims, user dissatisfaction or excessive operating costs. Value management can help to avoid these problems.

Panel 7.2 40-hour workshop

In the USA the classic VE exercise is a 40-hour workshop attended by the value manager and an independent design team. The findings are reported to the client and project manager for further action/implementation.

While an independent design team has the advantages of providing a fresh and critical approach and an independent review, in the UK the disadvantages are generally believed to outweigh them. These include:

- conflict with the existing design team;
- loss of time while the external team becomes familiar with the project;
- the additional cost of a second design team; and
- delay and disruption to the design process during the review.

Also, the external team may feel obliged to identify cost savings to justify their fee.

Source CIRIA, 1996

VP and VE are mainly applied in the concept and definition phases and generally end when the design is complete and construction started. However VE can be applied at the construction stage to address problems or opportunities which may arise. At a later stage a tendering constructor may be expected to bring other value-improvement ideas and techniques for consideration by the owner.

Finally the project may run into practical, cost or time difficulties during construction, and here again solutions may be developed using VM.

7.7 Case studies

Case study 1: Value management session, Midlands Hospital

The VM session was the first session of its kind involving the wider project team, which included the ProCure 21 supply chain members and a number of clinicians from various affected departments.

The purpose of the session was to review, reflect on and understand some of the key project issues, as well as determining spatial adjacencies and linkages required with the rest of the hospital. The session was led by an eminent VM practitioner.

The first tool used in the session, the client's value system, was used to obtain ordinal measurement in the form of ranking for the client's values. The client's value system, based on a matrix approach, demonstrated that the three most important aspects to the client group were: flexibility, comfort and community accessibility. The client's value system concentrates on 'inside the building', i.e. the focus is how the building functions, rather than its external appearance.

The service development group reviewed typical patient flows through the new facility. This detailed analysis helped to achieve a consensus on requirements and a degree of ownership of the final solution.

The project team then used a brainstorming session, using 'post-it' notes on a working wall, to identify strategic needs and wants and technical needs and wants. The strategic functions identified the strategic mission for the project and the main functions that it requires to deliver for the client. The strategic wants were considered as non-essential or 'nice to have'. The technical needs and wants are the functions that form the brief for the project. The ProCure 21 team agreed to incorporate the technical needs into the project brief, as well as any strategic issues that were to be dealt with, by looking for a technical solution.

The VM exercise took the project team a step further in validating a conceptual model for the new facility. Once this was finalized the ProCure 21 supply team members could draw up the Project Execution Plan.

Case study 2 – Office building (reported in HM Treasury, 1996)

The sketch design for the outside walls of an office building indicated the use of precast concrete cladding panels. An analysis of the design showed a total of 450 separate panels of different types.

After a workshop review, which included a cladding manufacturer, the total number of panels was reduced to 280 with only 21 different types to cover the same area. Although an increased cost arose due to the need for a larger crane to hoist the panels, the net saving for the reduced number of moulds and perimeter waterproofing represented 10 per cent of the total cost of cladding. The cladding element of the project amounted to 25 per cent of the project's cost and, as a result of the workshop review, the overall saving equated to 2.5 per cent of the project's capital cost.

Case study 3 – Office building (reported in HM Treasury, 1996)

The detailed design of a bolt-on cladding system indicated an internal wall lining of insulation and painted plasterboard. Following a brainstorming session, the cladding manufacturer was asked to provide a price for incorporating the insulation and providing a metal finished panel on the inner face of the building. The plasterboard and its finish would be omitted.

The net effect was to increase the cost of the project by £125,000. However, omitting the plasterboard and paint meant fewer 'wet' trades on the project, saved three weeks on the overall construction period and increased the net lettable floor area by 2 per cent. The *value* of the finished building was increased in the order of £2 million for an additional outlay of £125,000.

Case study 4 – Hotel leisure facility (reported in McGeorge et al., 1997)

In a hotel development the architect had included the main hotel swimming pool and a children's paddling pool. The design team had assumed that the function of the children's pool was to allow the children to swim separately from the adults, thereby providing a more suitable facility for each.

In fact, the function of the pool was to keep much younger children safe whilst others swam, and there was no real objection to competent child swimmers using the same pool as the adults.

As a result of correctly defining the function, the VM team were able to generate ideas for alternatives providing a safe environment for the children. The small pool was replaced with a spray at a tenth of the cost. When constructed, the spray proved to be a huge success.

Case study 5 – Speculative office block, London (reported in the CIRIA Special Publication 129)

A developer proposed to construct a speculative office building in London with a net lettable area of 4,500 square metres and at a cost of £5 million. Initial studies indicated that providing the necessary space within the site and cost constraints would be challenging.

The developer decided to use VE and employed a facilitator to work with the design team to find the most effective solution. The facilitator convened a workshop during which it became clear that the relationship between net lettable area and the size of the service cores was crucially important to the viability of the design. Although the designers had already evaluated this, the combined efforts of all the parties working together creatively in a facilitated workshop environment identified a number of improvements to the outline design proposals. Potential improvements were also identified in the proposed wall-cladding system, and these were subject to more detailed study outside the workshop.

As a result of the workshop, the building cost 2 per cent (£110,000) more than the original budget. However, the increase in benefits of some £3.4 million more than paid for this.

Case study 6 – Dudley Southern Bypass (reported in Modernising Construction, NAO, 2001)

In 1998 Kvaerner won the project in competition, with an exceptionally low bid of £14.3 million; the contract was based on the ICE 5th with a Partnering Agreement. After a joint evaluation of the risks, the Dudley Metropolitan Borough Council (MBC) felt able to negotiate a target price which would still be below the second lowest bidder, and a target cost of £16.7 million was agreed. Dudley MBC agreed with Kvaerner that it would split 50/50 any 'pain' or 'gain' over or under that target price and Kvaerner would be paid an agreed maximum management fee of

£900,000. The project was completed five months ahead of schedule within the target cost and the budget agreed with the DETR.

Value engineering did identify savings. For instance, the original specification required the removal of 50,000 cubic metres of waste, to be replaced with quarry material. Much of the material was contaminated, but by working together and involving the Environment Agency in developing solutions, they were able to reuse most of the material within the project. By the end of the project, they had only taken 1,500 cubic metres to the tip, which prevented 25,000 lorry movements around Dudley.

Case study 7 – The Scottish Parliament building (reported in 'The Holyrood Inquiry', 2004)

Construction work began in July 1999. In September 1999 a value engineering exercise was implemented in order to reduce the construction cost by £25 million. The exercise identified several hundred recommendations, the vast majority of which could be dealt with by the project team. Some of the recommendations required a high-level decision from the Scottish Parliament Corporate Body (SPCB). Table 7.2 gives an indication of the issues considered by the SPCB.

Lord Fraser reports that the exercise failed miserably in achieving its stated goal of achieving the £25 million required. The workshop never identified achievable savings of the magnitude required. Likewise, when the client realized that these decisions would have a significant impact on the quality of the building they did not face up to the reality of the situation. Lord Fraser comments that '*To some extent the Value Engineering exercise could be interpreted as a knee jerk reaction to a budgetary crisis*.'

Case study 8 – Refit project for Pizza Hut (Constructing Excellence website)

In 1997 Pizza Hut was anticipating a programme of 25 refit projects (Pizza Delivery Units). At an estimated/budget value of £145,000 each, this amounted to a programme value of over £3.5 million. In order to review the projects before going on site, a series of three half-day value management workshops was convened comprising client representatives (area manager and property manager) and the consultants (designer, quantity surveyor and services engineer). An experienced value management facilitator from outside the project team facilitated the workshops.

The three workshops followed a traditional format of information exchange, functional analysis, brainstorming of alternative solutions, evaluation of alternatives, acceptance and

Table 7.2 Examples of VM savings considered on the Scottish Parliament building

Item	*Potential saving*	*Decision of the SPCB*	*Actual saving*
Reduce car parking provision from 129 to 50	£750,000–£1,500,000	Reduce to 65 spaces	£667,000
Rationalize bar/lounge/ restaurant	In excess of £1,000,000	Maintain existing provision	–
Delete wash handbasins in MSP rooms	£210,000	Agreed to be deleted	£209,160
Reduce standard of media accommodation fit out	£235,000	Agreed	£236,140

implementation. This resulted from nine hours of workshop and a similar amount of work outside the workshops.

Through members of the team a total of £14,000 per project was saved, equivalent to £350,000 capital cost on the whole programme. In some areas standards were actually raised and longer-term maintenance was reduced. A shorter contract period was also established and shorter delivery times for certain long-lead items.

The total cost of the value management exercise was estimated at less than £10,000, giving a return of 35:1 on the investment.

Simister and Green (1997), through 17 value management case studies, identify the practitioner's role and the purpose of the VM exercise. They further identify the reasons why the VM exercise worked well in ten of the cases but not so well in seven cases. Reasons for success included: clear leadership from the client; involvement of client decision-makers; willingness of client/designers/management to re-evaluate previously fixed design; clear articulation of client's requirements; and proactive workshop participants. Reasons why the VM exercise did not work so well included: client not able to set clear objectives; too many problems to be solved; reluctance to consider change as design work already complete; and changed objectives during the VM workshop.

The erstwhile Office of Government Commerce (2007) also produced an excellent VM review covering seven case studies on the following projects:

1 Hexable Dance, Kent – describes how the project moved from being unaffordable to reality through the effective application of VM techniques.
2 Open University – describes how the Estates Department delivered a £17 million library using the principles of partnering and VM. Cost savings were achieved at a VM study cost of £120,000.
3 Kintry Housing Partnership, Edinburgh – illustrates how VM was used during one phase of a major housing project to improve the partnering performance, which resulted in a 7 per cent saving of £500,000.
4 Council house improvement (Scotland) – VM methods reinforced partnering performance on this £144 million project to reduce defects by 10 per cent and costs by £1.75 million.
5 NHS Teaching Hospital, Stoke-on-Trent – on project A the VM study helped build a common understanding of the project brief and the team achieved savings of about £4 million on the £13 million project. On project B the VM workshop achieved annual savings of £4.5 million on the PFI £52 million annual Unitary Payment.
6 Withington Community Hospital, Manchester – describes how the VM methodology facilitated the successful delivery of a project using an innovative approach.
7 Antler's Bridge, California – VM was used to save £7 million and improved performance by 17 per cent. (It is noted that the US Federal Highway Administration requires VM studies for all projects exceeding $25 million. Furthermore, the California Department of Transportation requires the assessment of non-monetary benefits on all VM studies.)

7.8 Conclusions

The above case studies demonstrate that real benefits and cost savings can be secured by implementing a value management approach. Case study 1 identified how the VM approach enabled an NHS client to determine special adjacencies and linkages and identify the client's value system as a basis for validating a conceptual model for a new hospital facility.

Case studies 2 and 3 showed how significant savings could be achieved by redesigning an alternative size and type of cladding. In case study 4 Dr Angela Palmer brilliantly illustrated the classical benefit of the VM approach by giving an example in which the project team questioned the fundamental purpose of a children's paddling pool.

Case study 5, the speculative office block, illustrated how the VM exercise showed that a little extra expenditure would result in a significantly greater net lettable area. Case study 6 demonstrated the benefit of value engineering within a partnering approach on the Dudley Southern Bypass, which resulted in a considerable saving in the removal of excavation waste.

Case study 7 demonstrated the difficulty of achieving real savings through value engineering on the hugely controversial Scottish Parliament building.

The Pizza Hut case study demonstrated how VM, when used by an enlightened client, resulted in cost savings, improved standards and shorter delivery times on 25 refit projects.

Finally, the seven case studies reviewed by the OGC demonstrated the benefits that VM has brought to central and local government projects, including improvement in leadership and decision-making, effective team working, pre- and post-construction performance improvement, innovation and defect reduction.

7.9 Questions

Question 1

Consider the function of an internal wall in an office complex.

Question 2

Give specific examples of potential unnecessary costs identified in Items 1–5 in Section 7.5 Value engineering.

Question 3

The University of Metropolis is planning a new state-of-the-art teaching facility for the School of the Built Environment. As the client's chosen project manager, write a 500-word report to your client, explaining the key concepts and benefits of including a value management approach and state what will be required from the client and when.

7.10 References/further reading

Connaughton, J.N. and Green, D.G. (1996) *Value Management in Construction: A client's guide, CIRIA Special Report 129*, CIRIA.

Dallas, M.E. (1992) 'Value management – Its relevance to managing construction projects', *Architectural Management* (ed. P.Nicholson), Spon, pp. 235–246.

Dallas, M. (1998) 'The use of value management in capital investment projects', *Session Guide Television Education Network Video: Quantity surveying focus*, March.

Dallas, M. (2006) *Value and Risk Management: A guide to best practice*, Blackwell Publishing, Oxford.

Dell' Isola, A.J. (1982) *Value Engineering in the Construction Industry*, 3rd edition, Van Nostrand Reinhold.

Fraser, L (2004) *The Holyrood Inquiry*, Scottish Parliamentary Corporate Body.

Green, S.D. (1992) *A SMART Methodology for Value Management*, Occasional paper No. 53, CIOB.

Green, S.D. and Popper, P.A. (1990) *Value Engineering: The search for unnecessary cost*, Occasional paper No. 39, CIOB.

HM Treasury (1996) *CUP Guidance Note No 54: Value management*, HM Treasury.

ICE (1996) *Creating Value in Engineering – Design and practice guide*, Thomas Telford.

Kelly, J. and Male, S. (1993) *Value Management in Design and Construction: The economic management of projects*, E & FN Spon.

Kelly, J., Male, S. and Drummond, G. (2004) *Value Management of Construction Projects*, Blackwell.
McGeorge, D., Palmer, A. and London, K. (2002) *Construction Management New Directions*, 2nd edition, Blackwell Science.
NAO (2001) *Modernising Construction, Report by The Comptroller and Auditor General*, National Audit Office HC 87 Session 2000–2001.
Office of Government Commerce (2007) *Value Management in Construction: Case studies*: http://webarchive.nationalarchives.gov.uk/20110601212617/www.ogc.gov.uk/documents/CP0152ValueManagementInConstruction.pdf – cited 20 October 2012.
Simister, S.J. and Green, S.D. (1997) 'Recurring themes in value management', *Engineering, Construction and Architectural Management*, Vol. 4, No. 2, pp. 113–125.

Websites

www.constructingexcellence.org.uk – Value Management fact sheet – cited 12 December 2006.
www.davislangdon.com – Value engineering cost model – accessed August 2005.
www.ivm.org.uk.

8 Risk management

8.1 Introduction

Max Abrahamson, the eminent construction lawyer, considered risk management 'the most delicate and dangerous subject I could find' (Abrahamson, 1984). This comment indicates the potential difficulties of attempting to manage risk. Indeed, sometimes it seems as though it is not a science, but more an art, based on years of experience and 'gut-feelings'. Risk cannot be ignored. Indeed, Professor John Uff states that 'Engineers must also learn to handle and become familiar with risk and its consequences, which form an essential element of engineering' (Uff, 2002).

Risks and their interactions can emerge at any time: at the front-end, during construction, or at operation stage and can build up to shatter carefully laid plans. Indeed, the only certainty is that unforeseeable events will materialize. Uncertainty springs up as issues are brought to the fore, dormant tensions emerge and interdependent links are triggered (Miller and Lessard, 2000). Curtis *et al*. (1991) observe

> The quality of risk management will be improved if risks are identified and evaluated in a systematic way, and allocated to the parties best able to control them, and if parties expected to bear the risk receive adequate reward for doing so.

Sir Michael Latham considered that 'No construction project is risk free. Risk can be managed, minimized, shared, transferred or accepted. It cannot be ignored' (Latham, 1994). Everyone should be concerned with risk management, because risk and uncertainty could have potentially damaging consequences on a project. For a property developer in the pre-feasibility stage, it may influence whether to undertake a marginal project, particularly if there is likelihood of the project finishing late and over budget. For a contractor or subcontractor, unforeseen risks may mean incurring losses that are not recoverable.

British Standard 4778 Section 3.1: 1991 defines risk management as:

> the process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence.

The process must have the aim of identifying and assessing the risks. Risk management and risk assessment, as techniques, will not remove all risks. The aim must be to ensure that risks are assessed and managed in an effective manner to achieve the overall objectives of the project.

The 1999 NAO report *Modernising Construction* highlighted inadequate use and understanding of value management and risk management as major barriers to improvement in construction performance (*Achieving Excellence in Construction Procurement Guide 04*, 2003).

There may be formal requirements for risk analysis for many reasons, including: economic viability assessment; financial feasibility assessment; insurance purposes; accountability; contractual purposes; tendering; regulatory purposes; and communication purposes (Cooper and Chapman, 1987). Critically, health and safety risks are, by statute, required to be assessed in order to demonstrate that they have been reduced to a level as low as reasonably practicable. Furthermore, contract risks must be assessed for the purpose of pricing, by whichever party is to assume the risk, taking into account any insurance cover required. However 'Even where insurance is available, its effect is not to remove risk. The universal legal principle of subrogation transfers the rights of the party who is indemnified to the insurer, who may seek to recoup his losses against whoever is legally liable to the insured person' (Uff, 2002).

Thomson and Perry (1992) identified that risk management may involve:

- identifying preventative measures to avoid or reduce a risk;
- proceeding with a project stage by stage to reduce uncertainty though better information;
- considering risk transfer in contract strategy, with attention to the motivational effects and the control of risk allocation;
- considering risk transfer to insurers;
- setting and managing risk allowances in cost estimates, programmes and specifications;
- establishing contingency plans to deals with risks when they occur.

Traditionally, risk in construction was either ignored or dealt with in an arbitrary way, e.g. by including a 5 per cent contingency factor in the estimate. Project contingencies provide an allowance to cover a client's risk exposure but make little contribution to its management; indeed this approach may contribute to the *variation culture* (Rawlinson, 1999).

Fenn (2000) reviews the allocation of risk of ground conditions in international contracts and notes that:

> Placing the risk for site conditions with the contractor means that the contractor must include a contingency sum to deal with conditions if they arise. If the contractor does this and the ground conditions are not encountered, the owner has paid for a non-occurring risk. If the risks are encountered and exceed the contingency amount, the contractor is forced to make good the shortfall elsewhere; or go out of business.

Fenn (2000) citing Smith (1996) further notes that 'In the area of geological survey it has been estimated that for an expenditure of less than 1% of the construction cost, differing site conditions claims averaging 28% of the contract price might be dramatically reduced.'

Management of risk is an ongoing process throughout the life of the project, as risks will be constantly changing. Risk management plans should be in place to deal quickly and effectively with risks if they arise. It is important to work as an integrated project team from the earliest possible stages on an open book basis to identify risks throughout the team's supply chains (OGC, 2003).

Risk management can be considered to have three stages: identification; analysis and response.

8.2 Risk identification

The initial step is the identification and assessment of the risks associated with a proposed construction project or contract at the early stages of the project's life. The identification process will form the basis whereby the risks, uncertainties, constraints, policies and strategies for the control and allocation of risk are established.

Perry and Hayes (1985) suggest that the burden of responsibility for the identification of risks lies with the client, as they will be keen to achieve the overall objectives of completion within time, within budget and to an acceptable quality. The contractor will also need to be able to identify the risks in the contract in order to prepare the tender.

The potential risks in construction projects are many and varied. One of the most comprehensive lists of risks, identifying over 100 potential issues, was produced by Perry and Hayes, classified into physical, construction, design, political, financial, legal–contractual and environmental risks (Perry and Hayes, 1985).

Rawlinson (1999) identified that the principal categories of risk that the client may face resulting from a major capital project are potentially much wider than additional construction costs and could include:

- project risk – concerned mainly with time and cost;
- consequential risk – the knock-on effects of project shortfalls on the clients' business/organization;
- benefits risk – the effect of the project delivering more or less than the expected benefits;
- the effect on share price or public perception of the business/organization due to public success or failures.

Table 8.1 Sources of risk to client's business from construction projects

Heading	*Change and uncertainty due to:*
Political	Government policy, public opinion, change in ideology, dogma, legislation, disorder (war, terrorism, riots)
Environmental	Contaminated land or pollution liability, nuisance (e.g. noise), permissions, public opinion, internal/corporate policy, environmental law or regulations or practice or 'impact' requirements
Planning	Permission requirements, policy and practice, land use, socio-economic impacts, public opinion
Market	Demand (forecasts), competition, obsolescence, customer satisfaction, fashion
Economic	Treasury policy, taxation, cost inflation, interest rates, exchange rates
Financial	Bankruptcy, margins, insurance, risk share
Natural	Unforeseen ground conditions, weather, earthquake, fire or explosion, archaeological discovery
Project	Definition, procurement strategy, performance requirements, standards, leadership, organization (maturity, commitment, competence and experience), planning and quality control, programme, labour and resources, communications and culture
Technical	Design adequacy, operational efficiency, reliability
Human	Error, incompetence, ignorance, tiredness, communication ability, culture, work in the dark or at night,
Criminal	Lack of security, vandalism, theft, fraud, corruption
Safety	Regulations (e.g. CDM, Health and Safety at Work), hazardous substances (COSHH), collisions, collapse, flooding, fire and explosion

Source: Godfrey (1996)

The list detailed in Table 8.1 is not, of course, definitive; indeed, it would be foolhardy to think that it was. Some key issues are never considered as risk factors by client organizations. For example, on the Scottish Parliament building the deaths during the early construction period of two key players: the First Minister for Scotland – Donald Dewar and the architect, Enric Miralles had a significant impact on the project.

The CIRIA report 125 (Godfrey, 1996) states that 'It is impossible to identify all risks. To believe you have done so is counter-productive to risk management and dangerous. Always expect the unexpected.'

It is worth reflecting on some of the unforeseen risks that have affected construction projects over the past 30 years:

- power strikes/3-day working week/lack of materials, e.g. steel (1970s);
- widespread industrial action (1970s);
- 25 per cent annual inflation (1970s);
- civil unrest/miners' strike (1980s);
- poll tax riots (1980s);
- IRA terrorism (1980s);
- petrol tax protestors (2000);
- widespread flooding (2000 and 2012).

Likewise, when considering risks likely to be encountered by contractors and specialists, other risks may occur which are never anticipated, e.g. collapse of a tower crane, or the weather may

Panel 8.1 Particular risks for main contractors and specialist contractors

- Poor tender/briefing documents;
- client who will not commit;
- inexperienced client;
- non-standard contract documentation;
- ultimate client failing to sufficiently acknowledge and reward quality and value for money;
- poor design for construction, for example when 'buildability' is not addressed;
- unexpected problems relating to the site, such as contamination or unusual ground conditions;
- coordination problems – this could be a particular problem for specialists;
- component and/or materials suppliers unable to meet delivery and/or cost targets;
- faulty components and/or materials;
- accidents and injuries to staff;
- weather interrupting work;
- delayed payments;
- poor documentation of records;
- lack of coordination of documentation;
- poor guidance for operatives;
- poorly trained or inadequately trained workforce;
- industrial disruption.

Source: Constructing Excellence, 'Risk Management' Fact Sheet make a significant impact. For example, on Foster + Partners' high rise Willis building in London the wind stopped the tower cranes from operating for 40–50 per cent of the time during the winter, compared with the 20 per cent anticipated (Lane, 2007).

When calculating the risks at tender stage, contractors/specialist contractors should carry out a tender risk assessment. Each identified risk should have some measure of risk probability, impact and a proposal for management of that risk. A typical piling contractor's tender risk assessment would identify the following issues:

- site constraints: including access, working space, headroom, obstructions, site topography;
- safety and environment: including safety, working hours, noise and vibration restrictions, ventilation, road cleaning, pile platform;
- specification: including tolerances, depth limits, technique, water-tightness, settlement, testing;
- ground conditions: including site investigation, hard or soft dig, obstructions, water level, sulphates, salts, contamination, mining activities, voids in chalk, excessive break;
- design: including adequacy of information, safety factors, settlement and suitability of design, alternatives;
- programme: including anticipated lead time, plant and labour availability, design time, permits, method statements, sectional completion milestones, holiday periods, working hours, material availability, interfaces, contractor workload;
- contract and pricing: including adequacy of documents, scope of work, ground risk, lump sum or guaranteed maximum price, applicable damages, interfaces, extension of time risks, payment terms, retention, bonds, guarantees, credit-worthiness, fixed-price period, shared cost savings;
- miscellaneous: including aggregate tax, landfill tax, inflation, material market instability, new legislation.

The above list of risks, produced by Gary Bibby of Gardner & Theobald and Robin Wood of Cementation Foundations Skanska, gives us a significant insight into the practical issues facing a major piling contract when tendering for a project (Bibby and Wood, 2004).

Building magazine (16 February 2007) reported that Bovis Lend Lease had announced that it would change its tendering policy after taking a £48 million loss on work in Britain, primarily on its Manchester Joint Hospital PFI scheme. Bob Johnson, Bovis's global chief executive said that 'the firm had taken it on without fully understanding the risks and did not price it correctly'.

Research by Shen (1997) on construction risks associated with project delays by contractors in Hong Kong identified the following risks ranked in order of severity: insufficient or incorrect design information; variations in ground and weather conditions; subcontractors' manpower shortage; shortages of materials/plant resources; poor coordination with subcontractors; poor accuracy of project programme; shortage of skills/techniques; and abortive work due to poor workmanship.

8.3 Risk analysis techniques

The purpose of risk analysis is to quantify the effects on the project of the risks identified. The first step is to decide which analytical technique to use. At the simplest level each risk may be treated independently of all others, with no attempt made to quantify any probability of occurrence. Greater sophistication can be achieved by incorporating probabilities and interdependence of risks into the calculations, but the techniques become more complex. The choice of technique will usually be constrained by the available experience, expertise and computer software.

Whichever technique is chosen, the next step requires that judgements be made of the impact of each risk and in some cases of the probability of occurrence of each risk and of various possible outcomes of the risk.

The main objective of risk analysis must be to assess the effects on the project by the risks identified. The techniques range from subjective assessments through to the use of sophisticated techniques using computer software. The approaches can be categorized under two broad headings:

1 the summation of individual risk exposures to calculate a project risk allowance; techniques include expected monetary value (EMV) and Monte Carlo simulation;
2 the statistical calculation of average and maximum risk allowances; techniques include application of the central limit theorem and multiple estimating using the root mean square (RMS) method.

Identification of the potential risks can be achieved by:

- interviewing key members of the project team;
- organizing brainstorming meetings with interested parties;
- using the personal experience of the risk analyst;
- reviewing past project experiences.

Dr Steve Simister (Simister, 2000) identified the differences between a qualitative and quantitative approach.

In the qualitative assessment, which is recorded and analysed in the risk register, it is necessary to ask the following questions. What is the risk? How might it occur? How likely is it (probability)? How good/bad might it be (impacts)? Does it matter? What can we do? When should we act? Who is responsible?

In contrast, in a quantitative assessment the computer model, e.g. developed based on spreadsheets and @Risk software, is used for the following purposes: modelling uncertainty; simulating combined effects of risks; predicting outcomes, range of min/max expected; testing scenarios; setting confidence limits; identifying criticalities; and determining options.

Calculating risk allowances

Method 1 – Expected monetary value

The assessment identifies the impact of risks in terms of both the *impact* and the *probability of occurrence.* This can be expressed as the simple formula:

Risk exposure = Impact x Probability.

It is important that all the potential risks and uncertainties which can affect the project and are likely to act as constraints on the project be identified as early as possible.

Once the risks have been identified, the risks are then subjected to an assessment that categorizes the risks into a subjective probability of occurrence and into three categories of impaction on the project – optimistic, most likely and pessimistic outcome. Two rules should be obeyed in the calculation: first, the most likely outcome must have the highest value and, second, the total value of probability for the three outcomes must always equal one.

This method is simple and transparent and allows the consideration of more than one risk. However it has the disadvantage that it is unable to consider linkages between risks.

Consider the calculation of the risk allowance to be made for the potential increased lengths to the piling due to the uncertain ground conditions.

	Outcome £	Impact (I) £	Probability (P)	(I x P) £
Cost plan allowance	1,350,000			
Optimistic outcome		150,000 saving	0.30	(45,000)
Most likely outcome		150,000 extra	0.50	75,000
Pessimistic outcome		250,000 extra	0.20	50,000
Expected monetary value				80,000

So, £80,000 should be added to the cost plan allowance for the piling.

Depending on the size or complexity of the project, it may be necessary to carry out a *secondary* risk assessment to identify consequential secondary risks.

This same technique can be used by contractors in order to establish an allowance for risk factors when compiling a tender or a quotation for a variation. David Neale, Director of May Gurney (Construction) Ltd described the difficulties in identifying the risks in a design and build highway project which involved widening and upgrading the existing carriageway. In his paper (Neale, 1994) described the development of a crude risk model (similar to the above cost plan) in which the contractor calculated an explainable sum to be added to their tender.

In the event none of the risks identified occurred and instead the contractor encountered a totally unforeseeable event where the design responsibility was the contractor's and which cost more than the total allowance.

The author (Potts, 2003) also described a similar situation in connection with a quotation for a major variation submitted prior to the work being executed. The risk allowance proved inadequate to cover the substantial additional cost which, once the quotation was accepted, was considered the contractor's risk.

Uff (2002) states:

> The conventional engineering approach has been to evaluate risk as the product of probability times impact. However, this approach is criticised by Chapman and Ward as fundamentally flawed on the grounds that it fails to take account of known and unknown uncertainties and of bias and may involve a serious misrepresentation of reality.

Cooper and Chapman (1987) and Chapman and Ward (2003a) describe more sophisticated approaches to risk management based on techniques developed on oil fields and major gas terminals. Of particular interest is Chapman and Ward's research describing a 'constructively simple' approach to estimating using a decision-support modelling paradigm based on project risk management and operational research concepts (Chapman and Ward, 2003b).

Decision trees

Decision trees can be useful where the scenario is more complex. They are graphical representations that are useful in assessing situations in which the probabilities of particular events occurring depend on previous events and can be used to calculate expected values in these more complex situations.

The decision tree in Figure 8.1 shows two risks – A (Adverse weather at the contractor's risk) and B (Potential claim from the client of delay damages – acceleration is thus required to make up lost time).

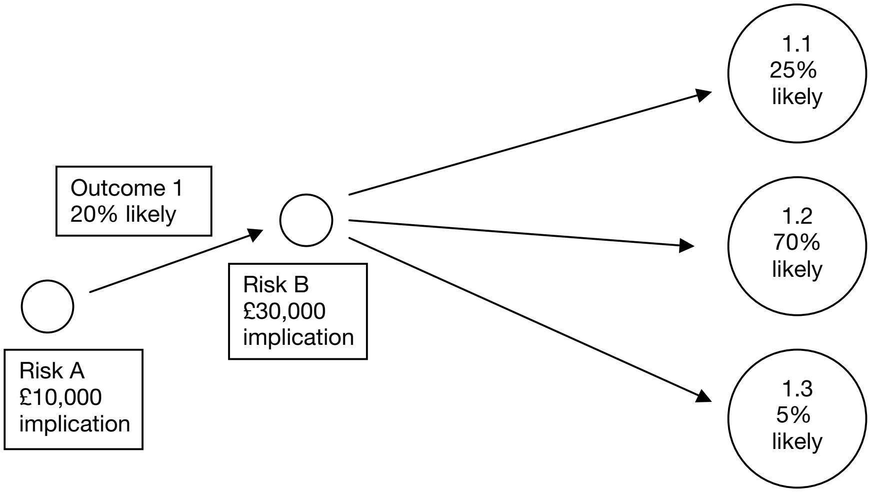


Figure 8.1 Simple decision tree

Risk A has a 20 per cent chance of occurring, with a monetary value of £10,000. If outcome A occurs, a second risk, B, is introduced and there are three likely outcomes, 1.1 (pay bonuses to own labour), 1.2 (import additional labour) and 1.3 (subcontractor's responsibility). The monetary value of Risk B is £30,000.

Using the decision tree, the following financial risks are identified:

Outcome 1.1 has a financial risk of (£10,000 x 0.2) + (£30,000 x 0.25) = £9,500
Outcome 1.2 has a financial risk of (£10,000 x 0.2) + (£30,000 x 0.70) = £23,000
Outcome 1.3 has a financial risk of (£10,000 x 0.2) + (£30,000 x 0.05) = £3,500.

So, if possible you should try to achieve outcome 1.3 (subcontractor's responsibility!) as this has the least potential cost. This example shows how these calculations can easily become complex and highly theoretical. Some might argue that this conclusion could have been identified by inspection of the facts, common sense and gut feeling. Indeed this whole scenario may well rebound back onto the main contractor if they try to implement harsh terms in the subcontract and the subcontractor's personnel walk off-site.

Indeed this was the scenario in Hong Kong when the giant Gammon Kier Lilley JV (GKL) tried to impose tendered BofQ rates onto the local labour-only architectural subcontractor. Due to a shortage of skilled workers the subcontractor was beginning to make a financial loss on the rates quoted in his tender and requested additional payments. GKL insisted that he should do the work at the rates quoted at tender and which were included in his subcontract agreement. The subcontractor's reaction was to take his men off-site and the owner disappeared into China for two weeks. GKL soon realized who was carrying the risk – it was them, not their subcontractor!

Sensitivity analysis

The basis of a sensitivity analysis is to define a likely range of variation for elements of the project data. The final project cost or duration is then assessed for each variation in the data. In effect, a series of *what-if* estimates is produced.

The results of sensitivity analyses are often presented graphically, on a spider diagram, which readily indicates the most sensitive or critical areas for management to direct its attention towards.

One weakness of sensitivity analysis is that the risks are treated individually and independently. Caution must therefore be exercised when using the data directly to assess the effects of a combination of risks.

Method 2 – Monte Carlo simulation

Sophisticated analysis techniques are sometimes used to quantify the occasion of risks. Mathematical models and analytical techniques are often useful indicators of trends and problems. However, these techniques should not be relied upon as the sole guide to the decision-making process.

The Monte Carlo simulation method relies on random calculation of values that fall within a specified probability distribution. The basic steps are as follows:

1 Assess the ranges of variation for the uncertain data and determine the probability distribution most suited to each piece of data.
2 Randomly select values for the data within the specified range and taking into account the probability of occurrence.
3 Run an analysis to determine values for the evaluation criteria for the combination of values selected.
4 Repeat steps 2) and 3) a number of times. The resulting collection of outcomes is arranged in sorted order to form a probability distribution of the evaluation criteria. The accuracy of the final distribution depends on the number of repetitions, or iterations: usually between 100 and 1,000.

Since the outcome from the Monte Carlo analysis is a collection of, say, 1,000 values of each evaluation criterion, it is unlikely that the same value for the evaluation criterion will be calculated more than a small number of times. The values are therefore grouped into class intervals. The results are presented as frequency and cumulative frequency distribution.

It is usual to carry out a probabilistic time analysis with the aid of a CPM network to model the project schedule. The same method can be used for probabilistic cost analysis, especially when the cost estimate can be broken down into the same categories or activities as the schedule and when cost risks are related to time costs (Norris *et al*., 1992).

Monte Carlo simulation enables linkages to be established between risks and is based on widely available computer software. However, the calculations can easily become highly complicated.

Method 3 – Central limit theory

This is a simple technique used for calculating the overall risk allowance for projects, which provides a confidence limit of 90 per cent. The model has three elements:

1 a base estimate which should be risk-free;
2 a calculation of the individual risk allowances calculated using the formula: Risk allowance = Impact (I) x Probability (P)
(the sum of these risk allowances should provide a 50 per cent risk allowance); and
3 calculation of a 90 per cent risk allowance using the formula:
$X = 1.3 \sqrt{} S (I^2 \times P \times (I - P))$.

The 90 per cent risk allowance is essentially a lump sum contingency. The technique is easy to calculate on a spreadsheet and only one outcome needs to be considered; however, linkages between risks cannot be considered.

Method 4 – Multiple estimating using root mean square

This technique has been used extensively by the Ministry of Defence and other public sector bodies. The calculation requires the calculation of three estimates:

1 the base estimate which should be risk-free;
2 the average risk estimate – defining the project contingency; and
3 the maximum likely risk estimate – calculating the 90 per cent risk allowance.

The risk estimate is derived from the formula: Risk allowance = Impact x Probability.

The maximum risk allowance (MRA) is calculated using the following formula:

$$MRA = \sqrt{S\,((Imax \times Pmax) - (Iave \times Pave))^2}$$

(Where: Imax = the maximum risk impact
Pmax = the maximum probability, typically a 90 per cent confidence limit
Iave = the average risk impact
Pave = the average probability, typically 50 per cent confidence limit.)

The calculation of both average and maximum risk allowances also requires the distinction between fixed and variable risks.

The multiple estimating technique provides a thorough appraisal of the project risks. However the process requires a complex calculation entailing two estimates and the distinction between fixed and variable risks. The example above is based on an actual calculation used by the client's project managers/cost consultants when establishing the lump sum contingency on a major complex building project in Birmingham.

8.4 Risk register

In the last decade or so the use of the risk register as a key control document has gained acceptance with leading clients. The risk register lists all the identified risks and the results of their analysis and evaluation, and information on the status of the risk. The risk register is an iterative working document used by the construction project team to record project risks and associated actions. It should be maintained collectively by the integrated project team and regularly reviewed and updated during the project cycle to reflect risk management actions and outcomes. If used correctly the risk register has the potential to challenge the project team to work together proactively in order to solve problems.

The UK Government's *Green Book, Appraisal and Evaluation in Central Government* identifies best practice for public sector bodies and notes that the risk register should contain the following information: risk number (unique within register); risk type; author (who raised it); date identified; date last updated; description; likelihood; interdependencies with other sources of risk; expected impact; bearer of risk; countermeasures; and risk status and risk action status (HM Treasury).

The risk register is important for the following reasons:

- monitoring and, if necessary, correcting progress on risk mitigation measures;
- identifying new risks;

Table 8.2 Project manager's risk analysis report at feasibility stage

UNIVERSITY OF METROPOLIS
PROJECT MANAGER'S REPORT
Risk analysis – Client project risks (feasibility stage)

		AVERAGE RISK				MAXIMUM RISK		
Ref.	*Description of risk element* *(a)*	*Type* *(b)*	*Base value of risk element (£K)* *(c)*	*Probability Factor (F) or confidence limit (V)* *(d)*	*Value (£K)* *(e)*	*Probability factor (F) or confidence limit (V)* *(f)*	*Value £K* *(g)*	*Square of the deviation* *(h)*
B010	Fitting out of school	F	70	0.9	63	1	70	49
B021	Teaching block 1	F	1,400	0.9	1,260	1	1,400	19,600
B023	Private Finance Initiative	V	N/A	50%	750	90%	1,500	562,500
B030	Equipment purchase	F	3,500	0.5	1,750	1	3,500	3,062,500
B043	Retail units main entrance	F	100	0.1	10	1	100	8,100
B046	Library	F	100	0.25	25	1	100	5,625
B050	Fixtures	V	N/A	50%	50	90%	100	2,500
B051	Existing boiler house	F	250	0.25	63	1	250	35,156
B061	Boardroom	F	TBA					0
AVERAGE RISK ALLOWANCE					3,971	Square root of the sum of the deviations		1,923
Add to the average risk allowance								3,971
MAXIMUM RISK ALLOWANCE (£K)								5,894

Notes: F = fixed (expressed as a ratio)
V = variable (expressed as a percentage)
If (b) is 'F' then (e) = (c) x (d) and (g) = (c) x (f)
If (b) is 'V' then both (e) and (g) are estimated costs reflecting the levels of confidence, i.e. there is no 'base value'
(N/A = not applicable)

Explanation of probability ratios for fixed risks:

Unlikely	0.10
Could happen	0.25
As likely as not	0.50
Very likely	0.75
Almost certain	0.90
Certain	1.00

Explanation of confidence limits:
Average risk allows 50% confidence
Maximum risk is always 90% confidence, i.e. there is only a 10% chance of this being exceeded

Table 8.3 Typical contractor/client joint risk register (part only)

	Description of risk	*Description of impact*	*Impact*	*Proba-bility*	*Owner*	*Included in target*	*Sum included in target*	*Comments*
A	General ground problems	Disposal costs of unforeseen contaminated material	£20K	50%	50/50	Yes	£10K	200m^3 max assumed
B	Weather	Adverse weather – additional cost and time	£50K	50%	50/50	Yes	£25K	Additional temporary covers
C	External restraints	Land purchase on section – legal time delay	£100K	5%	Client	No	£5K	Non-critical section
D	Contractual problems	Delay of framework suppliers	£40K	10%	50/50	Yes	£4K	Consider acceleration
E	Design/ survey	Removal of asbestos in existing structures	£9K	30%	Client	No	£2.7K	Specialists required
F	Operational requirements	Delay in issue of permits	£20K	10%	Client	No	£2K	1 week assumed
G	Site specifics	Site security – loss of equipment	£50K	50%	50/50	Yes	£25K	Check details of insurance
H	Price build up	Increased cost – Inflation	£50K	50%	50/50	Yes	£25K	Steel/cement prices volatile

Source: Potts (2003)

- closing down expired risks;
- amending risk assessment for existing risks; and
- approving the drawdown of project contingencies by the client when required.

The author, Potts (2003) identified that the key to the successful management of risk throughout the project cycle on the Severn Trent Derby Sewage Works project was the compilation of a joint contractor/client risk register with regular reviews and modifications. This design and build target cost project with a pain/gain share arrangement was carried out under a 5-year framework agreement. Under this project the first attempt at identifying the risks was based on an unstructured methodology without constraints. The resulting risks were then listed on the risk register; the process was repeated with the aid of a risk matrix, checklists and past experience.

The *contractor/client joint risk register* was a dynamic control document, which was evolved by Seven Trent Water (STW) and the contractor, throughout the life of the project. All the risks, including potential variations, were subject to continuous review and modification.

A more complicated risk register could also include the following headings: ID number; description of the risk; likelihood (per cent); consequence – time impact (categorized as low, medium or high); consequence – cost impact (categorized as low, medium or high); owner; cost

Panel 8.2 Risk registers

Details of the risks should appear in the risk register. However, the detailed nature of the risk register means that it can be difficult to capture a meaningful summary of the current exposure to risk. A suggested approach is to assess each risk against a matrix of probability (high/medium/low probability) and impact (high/medium/low impact).

Risks that have a high score on both probability and impact, or a high score on one and medium on the other, are assigned a Red status (high risk, requiring careful attention) those that are low probability and low impact, or low on one and medium on the other, are given a Green status (risks need watching, but not a priority concern). Regular recording of the progress of risks is essential, because their status can change rapidly. A summary of Red risks could be reported at senior level via project board meetings, for example, so as to concentrate on the areas of highest risk.

Achieving Excellence in Construction (OGC, 2003) *Procurement Guide 04*

risk allowance in 'contract amount'; cost risk allowance as 'contingency'; predicted risk expiry date; actual risk expiry date; actions which are to be taken to avoid or reduce the risk and comments.

8.5 Risk response

The response to the risk will be appraised by the severity of the risk to the project. There are four risk mitigation strategies that can be adopted by the client and project team in order to reduce the risk exposure associated with a project: avoidance; reduction; transfer, or retention.

Avoidance

If the situation is assessed such that the risk is judged to have a serious consequence, then the situation may warrant a reappraisal of the project. It may be necessary to review the project's aims, to reappraise the concept or to cancel the project.

Reduction

Reducing the risks may involve redesigning the project, changing the procurement strategy or undertaking additional soil investigation to minimize changes to the foundations, changing the specification or incorporating different methods of construction to avoid unproven construction techniques.

Transfer

Perry and Hayes (1985) identified four common routes for the transfer of risk:

- client to contractor;
- contractor to subcontractor;
- client, contractor, subcontractor or designer to insurer;
- contractor or subcontractor to surety.

However, it should be noted that implementing transfer of the risks to others may result in development of different contract terms, payment of higher fees or additional premiums.

If the risks can be transferred, their consequences can be shared or totally carried out by someone other than the client. The client will be expected to pay a premium for this, so responsibility for initiating this form of risk response lies with the client.

Abrahamson (1984) considered that a party should bear a construction risk where:

- it is in his control; or
- he can transfer the risk by insurance; or
- the preponderant economic benefit of running the risk accrues to him; or
- to place the risk on him is in the interests of efficiency; or
- if the risk eventuates, it is not practicable to transfer the loss to another.

Retention

Risks that are retained by either party may be controllable or uncontrollable by that party. Where control is possible it may be exerted to reduce the likelihood of occurrence of a risk event and also to minimize the impact if the event occurs. It will be necessary to include a project contingency fund.

Managing the risks on international projects in developing countries can be particularly difficult. Zhi (1995) researched into risk management on a large 3-year residential-commercial complex building in a northern city of China. The project was executed under a type of PFI arrangement by a joint venture based on a 50 per cent/50 per cent share between a foreign company and a local government-backed company. Zhi (1995) noted how the foreign company identified 21 risk factors before signing the JV contract. These were reduced to the ten most significant risks by a panel of 30 professionals including representatives from the company. The probability of occurrence and the corresponding impact for each of the ten risks were then assessed and a ranking of the potentially most significant risks was produced, together with the risk response as follows:

1. High inflation (*use lump sum contracts with local contractors and annual rental contracts with tenants*).
2. Bureaucracy (*maintain close relationship with local government officials and record everything in writing*).
3. Low social security at the location (*install electric locks, security doors, door phone systems and closed circuit TV*).
4. Corruption (*appoint local firm as a consultant*).
5. Lack of nearby education (*provide free shuttle bus to inner city*).
6. Lack of transportation facilities (*provide free shuttle bus to inner city*).
7. Tax rate changes (*adopt a slow depreciation and quick profit return policy*).
8. Exchange rate (*consider buying and exporting Chinese products with the profits*).
9. Lack of legal system (*adopt a strategy of 'shaking hands'*).
10. Lack of nearby communications facility (*use the early booking method and pay an extra fee for prompt installation*).

Zhi's research highlighted the potential enormous risks facing an international contractor working in a developing country and identified the need to develop an effective strategy for managing such risks prior to signing the contract. In this regard, local knowledge is invaluable.

8.6 Strategic risk management

A most significant review of large engineering projects – defined as airports, urban transport, oil fields and power systems – was undertaken by an international team led by Roger Miller, the Hydro-Quebec/CAE Professor of Technology Management at the University of Quebec at Montreal. The purpose was to benchmark 60 worldwide projects and identify best practice, to shape research issues and to share learning (Miller and Lessard, 2000).

The key findings from observing how sponsors wrestled with the risks inherent in projects, as well as those arising from possible conflicts among the various co-specialized partners or stakeholders, is that the lead sponsors have developed a strong repertoire of strategies for coping with risk. The ability to frame risks and strategies represents a core competence for them. This competence spans the five types of management philosophies:

1 obtaining and framing information;
2 designing a process with a long *front-end* before technical, financial and institution details are locked in, followed by rapid execution of the project;
3 building coalitions that bring together varying information and skills and are structured to create strong incentives for performance and mitigate conflicts of interest;
4 the allocating of risk to the party best able to bear it;
5 transforming institutional environment risks through the creation of long-term coalitions that incorporate powerful influences on laws and rules.

These recommendations are very much in line with best practice advice such as the OGC (2003) and the *Constructing Excellence* programme within the UK.

Figure 8.2 has been developed based on a letter sent to *Building* magazine by Tony Clarke, director of management services at Knowles, in July 2005. In this letter he listed the causes of

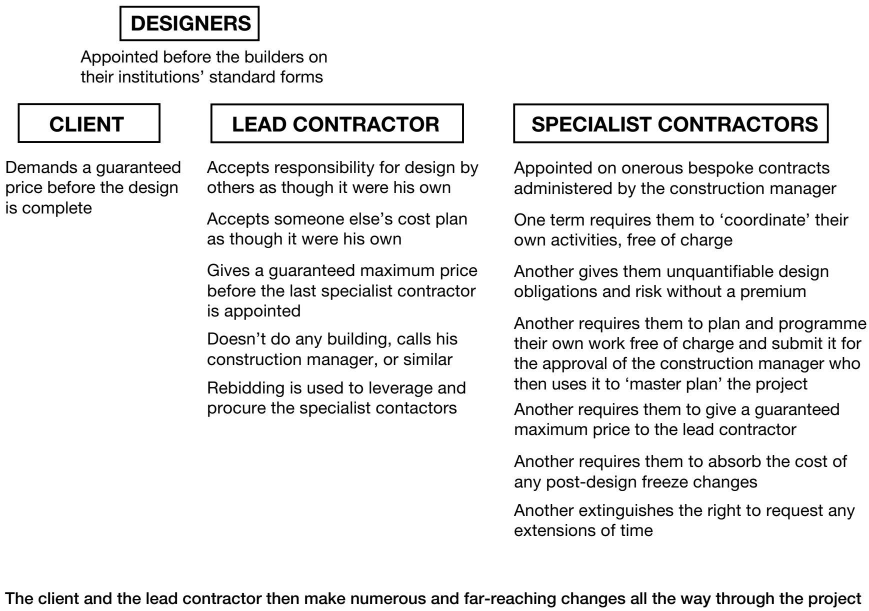


Figure 8.2 The real causes of disputes, or who carries the risk? (Developed based on letter from Tony Clarke to *Building* magazine, 22 July 2005)

disputes on projects such as: the Millennium Stadium, the Scottish Parliament building, The Great Eastern Hotel, The British Library, The Jubilee Line, The Royal Brompton Hospital and Portcullis House and conjectured that these same issues may be the cause of the problems on the Wembley Stadium project.

This is a most important contribution to our understanding of risk management on major projects. It shows that in many instances clients have attempted to dump the risk onto the lead contractor, who in turn has passed the risk down to the specialist contractors. The case studies throughout this book demonstrate that in practice this approach does not work and may rebound back onto the client with catastrophic consequences.

The words of Sir John Egan, '*We should all rethink construction*,' ring somewhat hollow. It is necessary to go back to Sir Michael Latham's recommendations on the 13 essentials of a modern contract contained in *Constructing the Team* (see Panel 2.1) and embrace the philosophy of partnering, mutual trust and cooperation found in the NEC Engineering and Construction Contract.

It is noted the British Standards Institute (BSI) have now introduced recognized international standards for risk management such as: BS ISO 31000: 2009 Risk Management. Principles and guidelines; and BS EN 31010: 2010 Risk Management. Risk assessment techniques. For a detailed explanation of the ISO 31000, access the presentation by John Shortreed, Director of Risk Research at the University of Waterloo, Canada.

8.7 Case studies

Case Study 1: Britain's first motorway – the Preston Bypass

Britain's first motorway – the M6 Preston Bypass (J29 to J32) opened in December 1958 and was closed to traffic after only 46 days' use due to frost damage. The 8 1/4 mile project was constructed by Tarmac (now Carillion) under a traditional ICE Engineer designed contract with bills of quantities.

This was a high-risk project with the potential for adversarial disputes and contractual claims. In the event, significant problems were encountered caused by a combination of three factors: the weather, the ground conditions and inadequate design.

In August 1956, after mobilization of the heavy earthmoving equipment, 13 inches of rain fell in one month putting a stop to any serious bulk earthworks until the spring of 1957. Subsequently large quantities of the excavated material, which was assumed could be used as filling material, was found to be unsuitable. This caused a change in the working methods and type of construction equipment used. Furthermore, it was necessary to import large quantities of filling and stabilization stone. Design problems included inadequate specification of the road surfacing and the sub-base.

Important lessons were learned on this pioneering project and specifications were soon changed for later motorways (Cox, 1998).

Case Study 2: Design and build: College of Further Education, West Midlands

Under the design and build procurement route the employer shifts the critical risks of design, construction and co-ordination to the contractor, and as a result contractors often find themselves carrying risks which were never anticipated at the tender stage.

The design and build of the £8.8 million College of Further Education in the West Midlands involved the demolition of the existing college and construction of two teaching blocks. At the feasibility stage the employer's engineer designed the flow of storm drainage to be connected into a local 'combined' sewer, i.e. one taking storm and foul water; this formed the basis of the contractor's tender. The contractor's engineer then took the proposed scheme which had been novated to the contractor and produced the working drawings.

On site a large amount of external storm water drainage was laid with the intention of connecting to the local sewer. Then the contractor discovered that the relevant legislation stated that the combined sewer was not to receive any further storm connections in accordance with ISO 14001: Environmental Management System. The only alternative for the contractor was to install two large soakaways and divert all drainage runs at a large additional cost. The contractor was unable to recover any damages from the employer's engineer and to make matters worse his own consultant design engineer went bankrupt.

The outcome of the event was a delay to the programme, additional expense for the contractor and damage to the reputation of the designers and the contractor (Grey, 2009).

Case study 3: The Millennium 'wobbly' Bridge, London

The Millennium Bridge over the Thames, linking the newly opened Tate Modern Gallery at Bankside with the City of London at St Paul's, was the first pedestrian bridge built over the Thames for over 100 years.

The bridge was intended to be one of the landmark projects heralding the new millennium. The innovative and complex structure featured a 4-metre-wide aluminium deck flanked by stainless steel balustrades, supported by cables, and was designed by a joint venture comprising architect Norman Foster, sculptor Anthony Caro and structural engineers Ove Arup.

Such was the interest in the new bridge that, when it opened to the public on 10 June 2000, an estimated 80,000 to 100,000 people crossed it. It soon became clear that all was not well as the deck swayed about and many reported feeling seasick.

After a prolonged series of tests, it was decided to adopt a passive damping system which would harness the movements of the structure to absorb energy.

After nearly 2 years of testing the alterations were deemed a success and the bridge finally opened to the public in February 2002. The alterations had cost an extra £5 million on top of the initial £18 million.

Postscript: the risk of design failure was not one of the ten principal risks identified in the pre-contract risk management exercise! (Urban75 website; Rawlinson, 1999).

Case Study 4: Royal Opera House, Convent Garden, London

The £200 million refurbishment of the Royal Opera House was one of the largest and most complex projects funded by the National Lottery Board. The project was executed using the construction management approach as this was considered an ideal process for managing risk.

The aim was to identify risks at the earliest possible opportunity and proactively manage them through the risk register. Actions were taken to contain and reduce the risks and to transfer the risks remaining through the contract to consultants and trade contractors. Project risks were therefore only transferred to trade contractors after they had been identified, analysed, quantified and minimized. The risks were clearly described in the tender documents and specific actions agreed with the trade contractors.

Cost risks on the project were minimized by the early award of those key trade packages that have a large element of specialized detailed design, on a lump sum design and construct basis. Around 70 per cent of the total project value was procured prior to project construction; the remaining 30 per cent was the subject of a detailed cost estimate.

Rigorous cost control procedures were established to identify and obtain client approval to all post-contract variations before implementation.

Time risks on the project were minimized by detailed analysis of the programme, construction methods and sequences, resources and logistics. Methods included critical path analysis, resource analysis and resource levelling, 3D CAD modelling of construction phasing and construction programme. Detailed method statements were produced for each critical element and comprehensive risk analysis undertaken of the programme linked to probability simulations (Trotter, 1995).

Case study 5: Risk management on the Scottish Parliament building

The following observations were made about risk management on the Scottish Parliament building by the Auditor General for Scotland:

> Risk management for the Holyrood project was not good practice. In my 2000 report I concluded that accounting for risk was insufficient. I showed that contrary to good practice there was no quantified allowance for the major risks facing the project. I recommended that this should be established and the results used as a basis for an action plan to manage the risks. Project management introduced a process for quantifying risks from October 2000 and then conducted a number of risk reviews.
>
> Although by definition risk is uncertain, some 70 per cent of the risk identified by the October 2000 workshop was for items that were categorized as 'highly likely' i.e. assessed by the workshop members as having at least a 95 per cent probability of occurring. Each of these items carried with them varying levels of likely impact on programme.
>
> Moreover the risk evaluation did not attempt to evaluate the monetary value attached to the risks to the time schedule. If it had it would have added further risk cost.
>
> However, in the Holyrood project the general approach was to accept cost increases and include them in the forecasts as the risks materialized. Because there was no agreed budget limit after June 2001, there is little evidence that forceful action was taken to prevent or reduce the increase in cost.
>
> Auditor General for Scotland, Audit Scotland (2004)

8.8 Conclusions

We have reviewed some of the main techniques and methodologies for risk management relevant for construction projects and identified that real benefits can occur with their use. However there is no panacea for successful management of risk; it should be viewed constructively and creatively. Rigid application of a set technique or procedure is not advocated or encouraged. Indeed methodologies are, relatively speaking, in their infancy and evolving with practice.

Interest in risk management comes mainly from educated clients and is regularly adopted as integrated front-end service. Ongoing risk management studies throughout the project are largely limited to the public and utilities sectors. Wood and Ellis's research found that the use of risk management workshops and the production of risk registers is commonplace. The use of Monte Carlo simulation is widespread through the use of specialist software. However, there seems some scepticism among the leading UK cost consultants regarding the usefulness of complex risk analysis techniques and there is a predisposition to rely on judgement based on experience (Wood and Ellis, 2003).

The initiative for the application of risk management lies with the client and their professional advisers, particularly the project manager and cost manager. Some changes in normal policy may be required, e.g. building adequate time for risk management into the project programme, training and perhaps experimentation with techniques.

8.9 Questions

Question 1

Identify two unexpected events that have occurred on a construction project with which you have been involved. What was the impact on the project and how were they dealt with?

Question 2

The University of Metropolis, together with the local City Council, is developing a brownfield site adjacent to an old gasworks in order to provide a large Science and Technology Park.

It is anticipated that the project will be carried out in phases over a period of 5 years.

1 Identify the main strategic risks for the client organization and how these might be avoided/mitigated.
2 Identify the main risks for the contractor and how these might be avoided/mitigated.

Question 3

John W. Hinchey, partner with King and Spalding LLP in Atlanta, Georgia, identified 'Ten ways owners can avoid or mitigate construction risk' (Hinchey, n.d.). Critically review this article making specific reference to your own market.

8.10 References/further reading

Abrahamson, M. (1984) 'Risk management', *International Construction Law Review*, Vol. 1, pp. 241–264.

Audit Scotland (2004) *Management of the Holyrood Building Project, Prepared for the Auditor General for Scotland*, June, Audit Scotland.

Bibby, G. and Wood, R. (2004) 'Piling', *Building*, 15 October, pp. 64–67.

British Standard 4778 Section 3.1: 1991 Quality vocabulary. Availability, reliability and maintainability terms. Guide to concepts and related definitions.

Clarke, T. (2005) 'Fifteen golden rules', Letter to *Building*, 22 July, p. 32.

Chapman, C. and Ward, S. (2003a) *Project Risk Managemen*t, 2nd edition, John Wiley & Sons Ltd.

Chapman, C. and Ward, S. (2003b) 'Constructively simple estimating: A project management example', *Journal of the Operational Research Society*, Vol. 54, 1050–1058.

Constructing Excellence, 'Risk Management' Fact Sheet: www.constructingexcellence.org.uk – cited 20 October 2012.

Cooper, D. and Chapman, C. (1987) *Risk Analysis for Large Projects: Models, methods and cases,* John Wiley & Sons.

Cox, J., detailed account of the Preston Bypass project within 'The Motorway Archive': www.iht.org/motorway/m6preston.htm – accessed 22 October 2012.

Cox, L.J. (1998) 'Britain's first motorway: The Preston By-pass', *Tarmac Papers, The Archives and History Initiative of Tarmac Heavy Building Materials*, Vol. II: 1998 Quarry Products Number.

Curtis, B., Ward, S. and Chapman, C. (1991) 'Roles, responsibilities and risks in management contracting', *CIRIA Special Publications* 81.

Edwards, L. (1995) *Practical Risk Management in the Construction Industry*, Thomas Telford.

Fenn, P. (2000) 'Review of international practice on the allocation of risk of ground conditions', *International Construction Law Review*, pp. 439–453.

Flanagan, R. and Norman, G. (1993) *Risk Management and Construction*, Blackwell Scientific.

Godfrey, P.S. (1996) *Control of Risk: A guide to the systematic management of risk from construction*, Special Publication 125, CIRIA.
Grey, M. (2009) 'The risks to the contractor under design and build', *Unpublished Dissertation*, BSc (Hons) Commercial Management and Quantity Surveying, University of Wolverhampton.
Hill, E. (1998) *Managing Risk – Methods for software systems development*, Addison Wesley Longman.
Hinchey, J.W. (n.d.) 'Ten ways owners can avoid or mitigate construction risk': www.kslaw.com/Library/publication/Hinchey_ten_ways.pdf – cited 23 October 2012.
HM Treasury (2011 update) *Green Book, Appraisal and Evaluation in Central Government*, The Stationery Office: www.hm-treasury.gov.uk/d/green_book_complete.pdf – cited 22 October 2012.
Institution of Civil Engineers and the Faculty and Institute of Actuaries (1998) *Risk and Management for Projects*, Thomas Telford.
Lane, T. (2007) 'Dancing with disaster', *Building*, 27 April.
Latham, M. (1994) *Constructing the team: Final report of the government/industry review of procurement and contractual arrangements in the UK construction industry*, HMSO.
Miller, R. and Lessard, D.R. (2000) *The Strategic Management of Large Engineering Projects*, The MIT Press.
Neale, D. (1994) 'New highways design and build contract: What the contractor thinks about the contract', IHT Cambridge, symposium.
Norris, C., Perry, J.G. and Simon, P. (1992) *Project Risk Analysis and Management: A guide by The Association of Project Managers*, CPS Project Management Ltd.
OGC (2003) *Achieving Excellence in Construction Procurement, Guide 04 Risk and Value Management, OGC.*
Perry, J.G. and Hayes, R.W. (1985) 'Construction Projects – Know the risk, *Chartered Mechanical Engineer*, February, pp. 42–45.
Potts, K. (2003) 'Risk management on variations – Two civil engineering case studies', *RICS Foundation Construction and Building Research Conference*, University of Wolverhampton, 1–3 September.
Raftery, J. (1994) *Risk Analysis in Project Management*, E & FN Spon.
Rawlinson, S. (1999) *Risk Analysis and Risk Management*, Notes to support Television Education Network video, January.
Shen, L.Y. (1997) 'Project risk management in Hong Kong', *International Journal of Project Management*, Vol. 15, No. 2, pp. 101–105.
Shortreed, J., Director of Risk Research at the University of Waterloo, Canada (2008): www.irr-neram.ca/pdf_files/ISO%2031000.pdf – accessed 16 May 2012.
Simister, S. (2000) 'Risk management', Lecture to postgraduate students, unpublished notes, University of Wolverhampton.
Smith, N.J. (1999) *Managing Risk in Construction Projects*, Blackwell Science.
Smith, R. (1996) 'Risk identification and allocation: Saving money by improving contracts and contracting practices', *International Construction Law Review*, pp. 549–569.
Thompson, P. and Perry, J. (eds) (1992) *Engineering Construction Risks: A guide to project risk analysis and risk management*, Thomas Telford.
Trotter, S. (1995) 'Procurement – A case study', *Effective Project Management Conference*, School of Business and Industrial Management, 4 December.
Uff, J. (2002) 'Risk in engineering: Is it such a bad thing?', The 90th Thomas Hawksley Memorial Lecture, Institution of Mechanical Engineers.
Wood, G.D. and Ellis, R.C.T. (2003) 'Risk management practice of leading UK cost consultants', *Engineering, Construction & Architectural Management*, Vol. 10, No. 4, pp 254–262.
Zhi, H. (1995) 'Risk management for overseas construction projects', *International Journal of Project Management*, Vol. 13, No. 4, pp. 231–237.

Websites

https://bsol.bsigroup.com/en/BsolHomePage.
www.constructingexcellence.org.uk.
www.hm-treasury.gov.uk.
www.urban75.org/london/millennium.html – accessed 22 October 2012.

9 Whole-life costing

9.1 Introduction

Whole-life costing (WLC) is now established as an important tool, which is changing the whole approach to design, procurement and construction and delivering major benefits. Whole-life costing is used to describe a form of modelling technique which can embrace a mixture of capital and running costs. *Life-cycle costing* is an older term for the same thing; *costs in use* is now an obsolete term.

The New Construction Research and Innovation Strategy Panel (nCRISP), defines whole-life costing as: 'The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset' (Constructing Excellence, 2004).

The Building Research Establishment gives the definition: 'Assessment of the whole life performance and cost of an asset over its lifetime takes into consideration initial capital costs and future costs, including operational costs, maintenance costs and replacement/disposal costs at the end of its life.'

Many public and private sector clients now procure on cost of ownership, not capital cost. Recent initiatives, such as *Achieving Excellence* and the drive for *Egan compliance* among housing associations demonstrate this trend. Local authorities often adopt whole-life costing as part of their response to their duty to deliver best value.

Consortia formed to undertake PFIs and PPPs also demand identification of whole-life costs in order to prepare detailed financial and risk management plans for projects. PFI and PPP contracts include non-availability clauses that may impose severe financial penalties on consortiums running schools if, say, a maintenance problem leads to a classroom being unavailable for use. So choices about a roof finish should not just be considered in terms of installation and maintenance costs – the whole-life costs should take into account the risk of the roof leak, the cost of repairs and the associated penalty. It is significant, though, that research evidence suggests that some contractors appear to overlook this important evaluation when preparing PFI bids (Swaffield and McDonald, 2008).

Within the report *Better Public Building* (produced in 2000 by the Department of Culture, Media and Sport) then Prime Minister Tony Blair stated 'integrating design and construction delivers better value for money as well as better buildings, particularly when attention is paid to the full costs of a building over its whole lifetime'.

Whole-life costing is not an optional extra. The Treasury, the National Audit Office and the Audit Commission expect it. A new British Standard BS ISO 15686 – *Service life planning of* *buildings and constructed assets* – provides the foundation for service life planning and the use of whole-life costing.

9.2 Understanding the relevance of WLC

Whole-life costs are substantially greater than capital or initial costs – it is estimated that the operational expenditure will be five–ten times as much as the capital cost. However, these ratios are small when compared with the ratio of capital expenditure to the operating costs of businesses occupying the building, which could be anything between 100 and 200 times as much as their building's initial costs. These ratios indicate that a 1 per cent improvement in productivity/output of staff would effectively pay the entire capital costs of the building (Constructing Excellence, 2004, *Whole Life Costing Factsheet*).

The following are considered some of the major benefits in implementing whole-life costing:

- It encourages communication between the stakeholders and leads to an improved project definition.
- The cost of ownership and occupation are clarified.
- The total cost of ownership/occupation is optimized.
- It enables early assessment of risks.
- It promotes realistic budgeting.
- It encourages discussion and decisions about materials choices.
- It enables best value to be attained.
- It provides actual figures for future benchmarking.

Whole-life costing should be included in the client's brief. It should be used as a decision-making tool throughout the procurement, construction and use of the project stages, e.g. initial investment appraisal, feasibility study of alternatives, outline and detailed design, tender appraisal, assessment of variations, handover and post-occupancy. Wang *et al*. (2010) for instance provide an example of its application in sustainable design selection for a flagship commercial development in Shanghai.

Whole-life costing has the potential for adding real value to a project. However it is critical to involve the whole supply chain early in the design cycle as 80 per cent of the future costs of running maintenance repair is fixed in the first 20 per cent of the design process. Experts in building services and facilities management should not be overlooked during the early design assessment if the full long-term environmental and economic advantages are to be secured.

The concept of whole-life costing was first introduced into the procurement assessment on the Ministry of Defence's *Building Down Barriers* projects. As part of the Defence Estates Prime Contracting strategy, potential contractors who bid had to forecast the whole-life costs along a series of milestones. Part of the payment on the 7-year project was based on performance against the milestones.

9.3 The basic steps in WLC

Whole-life costing is one of three evaluation processes that need to be undertaken during the design phase of any project. The other two are technical evaluation and environmental evaluation. The final choice of scheme will be a compromise between these three. Before a WLC analysis can be undertaken it is essential that a value engineering exercise is undertaken, and repeated as necessary, in order to remove all unnecessary cost from the functional/technical specification.

The Constructing Excellence factsheet, *Whole Life Costing* (2004), identifies that the following basic steps should be followed in order to identify the whole cost of an asset:

1 Identify the capital and operational costs and incomes.
2 Identify when they are likely to occur.
3 Use discounted cash flow analysis to bring the costs back to a common basis – items should normally be entered into the analysis at the current cost and a *real* (excluding inflation) discount rate applied. Normally this will be done on a commercial spreadsheet package, which includes equations for discounted cash flow.
4 Undertake sensitivity analysis of the variables such as the discount rate, the study period, the predicted design lives of components, assumptions about running costs, etc.

Expected life of a component

Predicting the life of a component is not an exact science. Numerous factors interact to determine the durability in practice. For example, there may be several levels of different specification within one component. Furthermore, the actual replacement interval is often determined by economic, technical or functional obsolescence. It is notoriously difficult to assess when or how obsolescence might strike. Critical factors might include changing land values on which the building stands, while changing information technology cabling requirements and changing safety requirements might contribute to rendering certain buildings obsolete.

Feedback from practice is an important source of durability data including:

- latent defects insurance schemes (e.g. NHBC, Zurich);
- condition surveys and defects investigations;
- maintenance records/repairs databases.

Panel 9.1 Determining element life

Kirk and Dell'Isola (1995) identified three different definitions of the life of equipment, materials or other components:

- Economic life – estimated number of years until that item no longer represents the least expensive method of performing functions required of it.
- Technological life – estimated number of years until technology causes an item to become obsolete.
- Useful life – estimated number of years during which an item will perform the functions required of it in accordance with some pre-established standard.

These headline statements are meaningless without some form of context. For example, the same water pump is unlikely to have as long a life when used in a hard water area compared to one maintained exactly the same way in a soft water area. .

Source: Elements needed for a whole life cost analysis: www.bsria.co.uk/news/1902 – cited 22 October 2012

Panel 9.2 Establishing the maintenance and energy costs

Over the life of the analysis the combined revenue, cost of utilities and maintenance can easily exceed the original capital expenditure. For example, it has been estimated that a highly serviced healthcare facility could spend the maintenance and operations budget equivalent of the capital cost every 3–5 years.

Relying on rule-of-thumb data can lead to a high degree of inaccuracy. The maintenance costs on 'hospitals' vary between a lower cost of £0.91/m^2 and an upper cost of £36.46/m^2 (1:40); whilst the difference on 'offices' varies between £0.09 and £35.89/m^2 (1:400)!

Source: 'Elements needed for a whole life cost analysis' (BSRIA, 2006)

Published information on the life expectancy of building components is also available from the following sources:

- RICS Building Running Costs (BRC) Online, a service of the Building Cost Information Service (BCIS);
- Housing Association Property Mutual (HAPM) *Component Life Manual* (HAPM, 1996);
- Building Performance Group (BPG) *Building Fabric Component Life Manual* (BPG, 2000);
- *BPG Building Services Component Life Manual* (BPG, 2001);
- Chartered Institution of Building Services Engineers (CIBSE) *Guide to Ownership, Operation and Maintenance of Building Services* (CIBSE, 2000);

Another useful resource for component durability is The Construction Durability Database of BLP (Building Life Plans Ltd). This database provides up-to-date durability and specification data for building components and is based on 25 years of data collection and research. Access to the database and to the updated information is provided free of charge to employees of Registered Social Landlords.

Elements to consider

The following items should be considered in the whole-life cost model:

- lifespan of building or asset;
- construction: site, design, construction, health and safety, commission, fit out, professional fees, in-house fees, statutory fees, finance, etc;
- facility: rent/rates, energy for heating/cooling/power/lighting, utilities, maintenance, repair/replace, refurbish, management, security, cleaning, etc;
- disposal: dismantle, demolition, sale, etc.

The list is not comprehensive and will depend on the type of building or asset. However, it gives some indication of the key issues to consider.

9.4 Money, time and investment

A sum of money received some time in the future will always be worth less than the same sum of money today and the difference will depend on:

- the length of time involved;
- future risks;
- the probable interest rates.

In doing the calculations it is a good idea to assume an interest rate that would reflect likely inflation and any special risks over the period concerned rather than a rate which might actually be obtainable today.

In considering development finance we have three kinds of expenditure/income, which we need to compare with each other:

- lump sums today;
- lump sums in the future;
- sums of money occurring at regular intervals during the period under consideration.

We cannot compare these, one with the other, unless we modify them in some way in order to put them on a common basis. There are two basic methods, and as usual they are just different ways of expressing the same thing – *present-day value* and *annual equivalent*.

Present-day value

All expenditure is expressed as the capital sum required to meet present commitments plus the amount which would have to be set aside today to provide for future payments, discounted to allow for accumulation of interest. Income is similarly treated; future income is discounted to the present day in the same way.

Table 9.1 shows that £1,000 received in 1 year's time (based on a 5 per cent interest rate) will have the present value of £952. Likewise, if £1,000 is received in 10 years' time, it will have a present value of only £614.

The concept of Net Present Value (NPV) – value at today's date – is important as it is used by major international clients, including the World Bank and the Hong Kong Mass Transit Railway

Table 9.1 Present value and discount rate (based on 5 per cent)

Time (mid-year)	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
PV of payment (mid-year)	£1,000	£952	£907	£864	£823	£784	£746	£711	£677	£645	£614

Panel 9.3 Observations on the discount rate

The change from 6 per cent to 3.5 per cent for the standard rate to be used (dictated by HM Treasury in April 2004) effectively puts a higher weight on future costs, with the aim of encouraging longer-term, more sustainable, development.

The choice of the discount rate (interest rate) used can have a dramatic effect on the outcome of the analysis. As an example, an annual energy bill of £100,000 over 30 years will have a present value of around £1.84 million if a 3.5 per cent interest is taken, but only £656,600 at 15 per cent.

Corporation, to evaluate contractors' bids. Thus, if a contractor's overall lump sum was low but they required a greater proportion of payment in year 1, this would be reflected in the NPV calculation.

The UK Government's recommended discount rate is 3.5 per cent (*Green Book*). Calculating the present value of differences between the stream of costs and benefits provides the net present value (NPV) of an option. The NPV is the primary criterion for deciding whether government action can be justified (HM Treasury, 2003).

Annual equivalent

This is the total of:

- any regular annual payments and income, such as wages, rents, etc;
- annual interest on items of capital expenditure;
- a sinking fund, the amount which would have to be put away annually to repay the capital cost at the end of the period.

Alternatively, the annual interest and sinking fund can be combined and expressed as the annual instalments which would be required to pay off the capital costs and interest over the term of years in question (rather like paying off a loan for a house through a mortgage).

Both of these methods will give a similar answer, and which one is used is purely a matter of convenience and depends on whether you are thinking in terms of capital finance or in terms of annual income and expenditure.

9.5 Calculations

In the following formulae n represents the number of years and i is the interest rate expressed as a decimal fraction of the principal, e.g. 5 per cent = 0.05.

The following standard time value of money tables should be downloaded from the internet.

Table 1 – Present Value Factors
Table 2 – Present Value of Annuity Factors.

Formula 1 – Compound interest = $(1 + i)^n$

If a sum of money is invested for some years it will have earned some interest by the end of the first year. Compound interest assumes that this earned money is immediately added to the principal and reinvested on the same terms, this process being repeated annually.

What will be the value of £5,500 invested at 9 per cent compound interest for 5 years?

Formula $(1+i)^5$ shows that £1 so invested will grow to £1.54.

£5,500 will grow to £5,500 x 1.54 = £8,470.

Formula 2 – Present value of £1 = $1/(1 + i)^n$

In the compound interest example, £5,500 invested for 5 years at 9 per cent grew to £8,470. The converse of this is that the present value of £8,470 in 5 years' time at 9 per cent interest is £5,500; i.e. the amount that will grow to that sum at the end of 5 years.

What is the present value of £1,200 in 35 years' time discounted at 10 per cent per annum?

By the use of the formula, the present value of £1 in such circumstances is 0.0356 (refer to

Table 1 – Present Value Factors). The present value of £1,200 is therefore 1,200 x 0.0356 = £42.72.

Formula 3 – Present value of £1 payable at regular intervals

$[(1+i)^n - 1]/[i\,(1 + i)^n]$

This formula shows the present value of future regular periodic payments or receipts over a limited term of years. It is, therefore, very useful for assessing the capital equivalent of things like running costs, wages or rents.

What is the present value of £1,200 payable annually for 10 years, assuming an interest rate of 8 per cent per annum?

Example

It is desired to compare the whole-life costs of two types of windows for an office building, whose life is intended to be 40 years. The rate of interest allowed is 3 per cent per annum compound.

Whole-life costs of Windows Type A

Windows Type A will cost £900,000, will require redecorating every 5 years at a cost of £20,000 and will require renewing after 20 years at a cost of £1,200,000.

	£
Initial cost	900,000
Present value at 3 per cent of:	
Redecoration after 5 years: £20,000 @ 0.8626 (PV of £1)	17,252
Redecoration after 10 years: £20,000 @ 0.7441	14,882
Redecoration after 15 years: £20,000 @ 0.6419	12,838
Renewal after 20 years: £1,200,000 @ 0.5537	664,440
Redecoration after 25 years: £20,000 @ 0.4776	9,552
Redecoration after 30 years: £20,000 @ 0.4120	8,240
Redecoration after 35 years: £20,000 @ 0.3554	7,108

	£1,634,312
	=========

Whole-life costs of windows Type B

Windows Type B will cost £1,250,000 and will last the life of the building without any maintenance, although a sum of £300,000 is to be allowed for general repairs after 20 years.

	£
Initial cost	1,250,000
Present value at 3 per cent of:	
Repairs after 20 years: £300,000 @ 0.5537	166,110

	£1,416,110
	=========

Saving by using Windows B is therefore £1,634,312 minus £1,416,110 = £218,202. It would therefore appear to be justifiable to use the initially more expensive Windows Type B, as this will prove much the cheaper in the long run.

Inflation

The discount rate is not the inflation rate but is the investment *premium* over and above inflation. Provided inflation for all costs is approximately equal, it is normal practice to exclude inflation effects when undertaking Life-Cycle Cost analysis (HM Treasury, 2003). In recent years inflation in the UK has been 2–4 per cent per annum; however, 15 years ago it was in double figures and in the early 1970s, following the Middle East crisis, it was over 25 per cent per annum.

The solution to the example above did not take into account inflation. If the original windows were worked out on the basis of 10 per cent annual inflation and 13 per cent interest we would get much the same result as with no inflation and interest at 3 per cent.

9.6 Problems with assessing whole-life costs

We have seen how whole-life costing enables us to consider the long-term implications of a decision and provides a way of showing the cost consequences. It has been identified by Ferry *et al.* (1999) that there are a number of potential fundamental problems in using a whole-life costing approach such as the following:

1 Initial and running costs cannot really be equated:
   - The maintenance charges will fall upon the purchaser not on the developer.
   - Even with public buildings, e.g. schools, the bulk of the construction costs are paid for by one authority, with another authority responsible for maintenance.
   - Money for capital developments is often more difficult to find than money for current expenditure.
2 The future cannot really be forecast:
   - The cost of maintenance is pure guesswork.
   - The amount of money spent on decoration and upkeep is determined more by the body responsible for maintenance, e.g. new owners, than by any quality inherent in the materials.
   - Hard-wearing materials may give an old-fashioned appearance and may be replaced before they are life expired.
   - Major expenditure on repairs is usually caused by unforeseen failure of detailing, faulty material or poor workmanship and is almost impossible to forecast.
   - Interest rates cannot be forecast with any certainty, particularly over long periods. Would you like to guess what the Bank of England (or the European Bank) would do in say 20 years?

Whilst these comments reflect genuine concerns, they have not in any significant way undermined the value of WLC, which is still widely used particularly in the evaluation of PFI schemes. However, it is useful to be aware of these potential limitations of WLC.

The National Audit Office Report, *Improving Public Services through Better Construction* (NAO, 2005), also identified four key barriers to successful whole-life costing. First, the lack of clarity on what is meant by whole-life costing. Second, a lack of robust historical data on running costs. Third, people making investment decisions need a tool not just based on cost but other drivers such as time, sustainability, quality and return on investment. The calculations are done in a vacuum and there is no way of comparing and evaluating the options. Finally, there is a lack of tangible evidence of the benefits of whole-life costing (Green, 2005). It is significant to note in the 2011 report of the NAO on *Lessons from PFI and Other Projects* that the issue of unreliable historical data on running and maintenance costs did not escape notice, being cited as a weakness in some departments' (e.g. Highways Agency) evaluation of PFI projects (NAO, 2011). In the Highways Agency's case, substantially lower costs were quoted by the PFI bidders for operations and maintenance, raising significant concerns about the agency's cost estimates.

In an effort to address some of these issues, the Building Cost Information Service (BCIS) has developed a standardized approach to whole-life costing. In 2007, BCIS launched *BCIS Occupancy Online*. Initially this service would provide information at the building level based on the estimates of maintenance and occupancy across a range of building types, and a profile for that expenditure based on the BMI occupancy cost plans. The user would be able to change the time period and the inflation or discount rate and adjust the costs for time and location to provide cash flow, at current or future prices and net present value (Martin, 2007). In 2008 an international standard BS ISO 15686-5:2008: Buildings and Constructed Assets, Service Life Planning – Life-cycle costing was introduced.

> Although this provided a set of principles enabling practitioners to produce consistent life-cycle costing analysis, it did not provide the UK guidance that was needed. So a working group was set up to produce guidance to the standard. This is called the standardised method of life-cycle costing (SMLCC) for construction procurement.
>
> (Martin, 2008: 76)

In his article in *Building* magazine, Joe Martin of the BCIS includes a budget life-cycle case study for a 1,000-capacity secondary school with a 30-year period of analysis showing construction costs of £16.3 million (43 per cent of total life-cycle costs), maintenance costs of £7.3 million (19 per cent of total life-cycle costs) and operation costs of £14.7 million (38 per cent of total life-cycle costs).

9.7 Whole-life value

Increasingly, major procurement in the public and private sector is being undertaken on the basis of not just lowest capital, or even whole-life costs, but *value* (Bourke *et al*., 2005). Whole-life value (WLV) encompasses economic, social and environmental aspects associated with the design, construction, operation, decommissioning and, where appropriate, reuse of the asset or its constituent materials at the end of its useful life.

An important part of whole-life costing is compiling the life-cycle assessment (LCA). This is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle.

However whole-life value includes more than whole-life costing or life-cycle assessments, which are integral to the process. The application of WLV includes the consideration of the perceived costs and benefits of some or all of the stakeholders' relevant value drivers. The key techniques that are integral to WLV evaluations of building and infrastructure projects include:

- Whole-life costing and life-cycle assessment: WLC deals primarily with financial costs, whereas LCA deals primarily with environmental impacts.

- Multi-criteria analysis: MCA is used in conjunction with both WLC and LCA to evaluate alternative options based on criteria developed with stakeholders.
- Group decision-making processes: these processes include value management and risk management to engage stakeholders in the WLV process.

Panel 9.4 Case Study: Whole-life costing on Crossrail

Crossrail is the largest addition to the rail network in the South East UK in 50 years and is expected to be delivered in its entirety within a funding envelope of £18.4 billion. It is a programme involving many delivery partners including Crossrail Central, London Underground, Network Rail, Docklands Light Rail, Canary Wharf Group and Berkeley Homes.

The project is being funded by all these partners, but in the main by Government, Transport for London (TfL), Greater London Authority (GLA) and London businesses. Project Delivery Partner for construction is a team of Bechtel, Halcrow and Systra who have been appointed as lead contractor responsible for coordinating activities of other contractors. Programme Partner responsible for strategic programme management and supervising the activities of the Project Delivery Partner is Transcend, a joint venture between AECOM, CH2M Hill and Nichols Group.

Enabling works commenced in December 2008 and it is expected that the main civil works will be completed in 2017. Design and construction are taking place concurrently.

There is a clear commitment to WLC on this project. The WLC policy states that 'CRL (Crossrail Ltd) recognises that the initial cost, while considerable, is only part of the total cost of Crossrail'. As a result it has actively considered WLC as part of the design and implementation process of this on going project.

A 50-year appraisal period from the delivery date is used to evaluate WLC, encompassing construction cost, operation, maintenance, renewal, disposal and replacement plus non-construction costs (e.g. land), asset income (but not revenue) and externalities such as carbon emissions.

Moorhouse Consulting was tasked with the development of the WLC tool. Beyond application of standard WLC methodology based on BS ISO 15686-5, HM Treasury *Green Book* and best practice guidance from the OGC (now defunct), the tool also embraced an evaluation of carbon dioxide equivalent (CO2e) emissions, both direct and indirect, priced as per DEFRA guidance, and a sustainability analysis framework based on a qualitative assessment of the many elements of sustainability as per the DfT Transport Analysis Guidelines on the web (WebTAG). The tool further allows swift comparison of up to four design options. These attributes all seem to align with the whole-life value approach.

According to Moorhouse Consulting, the development of this WLC tool not only raised the profile of WLC and sustainability goals, but also allowed an active management of the portfolio of engineering design options with different Capex (capital expenditure) - WLC trade-offs to deliver greater benefits to the overall programme. They further highlight the fact that, given the scale of this project, even a 0.1 per cent saving in WLC could be worth tens of millions of pounds.

Sources: Moorhouse Consulting and Crossrail websites

The WLV process will involve a number of iterations between the various stages and can be tailored to fit in with gateway reviews such as the OGC Gateway Process. Panel 9.4 provides an example of WLV in practice.

The publication *Achieving Whole Life Value in Infrastructure and Buildings* (Bourke *et al.*, 2005) is a significant landmark in the subject of whole-life value. It has been compiled by eminent academics and practitioners and identifies how WLV is achieved, the techniques and methods, and includes four case studies. It should be recommended reading for all construction cost consultants.

9.8 Conclusions

The introduction of PFI contract requirements and high running costs has meant that whole-life costing is gaining more acceptance within the construction/property sector. Whole-life costing is used early in the project cycle for feasibility and investment cases and for calculating budgets for maintenance. For an excellent example of a whole-life cost model for two call centres in Dudley and Derby, developed by Citex (now called Bucknall-Austin) see *Building* magazine 23 July 1999, pp. 72–79.

The objectives of whole-life costing are admirable, but in the past it often failed to deliver what it promised due to the absence of appropriate data. However, more data is now becoming available and being incorporated into sophisticated models.

With the development of the concept of whole-life value, which embraces not only costs but also environmental issues, value management and risk management, Kathryn Bourke at the BRE and colleagues have created a powerful new technique for the future that builds on whole-life costing.

9.9 Questions

Question 1

Consider the typical cash flow over a 50-year life expectancy of the following components:

1 flat roofs: two-coat built up felt/asphalt;
2 floor finishes: carpet/quarry tile;
3 windows: UPVC/timber painted/aluminium.

Question 2

A client is considering replacing his heating system. System A is the standard scheme whereas system B relies on additional insulation being provided. Evaluate the alternatives and make a recommendation.

Initial costs	*System A*	*System B*
	£	*£*
Boiler	160,000	175,000
Pipework and units	48,000	42,000
Insulation	12,000	32,000

Recurring costs

	£	£
Repairs	3,000 per annum	2,800 per annum
Replacement	40,000 (every 20 years)	32,000 (every 30 years)
Overhaul	15,000 (every 5 years)	15,000 (every 10 years)
Fuel	15,000 per annum	11,000 per annum

The expected life of each building is 60 years and the discount rate to be used is 4 per cent.

For the present value of a single sum and the present value of an annuity see *Parry's Valuation and Investment Tables* (Davidson, 2013).

Question 3

Refer to the RICS Research Paper Vol. 4, No.18, April 2003, *Whole Life Costing in Construction: A state of the art review* by Kishk, Al-Hajj, Pollock, Aouad, Bakis and Ming Sun.

1 Plot the use of WLC on a typical project against the stages within the RIBA Plan of Work.
2 Identify the characteristics of the available WLC software.
3 Critically review the main findings of the Report.

A copy of this report may be requested from the University of Salford website.

9.10 References/further reading

Ashworth, A. (2010) *Cost Studies of Buildings*, 5th edition, Prentice Hall.

Ashworth, A. and Hogg, K. (2000) *Added Value in Design and Construction*, Longman.

BCIS (no date) Building Running Costs (BRC) Online, Available at: http://www.rics.org/uk/knowledge/bcis/online-products/bcis-building-running-costs-online/ (accessed 26 June 2013)

BPG (2000) *Building Fabric Component Life Manual*, Taylor Francis Ltd.

BPG (2001) *BPG Building Services Component Life Manual*, Blackwell Science.

Bourke, K., Ramdas, V., Singh, S., Green, A., Crudgington, A. and Mootanah, D. (2005) *Achieving Whole Life Value in Infrastructure and Buildings*, BRE Bookshop.

Brandon, P.S. (ed.) (1992) *Quantity Surveying Techniques: New directions*, Blackwell Scientific.

BSRIA (2006) 'Elements needed for a whole life cost analysis': www.bsria.co.uk/news/1902 – cited 22 October 2012.

Building Life Plans Ltd (BLP), Report for the NAO on *Durability Assessment*: www.nao.org.uk/idoc.ashx?docId=660CB49B-D7F7-44CE-A61D-B3BC7390279D&version=-1 – accessed 25 October 2012.

Building Life Plans Ltd (BLP), Construction Durability Database: www.blplcc.co.uk.

CIBSE (2000) *Guide to Ownership, operation and Maintenance of Building Services*, Chartered Institution of Building Services Engineers.

Clift, M. and Bourke, K. (1999) *Study on Whole Life Costing*, Report number CR366/98, Building Research Establishment.

Constructing Excellence (2004) *Whole Life Costing Factsheet*, www.constructingexcellence.org.uk/pdf/fact_sheet/wholelife.pdf – accessed 20 October 2012.

Crossrail, 'Crossrail procurement policy': www.crossrail.co.uk.

Davidson, A.W. (2013) *Parry's Valuation and Investment Tables*, 13th edition, Routledge.

Ellingham, I. (2009) 'When life gets complicated', *Building*, 23 October, p. 33.

Ferry, D.J., Brandon, P.S. and Ferry, J.D. (1999) *Cost Planning of Buildings*, 7th edition, Blackwell Science.

Flanagan, R. and Norman, G. (1989) *Life Cycle Costing for Construction*, RICS.

Flanagan, R., Norman, G., Meadows, J. and Robinson, G. (1989) *Life Cycle Costing Theory and Practice*, BSP Professional Books.

HAPM (1996) *HAPM Component Life Manual*, Spon Press.

HM Treasury (1992) *Public Competition and Purchasing Unit Guidance No. 35 Life Cycle* Costing: http://archive.treasury.gov.uk/pub/html/docs/cup/cup35.pdf – accessed 25 October 2012.

HM Treasury (2003) *The Green Book: Appraisal and evaluation in central government*, HM Treasury.

Kirk, S.J. and Dell'Isola, A.J. (1995) *Life Cycle Costing for Design Professionals*, McGraw Hill, New York.

Lane, T. (2005) 'What we need is whole life value', *Building*, 23 September, p. 58.

Martin, J. (2007) 'It's always a forecast', *The Journal RICS Construction*, February, pp. 16–17.

Martin, J. (2008) 'Lifecycle costs', *Building*, 12 September, pp. 76–78.

Moorhouse Consulting, 'Whole life costing policy statement': www.moorhouseconsulting.com.

NAO (2005) *Improving Public Services through Better Construction*, Report by the Comptroller and Auditor General, HC 364-I Session 2004-2005, 15 March 2005, National Audit Office.

NAO (2011) *Lessons from PFI and Other Projects*, Report by The Comptroller and Auditor General, HC 920, Session 2010–2012, TSO: www.nao.org.uk/publications/1012/lessons_from_pfi.aspx – accessed 20 October 2012.

Office of Government Commerce (2005) *Achieving Excellence in Construction, Procurement Guide* 07 *Whole-Life Costing*, OGC.

RICS (1999) *The Surveyors' Construction Handbook – Section 2: life cycle costing*, RICS.

Robinson, G.D. and Kosky, M. (2000) *Financial Barriers and Recommendations to the Successful Use of Whole Life Costing in Property and Construction*, CRISP.

Swaffield, L.M. and McDonald, A.M. (2008) 'The contractor's use of life cycle costing on PFI projects', *Engineering, Construction and Architectural Management*, Vol. 15, No. 2, pp. 132–148.

Wang, N., Chang, Y-C. and Nunn, C. (2010) 'Lifecycle assessment for sustainable design options of a commercial building in Shanghai', *Building and Environment*, Vol. 45, No. 6, pp. 1415–1421.

Websites

http://usir.salford.ac.uk/12966/ – accessed 25 October 2012.
www.bcis.co.uk.
www.bre.co.uk.
www.bsria.co.uk/press/?press=345.
www.constructingexcellence.org.uk.
www.hm-treasury.gov.uk.
www.wlcf.org.uk.

10 Organizational methods (Part 1)

10.1 Introduction

> The contract strategy determines the level of integration of design, construction and on-going maintenance for a given project, and should support the main project objectives in terms of risk allocation, delivery incentivization and so on.
>
> (OGC, 2003)

The chosen strategy influences the allocation of risk, the project management requirements, the design strategy and the employment of consultants and contractors. The contract strategy has a major impact on the timescale and the ultimate cost of the project (see Figure 10.1).

The following four sub-sections should be considered:

- organizational method, e.g. traditional, design and build, management;
- type of contract, e.g. lump sum, admeasurement and cost reimbursable/target cost;
- bidding procedures, e.g. open, selective, two-stage, negotiated, EU regulations;
- conditions of contract, e.g. JCT 11 (SBC/Q), JCT 11 DB, JCT 11 MP, JCT 11 CM/A, ICC Measurement Version, ICC Design and Construct Version, IChemE lump sum (*Red Book*) , IChemE reimbursable (*Green Book*), NEC ECC 3rd edition, FIDIC, etc.

Additionally all projects, no matter where they are built, are often constrained within the particular environment. These outside forces are neatly embraced within the acronym 'PESTLE' and include: *Political* – the requirement to use particular 'home country' contractors or suppliers; *Economic* – necessity to spend within a certain timescale or uncertain funding; *Social* – requirement to use local labour, train apprentices and build local community facilities; *Technological* – requirement to use common computer systems within the integrated supply team; *Legal* – compliance with Acts of Parliament and safety regulations; *Environment* – conformance with national and local planning constraints and sustainability and waste management regulations.

Overview of contract strategy trends

The latest RICS *Contracts in Use* survey of building contracts in use during 2010 (Davis Langdon, 2012) generally showed a decline in the use of traditional BofQs to only 19 per cent of the total value captured in the survey. In contrast, Lump Sum – Specification and Drawings have

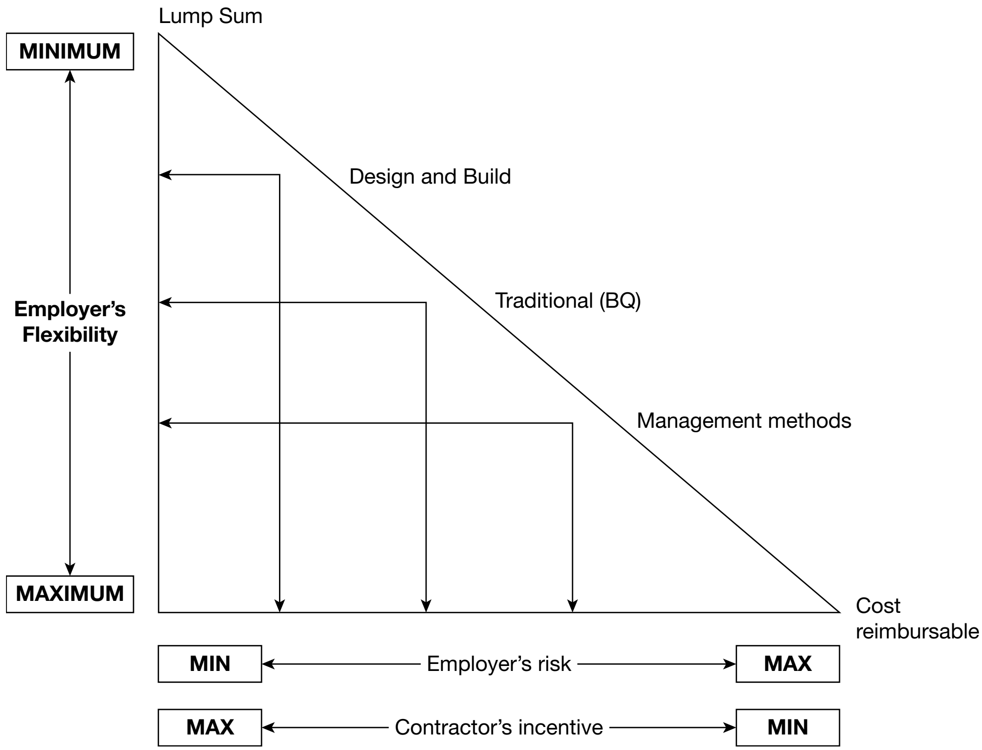


Figure 10.1 Characteristics of different types of procurement strategies (Barnes, 1983)

increased to 23 per cent of the total value, whilst Lump Sum – Design and Build is recorded as the most popular option at 39 per cent of the total value. Indeed, design and build is the most widely used strategy for all projects above £500,000, and over 50 per cent of contracts in the £20 million to £50 million value bands were procured on a design and build basis.

According to the 2010 survey Target contracts are increasingly popular, at 17 per cent of the total value with partnering agreements showing a marked decline to 1 per cent of the total value, from 16 per cent (in 2007), possibly reflecting the changing attitudes driven by current economic difficulties.

Remeasurement contracts are recorded at 1 per cent, with construction management and management contracts very rare at 0.1 per cent and 0 per cent respectively.

In the UK civil engineering and infrastructure sectors (35 per cent of total construction turnover) there has been a significant reduction in the use of the traditional *ICE Conditions of Contract Measurement Version*, 7th Edition. The NEC Engineering and Construction Contract family of contracts has swept all before it, with most clients choosing the Activity Schedule approach (either option A – Priced Contract or increasingly Option C – Target Contract). This latter approach enables the sharing of risks and encourages innovation.

Significantly the NEC family of contracts, which has been endorsed by HM Treasury's erstwhile Office of Government Commerce, was chosen for the 2012 London Olympics and the new London Crossrail project. In July 2009 the ICE Council decided to solely endorse the NEC3 Contract and in July 2010 the ICE along with the ACE and CECA issued a joint statement withdrawing the traditional *ICE Conditions of Contract* based on remeasured contracts.

Panel 10.1 Case study: Hong Kong airport and supporting rail and road infrastructure

The framework shown in Figure 10.1 is important as it shows the various options available to clients depending on their attitude to risk.

The Hong Kong airport at Chep Lap Kok with supporting rail and road infrastructure was a true mega project; it comprised ten inter-related projects (over 200 works contracts) with four separate sponsors – Hong Kong Government, Airport Authority, Mass Transit Railway Corporation (MTCR) and Western Harbour Tunnel Company. The £155 billion project was completed in 1998 after 6 years' construction using a British–Chinese–Japanese JV – at its peak with some 35,000 workers.

In Hong Kong the conditions of contract are normally onerous, with clients wishing to transfer risk to the contractors. On the airport project the conditions of contract were extremely onerous, with lump sum, fixed-price contracts adopted to the greatest extent possible to enhance certainty of final project cost. This approach is in direct contrast to the Heathrow Terminal 5 project where BAA took all the risk and managed the project through the use of integrated teams.

The important aspects of the Airport Core Programme (ACP) conditions of contract were:

- provision for lump sum, fixed-price form of contracts and an owner-controlled insurance programme;
- provision for the employer, through the engineer, to make variations (additions or deletions of works) to benefit timely completion of other ACP contracts;
- employer's ability, through the engineer, to order acceleration of work and to order contractors to recover their delays at no cost to the employer;
- provisions for employer-referable decisions relating primarily to extensions of time and additional payment to allow a greater degree of control over the actions of the engineer on these matters;
- stringent provisions for claim notification (which could result in the rejection of claims if not observed by contractors) so that the employer was informed of events that were likely to be disruptive to the programme and/or had cost implication at an early stage;
- introduction of a tiered disputes resolution process (mediation, adjudication and arbitration, with mediation mandatory) to help achieve significant time and cost savings when disputes arose.

Source: Lam (1998)

Postcript: Dean Lewis, Senior Resident Partner, Masons, Hong Kong provides a comprehensive overview of the process of dispute resolution by the different client bodies on the HK airport project. His research indicates that all claims on the 31 MTRC major contracts were settled at site level. In contrast, 154 disputes on the HK Government projects were only settled following mediation, adjudication or arbitration. Out of 58 contracts with the Airport Authority, formal disputes were raised on ten; in the event all were settled via intensive commercial negotiations or mediation despite three being referred to arbitration (Lewis, 2002).

Following a number of high-profile major civil engineering projects which incurred serious cost overruns in 2007, the Irish Government began replacing all existing public works contracts (the GDLA82 forms) with a new suite of contracts. These are aimed at providing fixed-price lump sum contracts that give price certainty and eliminate the potential for claims extras and overruns (O'Sullivan, 2007). The conditions affirm the employer's aim to transfer as much risk as possible to the contractor. The Agreement No. 1 sets the tone and intent of the contracts, stating that the contractor is deemed to have 'included for all allowances for risk, policies, practices, customs, and other circumstances that may affect its performance of the contract whether they could be foreseen or not.' Contractors will thus have to treat each tender for public works with a great deal more caution as the scope for post-tender cost recovery through contractual claims will be greatly reduced.

10.2 Traditional method

The traditional method of procurement is based on the rigid separation of design and construction. The client, usually after undertaking a feasibility study, appoints a team of consultants (led by the architect/engineer) to undertake the detailed design. The design team prepare detailed drawings, specification and often a BofQs. The tender documents are prepared and the contract awarded, usually to the contractor with the lowest bid. The contractor manages the construction using its own subcontractors together with nominated (e.g. under JCT 98) or named (e.g. under JCT 11) subcontractors. Nominated sub-contractors are those specified by the employer to be engaged by the main contractor to execute discrete parts of a project. By virtue of the main contractor having no discretion in their appointment, liability for the work nominated sub-contractors execute remains with the employer and they acquire special rights defined by the contract. With named sub-contractors on the other hand, the main contractor is given a choice of a range of sub-contractors named by the employer in the contract documents. Liability for work done by such sub-contractors remains with the main contractor who decides which sub-contractor to work with.

The lead designer is usually in control throughout all stages of the project, from conceptual design through design development, tendering, contract administration, supervision of the works and finally to handover of the completed project.

The traditional route is readily understood but has become less popular as more clients become aware of the potential high risks carried by them if the design is not complete or the BofQ accurate.

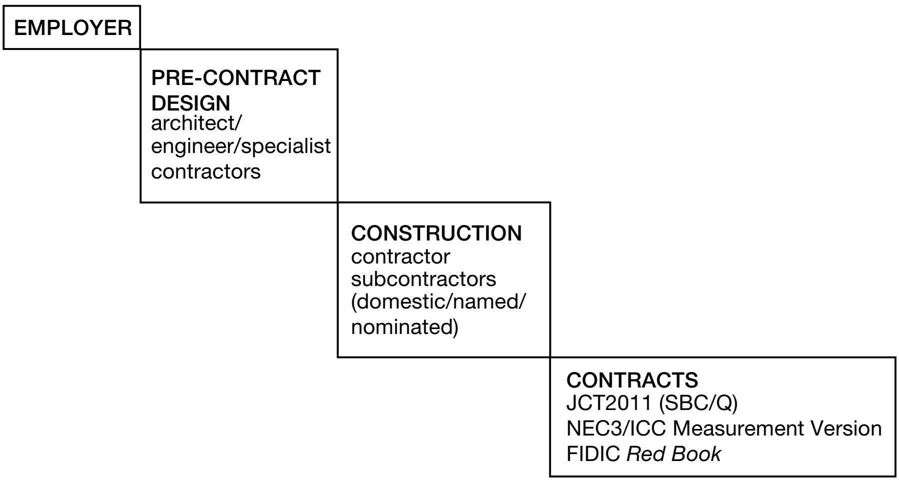


Figure 10.2 The traditional system

The strengths of the traditional approach are well documented and include:

- generally a high degree of certainty on the basis of the cost and specified performance before a commitment to build; however, variations and claims can make this less so;
- clear accountability and tight control at every stage; again, variations and claims can make this less so;
- competitive prices between main contractors;
- opportunity to combine best design and contracting skills in well-understood relationships;
- allows for nomination of particular specialists by client;
- flexibility in developing the design up to the contract documentation stage and, if necessary, varying the construction design; however, the costs can become less certain;
- well tested, in practice and in law;
- the client is able to recover costs from the main contractor in the event that the latter fails to meet contractual obligations;
- flushes out ambiguities in the documentation prior to tender.

Weaknesses include:

- uneasy guarded relationship between the parties; can easily become adversarial;
- engineer/architect has no liability for the performance of other members of the design team;
- client has no right of communication or instruction with the contractor;
- overall programme may be longer than for other strategies – alternative methods allow earlier commencement on site and completion;
- no opportunity for contractor to influence design or buildability during the design process;
- split responsibilities – client is in direct contract with many different parties, which can be a serious weakness in the event of major defects arising;
- does not encompass Egan's recommendations: 'fully integrated design and construction team'.

Rudi Klein, barrister and chief executive of the Specialist Engineering Contractors Group, identifies that:

> Traditional procurement is wasteful; it is a fragmented process with countless interfaces. It is hierarchical. Appointments are sequential. Those delivering the project do not have a chance to buy into key decisions on design, cost and risk, even though design cannot be fit for manufacture (and therefore cost effective) unless those who do the making have a say in what they're making. The role of traditional contracts is to buttress this state of affairs by shifting blame and encouraging confrontation.
>
> (Building Magazine, 17 September 2010, p. 57)

Klein's advice to those advising clients on traditional procurement methods is to be careful. 'Over the next few years you could run the risk of a negligence claim.'

If speed is a priority it is possible, however, to use accelerated traditional methods, usually through the use of two-stage tendering or negotiated tendering procedures. These enable design and construction to run more closely, securing some time saving but giving less certainty about cost.

The advantages of accelerated traditional methods are:

- Two-stage tendering allows early testing of the market to establish price levels and gives early contractor involvement resulting in speed of construction.
- Negotiated tendering allows early contractor involvement for *fast-tracking*, i.e. beginning work on site before the design is complete.
- Negotiated tendering also gives flexibility for design development as the construction proceeds.

Panel 10.2 Case study: Traditional procurement – Bath Spa

Initially estimated at £11 million, the Bath Spa project, a public leisure amenity, in the historic town of Bath in Somerset, England has become one of the most delayed and disrupted projects in recent times.

The project was funded via a £7.78 million grant from the Millennium Commission, who specified that the council must opt for a traditional JCT contract. The aim was to open for Christmas 1999; however, in the event, the contractor Mowlem did not start on site until 2000.

When the architect Grimshaw produced designs with *more clarity*, the costs rose to £15 million, then to £22 million.

In 2003 with construction complete, Grimshaw, as contract administrator, refused to certify practical completion because it had become apparent that the RIW Toughseal paint on the walls was peeling. In September it was reported that the steam room floors were also leaking.

Grimshaw claimed that the defects were construction related, whilst Mowlem claimed they were design related.

In February 2005 Mowlem offered to complete the project for £26.5 million under a design and build arrangement and drop all claims against the council. This proposal was never accepted.

In April 2005 following claims that Mowlem had refused to obey an Architect's Instruction requiring replacement of the floors in the steam room, Mowlem were told to leave the site.

A new project manager, Capita Symonds, was appointed to take the scheme to completion under an arrangement in which the Council would have direct control of the contractors. Capita Symonds later said they found a series of significant structural problems from leaking floors, rusty and outdated fittings and £700,000 worth of windows which had begun to delaminate.

The project was completed in 2006 with a final account of £45 million and with a flurry of law suits following in its wake.

Sources: *Building* (11 Feb 2005, 18 Feb 2005, 8 April 2005, 13 May 2005); *The Times* (24 April 2006); *The Telegraph* (15 Dec 2008)

The possible disadvantages are:

- less certainty on price before a commitment to build;
- competition may be diminished in negotiated tendering;
- more concentrated client involvement required to ensure efficient planning and control throughout the process.

As a postscript to the traditional procurement system it is worth mentioning procurement of public works in New York City, which seems out of step with the general international trend towards the use of alternative contract strategies.

New York City statutes require that contracts by state agencies for construction work be awarded to the lowest responsible bidder based on open competitive bidding. These requirements essentially mandate the traditional design–bid–build (DBB) approach to public works procurement, since competitive bidding requires a completed design, meaning that design services must be procured separately and before construction work is procured and that the selection process cannot be based on comparative evaluation of proposals (Raved, 2003).

Anecdotal evidence from an architect who has worked in New York identified the high level of corruption prevalent in the labour unions as a possible reason for the move away from a partnering strategy back to the traditional lump sum, fixed-price approach.

10.3 Design and build

Back in 1964 the Banwell Report remarked that 'in no other industry is the responsibility for design so far removed from the responsibility of construction'.

Today the contractor-led design and build procurement route is now established as the most popular procurement route. Furthermore, it is increasingly perceived as the appropriate answer for large and complex projects, sometimes designed by signature architects.

The process

The design and build strategy requires the contractor to take overall responsibility for both design and construction in return for a fixed-price lump sum. However, in practice, the client may appoint an independent project manager or quantity surveyor to safeguard their interests.

The client enters into a single contractual relationship with the contractor to design and construct the project in accordance with a performance specification prepared by the client. The contractor then enters into a series of separate agreements with consultants, specialist subcontractors and suppliers to deliver the project in accordance with the agreed performance specification. Since the contractor becomes solely responsible for all aspects of the project delivery process, most of the risks associated with design and construction are therefore borne by the contractor, giving the client greater protection.

The client generally invites tenders based on an outline design, critical specification and workmanship standards, completion time and other key information. At the earliest stage of the

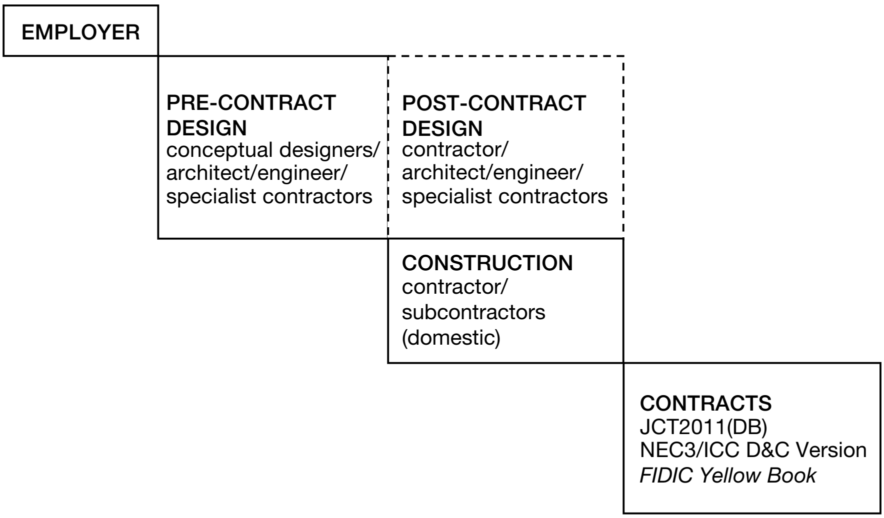


Figure 10.3 The design and build system

construction period, the contractor completes the outstanding design development, thus generating an overlap between the design development stage and construction stage which should in theory reduce the overall duration.

In practice, there may be two separate design teams, one employed by the client to develop the client's brief and the other employed by the contractor to undertake the detailed design work. It should be noted that the former design team may not be contractually linked with the contractor, though in some cases this design team may be novated to the contractor. Equally, the design team employed by the contractor is usually contractually remote from the client, and the client can only influence the output of the design through their intervention in the design approval process. This often leads to variations and changes in the original requirements.

Contractor's expertise

The design and build approach allows the contractor's design and construction team to consider, at the earliest conceptual stage, site-specific construction issues which a consultant working in isolation is not normally equipped to deal with. For example, on a large marine project the team will be able to establish: if the site is suitable for the use of large cranes; whether heavy floating barges can be used in a tidal location; how materials will be transported to the construction locations; whether there are suitable areas close to the site for setting up a precasting or preassembling yard; what skills are characteristic of the local labour force; and how the local weather during the construction period will affect the construction methods.

The most economic type of structure and the most suitable method of construction will depend on the answers to the above questions, together with the contractor's specific expertise and the availability of construction equipment. It is at this stage when the combined team has at its disposal all the relevant facts and techniques that increased productivity may be considered – thus reducing the overall cost to the client.

Flexibility

The design and build route is extremely flexible and many different versions have emerged over the past decades. The major difference between them is the amount of design input by the employer's designers and the contractor's designers; e.g. the client's contribution to the design may vary from 5 to 75 per cent.

The amount of tender documentation provided by the client (known in the JCT Design and Build Contract 2011 as the *Employer's Requirements*) can vary from little more than a written brief to a fully worked-out scheme. The greater the priority the client gives to design, the larger the amount of information which tends to be included in the tender documents. If a client's priorities are economy and speed then less design information will be included, leaving more scope to the contractor.

Three main categories of design and build approach can be identified:

Direct: designer/contractor appointed after some appraisal but not competition.

Competitive: conceptual design prepared by consultants; several contractors offer designs in competition.

Develop and construct: client's designers complete design to partial stage before asking contractors to complete and guarantee the design in competitive tender either with their own or using the client's designers (novation).

Panel 10.3 Case study: Design and build – Cardiff Millennium Stadium

The main reason that Laing lost so much money (£31 million) on the £99 Millennium Stadium in Cardiff was that it guaranteed a maximum price on the basis of sketchy designs that were still undergoing change.

The original design had masts raking out at 45 degrees at the four corners of the stadium, but a row between the stadium operator and its neighbours Cardiff Rugby Football Club led to these being revamped to two vertical and two raking masts.

The load calculations for the 480,000-member roof had to be redone. The problem was that the design was still developing as Laing fixed its price and was still developing as the roofing contractor hit the site.

Cardiff Ruby Football Club also refused to allow Laing's tower cranes to swing over its air space, cutting off access to one side of the ground.

Claims came in from subcontractors and, under the contract, Laing carried the risk and was left with the bill.

Shortly after the Stadium opened Laing were required to install 74 giant metal props in order to make the cantilevered stands safe for a New Year's Eve rock concert. A legal expert close to the project said that the contract documents were an absolute mess and that the situation, on liability, could be hard to resolve.

After this project the Laing Group was reorganized with the construction arm being sold to concrete specialist O'Rourke for £1.

Sources: *Building* (17 September 1999, 17 December 1999)

Responsibility for design

There are two standards of care which are relevant to the design and build strategy:

1 Reasonable skill and care
A duty imposed on a professional consultant who provides advice or a service. It is effectively a matter for professional judgment whether in providing that advice or service the consultant has exercised all the skill and care that can reasonably be expected. Only if professional negligence can be proven is the consultant liable for failure of the end product;
2 Fitness for purpose
A statutory requirement under the Sale of Goods Act and an implied term in any contract for the design and supply of a finished product. If the product is proved unfit for the intended purpose for which it was supplied, then, irrespective of whether the provider of the product has been negligent or not, there would be a liability for any failure of that product to perform.

The risk of the design meeting the client's requirement would be spread differently, depending on the contract strategy adopted.

Under the traditional and management approach:

- The consultant(s) who designed the project would not be liable for the performance of the completed project unless it could be proved that the consultant had failed to exercise the level of skill and care reasonably to be expected. Before recovering damages, the sponsor must prove actual professional negligence by the consultant, often a substantial hurdle to overcome in any litigation.

- The contractor(s) who only build the project using the design provided by the consultant(s) would be liable for fitness for purpose of the materials and components that were provided within the project. The contractor(s) would not be responsible for the performance of the works as a whole.

Under a design and build strategy:

- The contractor who designs and also builds a project would be liable not only for the fitness for purpose of the materials and components, but also for the completed project as a whole. Not surprisingly, it is unlikely that a contractor would be able to obtain professional indemnity insurance whilst taking on such a design obligation.

In the case of *Co-operative Insurance Society v Henry Boot (Scotland) Ltd TCC 1 July 2002* the contractor was deemed to have effectively audited, and adopted as its own, the design work of others. The fact that the piling, the offending elements of works, had been designed by consulting engineers did not protect the contractor who possibly unwittingly took on an obligation to complete the design. Following this case it is noted that subsequent JCT Design and Build Contracts (DB2005 and DB2011) now provide that the contractor is not required to check the design in the Employer's Requirements and will not be responsible for any inadequacy in it.

Strengths:

- Early completion is possible because of early commencement date and overlapping activities.
- There is a single point of responsibility for the total design and construct process after the selection stage – there is one backside to kick if anything goes wrong!
- The client can demand the quality and the performance specified.
- Price certainty is obtained before construction starts, provided the client's requirements are adequately specified and changes are not introduced.
- It can allow varying amount of client design input.
- Input by the contractor can lead to more economic design.
- It is less adversarial than the traditional approach.
- There is tender competition on alternative design solutions.
- There are direct lines of communication between subcontractor and designer.
- It reduces variations due to early collaboration between design and construction disciplines.

Panel 10.4 Case study: Design and build – Hammerson

For large schemes, generally of more than £20 million, Hammerson uses a two-stage bidding process. It will invite a few major contractors to work with its designers to develop the scheme and select one of them based on issues such as preliminary costs and overheads. When the design is 80 per cent complete, it will novate the design team to the contractor. The contractor then becomes a design and build contract with a target price guaranteed.

Source: '50 top clients a building directory', *Building*, Supplement, February 2003

Weaknesses:

- Competing schemes may not meet client's requirements unless specified in detail before the bidding begins.
- It may not produce the cheapest building in terms of whole-life costs.
- The client loses control over quality in design.
- Client's clearly-defined brief is required at commencement.
- Changes after commencement are expensive.
- Analysis of tenders may be subjective.

In 1992 the National Audit Office Report *Contracting for Roads* identified that the average cost increase in road projects in the late 1980s/early 1990s was 28 per cent. The NAO Report identified the main cause of increases in the cost of these projects, which were based on the traditional engineer-designed ICE contracts, as: unforeseen ground conditions, changes to the original design, statutory undertakers, poor design, engineer requirements, bad weather, inadequate planning, subcontractors and poor site management. In order to reduce the cost increases on future projects Hodgson (1995) identifies that the Scottish Office were the pioneers in the UK in introducing the design and build procurement route in the highway sector. In 1989 the largest D&B project was procured – the £30 million M8 St. James Interchange near Glasgow Airport with Balfour Beatty as the D&B contractor. Difficult ground conditions, resulting in more piling, cost the contractor more than planned and Balfour Beatty's civil engineering director, Brian Osborne, commented in the *New Civil Engineer* in November 1993, 'The biggest downside with design and build is pricing the risk.'

The employer's agent (EA)

Many cost consultants are now employed as the employer's agent (EA) under the design and build procurement route. The role taken by the EA must be clearly defined by the client and can vary from simple contract administration to a full project management service. Beyond specific contractual duties, other areas in which the EA can contribute include:

- drafting the project execution plan;
- managing the briefing and scope definition process;
- appointing design consultants, on a basis that facilitates the effective transfer of design responsibility;
- managing clients and third party liaison;
- preparing employer's requirements and other tender documentation;
- implementing change control;
- supporting use of warranties to meet the requirements of third parties.

For a full discussion on the role of the employer's agent see Simon Rawlinson's detailed article in *Building* (2007).

10.4 Guaranteed maximum price

Guaranteed maximum price (GMP) is a term used to describe a lump sum design and build contract. There are several options, the most common one being for the employer to prepare an outline design with a set of requirements or design criteria. The tenderers submit a price, the GMP, often with an elemental breakdown, and the client's design team is then novated to the successful tenderer.

Panel 10.5 Case study: Design and build – Wembley Stadium

When the contract to build the Wembley Stadium was first put out to tender in late 1999 on a fixed-price, lump sum basis Sir Robert McAlpine declined to bid, warning that 'The sums of money needed to adequately cover (the risk of the builders running over budget) would be expressed in tens of millions of pounds.'

In February 2000, Multiplex, a major Australian contractor submitted a bid in joint venture with UK contractor Bovis and was appointed as the preferred contractor. Bovis refused to accept a price reduction below £339 million and on 30 August the client WNSL terminated the joint venture. Two days later Multiplex made a solo offer to build Wembley in 39 months for £326.5 million, which was accepted 10 days later by WNSL 'subject to board approval'. In the negotiations that followed, after funding was secured, the figure was increased by £120 million to a guaranteed fixed price of £445 million.

This 40-month design and build project had the advantage of a late start with a well developed design, and few changes were envisaged. Any savings made by the contractor would be retained by them; likewise they would carry all risks. Multiplex told its shareholders that it was confident of securing a profit on the project.

Wembley's great technical challenge was the structural design, construction and erection of its signature arch. Multiplex awarded steelwork specialist Cleveland Bridge an 81-week, £60 million lump sum, fixed-price subcontract to fabricate, supply, deliver and erect the arch and roof.

However, in 2004 the site was severely disrupted between March and August as a legal dispute developed between Cleveland Bridge and Multiplex. Cleveland Bridge were subsequently ordered off the site and replaced by Dutch steel subcontractor Hollandia working on a 'cost-plus' basis.

In a claim against Multiplex for non-payment, filed at the Technology and Construction Court, Cleveland Bridge alleged that:

> by the Spring of 2003 there were serious problems arising from late and incomplete design by the civil and structural engineers, Mott Stadium Consortium (which had been novated to Multiplex), and delays in providing design information. The design changes and late information caused substantial cost increases, and delays and disruption to the subcontract works.

Though Cleveland Bridge and Multiplex agreed a plan for accelerating work, plus compensation for the resulting change in the subcontract terms, a legal row broke out over alleged non-payment and contract breaches.

In May 2005 Multiplex announced losses of £45 million; their shares crashed and were suspended on the Australian stock market. These losses for Multiplex did not take into account costs associated with claims from Cleveland Bridge (High Court writ claims of £20 million) or from the other subcontractors claiming a 15-week delay and associated disruption (estimated at £20 million).

An announcement said that the extent of the losses was dependent on five factors: the ability to successfully recover claims against third parties; the ability to meet the construction programme; costs associated with the project's steel work; the cost of the project preliminaries and, as required, acceleration; and the weather. To date, the project has so far generated seven court judgments.

After extensive delays Wembley Stadium was finally handed over to the client in March 2007. It was reported that Multiplex made a loss of £147 million on the project and the Australian family company was sold in June 2007 to a Canadian firm.

Sources: Mylius (2005); *Building* (31 May 2002, 11 October 2002, 29 October 2004, The contract provides that the design must be developed and built for the quoted GMP. If this is exceeded, the contractor's entitlement will still be capped at the level of the GMP. If it manages to complete its work for less than the GMP, the contract will provide who takes the benefit. This may be the contractor, or it may be shared between the employer and contractor, and sometimes also with the design team. The most common form of GMP allows the contractor to keep the savings. Payments are usually made based on the achievement of milestones. In theory, remeasurement, variations and claims should have no place in GMP contracts. However, in practice, GMP contracts will never be all-inclusive, they must be capable of adjustment to reflect extra works (Patterson, 1999).

The GMP approach works well in a partnering arrangement, allowing the contractor the opportunity to innovate and execute value engineering. One successful project executed using the design and manage approach with a guaranteed maximum price was the £247 million Birmingham BullRing retail project. On this project the contractor Robert McAlpine tendered for the scheme on the basis of a set of employer's requirements and a set of concept drawings. The bidders were not required to do any design work for the tender submission, but instead submitted proposals covering such aspects as the management, methodology, resourcing and pricing of the job. McAlpine was selected as a preferred bidder under a form of two-stage appointment and, after rigorously pricing and testing the cost plan, with considerable input from subcontractors and suppliers, the GMP was quickly agreed (Atkinson, 2001: 16–17).

In practice, however, disputes as to the scope of the works are not unknown. Geoff Brewer identifies two relevant cases (Brewer Consulting website). The first case was *Skanska Construction UK Ltd v Egger (Barony) Limited (2002)*. Skanska agreed to undertake design development, management and construction of a factory for Egger, an Austrian chip board manufacturer, in Scotland for a GMP of £12 million. In the event Skanska made claims for a further £12 million, with Egger counterclaiming for more than £4 million. 'At the heart of the dispute lay the question of what was originally contained in the contract and what was a change required by the employer.' Skanska were successful with some claims but not with others.

In the second case identified by Geoff Brewer, *Mowlem plc v Newton Street Limited (2003)*, Mowlem entered into a contract for the conversion of a former Post Office sorting office into 104 flats in Manchester. The contract was based on a heavily amended JCT With Contractor's Design 1998 with a requirement for a GMP for all of the contractor's obligations under the contract.

> This included that the contractor had satisfied himself as to all risks which might influence or effect the carrying out of the works. These embraced incorrect or insufficient information having been provided to the contractor, any inadequacy or inaccuracy in drawings or specifications, and any other matter irrespective of whether it was foreseeable at the time of entering into the contract.

Mowlem claimed that rectifying unforeseen defects to a concrete ring beam within the existing building was not within their contemplation and should be an extra. However, His Honour Judge David Wilcox, in the Technology and Construction Court, disagreed and Mowlem's appeal failed.

10.5 Turnkey

The turnkey contract has been adopted for many years on major multidisciplinary construction projects, particularly in the process plant sector, both in the UK and overseas. Under turnkey projects the entire process of design, specification, construction and commissioning is carried out by contracting organizations, often in joint venture or consortia. Sometimes the client may wish the contractor to finance, operate and maintain the facility.

Panel 10.6 Case study: Turnkey contract – Innogy Holdings

Innogy uses several different procurement routes depending on the project. Large power stations, such as the Staythorpe plant, which is currently on hold, are planned to be let under a turnkey contract.

For smaller power projects, the company appoints consultants that let the contract, most likely on a competitive tender basis. For such work as the servicing of boilers, Innogy has power engineering alliances.

Office projects are generally design and build contracts, and large refurbishment schemes are competitively tendered.

Source: '50 top clients a building directory', *Building*, Supplement, February 2003

The client will normally issue a brief based on a performance specification together with outline drawings indicating a preferred layout. The contractor's lump sum bids are evaluated first on a technical and performance basis and second on a financial basis for capital expenditure and running costs (using the discounted cash flow technique).

The advantages of the turnkey approach include single-source responsibility, relieving the client from the responsibilities for equipment and performance, a fast-track approach with design and construction overlapping and a lump sum price. The disadvantages of the turnkey approach include lack of client control and participation, the possibility of significantly higher overall cost than the traditional approach and very limited flexibility to incorporate changes.

Panel 10.7 Case Study: Design and build to turnkey – Arsenal's Emirates Stadium, London

In contrast to Wembley Stadium, Arsenal's new 60,000-seater £275 million Emirates Stadium opened two weeks ahead of programme on 22 July 2006 despite incorporating £35 million of extra works during its construction.

The stadium was only part of a £390 million development which involved the relocation of all the businesses on the new site, building a state-of-the-art recycling centre to rehouse Islington Council's refuse disposal service and large-scale regeneration in the area involving providing day care and health centres and 2,000 new homes.

The construction contract was the key project document that enabled the club to raise the debt finance to construct the stadium on a non-recourse basis. As with Wembley, the construction contract started life as a JCT standard form with contractor design. As the financing developed, amendments were negotiated to convert it to a lump sum, fixed-price, fixed-date 'turnkey' contract where most of the construction and programme risk lay with Sir Robert McAlpine, the contractor for the job.

McAlpine was prepared to accept single-point responsibility for design and construction on the basis that, on the conversion of the contract from reimbursable to fixed price, the professional team was novated to it. The professional appointments had been signed in advance with the novation in mind to provide the contractor with recourse against the professionals in event of a claim under the construction contract.

The Emirates stadium was voted *Building* magazine's Project of the Year in April 2007.

Sources: *Building* (9 June 2006, 23 June 2006, 20 April 2007, Supplement)

10.6 Joint ventures

Joint venture arrangements are an attractive means of cooperation between organizations. They are used in many industries and countries for temporary or selective cooperation. Most typically they are temporary arrangements for the purpose of carrying out one project – usually a major project. A joint venture can be defined as a number of firms collaborating on a project or a number of projects with a view to sharing the profits, each firm being paid on the basis of its agreed contribution in kind or in financial terms.

In general, joint ventures are not the easiest forms of organizations to manage and operate. Therefore there must be compelling reasons why parties to a construction contract resort to a formation of a joint venture in contrast to the conventional contractor/subcontractor relationship; these could include:

1 Pooling of resources and expertise
The author (Potts) worked as Senior Quantity Surveyor for a Gammon Kier Lilley (GKL) joint venture on the North Nathan Road project on the first stage of the Hong Kong MTR. The Hong Kong firm Gammon provided all local Chinese supervisory labour up to general foreman level throughout the project; Kier were responsible for constructing the three underground stations (Waterloo, renamed Yau Ma Tei; Argyle, renamed Mong Kok; and Prince Edward station), with Scottish tunnelling specialist Lilley responsible for all the tunnelling between the stations.

2 Sharing of risks
The main risks on construction projects have been identified by Perry and Hayes (1985) and include:

- physical – ground conditions/loss or damage by flood or fire;
- environmental – public inquiry/pollution;
- design – new technology/incomplete design/temporary works;
- logistics – transportation/access;
- financial – cash flow/exchange rates/adequacy of insurance;
- legal – liability for others, local law, conditions of contract;
- political – war/revolution/imported licences;
- construction – feasibility of methods, rates of production, industrial relations/safety;
- operational – fluctuations in market demand/maintenance/fitness for purpose.

In the event, on the Hong Kong North Nathan Road projects the major problems concerned ground conditions – isolated rock boulders were encountered when constructing the secant piled station walls. The large-diameter piling augering equipment, which had been mobilized from the UK, proved to be inadequate with the only solution being the old Chinese technology of hand-dug caissons. However, before these could be constructed, four grout curtains were required to be built on the outside and inside of the station walls in order to stabilize the ground and keep out the water. This massive additional expenditure and subsequent delay and acceleration costs subsequently became the subject of a multi-million pound claim.

3 Entry to foreign markets
An overseas contractor can enter a local market with some degree of comfort, by establishing a joint venture with an established contractor. Indeed, many countries have enacted foreign investment controls, which require foreign companies to enter into arrangements with one or more local companies with a view to imparting their expertise to the local firms in order to decrease the country's dependence on foreign expertise in the future.

4 Access to technological improvements
Few companies can maintain cutting-edge knowledge in all their critical activities. Corporate partnerships can be used to gain access to new competencies and technologies.

Main types of joint ventures

Joint ventures can take a variety of forms with varying degrees of complexity. The three main types can be classified as follows:

1 A simple contractual relationship
Contractual joint ventures are entirely governed by contract and do not involve the establishment of a legal separate identity. One or more contracts can define the manner in which the joint ventures are to be conducted and the respective duties and responsibilities of the parties.
In a contractual joint venture, unless they agree to the contrary, each of the parties will be liable for its own acts and omissions. In addition, contractual joint ventures are transparent for tax purposes, leaving each party to arrange its own tax affairs without interference from the other.
2 A partnership agreement
Unlike contractual joint ventures, the establishment of a partnership provides the joint venture partners with an independent vehicle capable of trading under its own name. The establishment and operation of a partnership under English law is governed by the Partnership Act 1890 and by case law.
In practice the partnership structure is employed relatively infrequently in commercial joint ventures. The principal reason for this is the perceived exposures arising from the fact that each partner is personally liable for the full amount of the partnership's liability to third parties.
3 A limited liability company
The joint venture company (JVC) is the most common form of organizational structure where the parties wish to establish and operate a jointly owned business. The JVC, unlike a partnership, will have a distinct legal entity with separate interests from its members. A JVC is thus able, under its own name, to sue and be sued and enter into contracts with third parties.
A company's objects and powers are set out in its Memorandum of Association. The regulations governing its conduct are set out in the Articles of Agreement. In addition, JVCs also complete a Shareholders' Agreement in which the parties would normally set out the manner of establishing, funding and operating the JVC.

The formation and operation of a joint venture company is complex compared to a partnership. These complexities result from the fact that the constitution, operation and rights of shareholders are prescribed by statute and case law. The advantages of the JVC are generally perceived as threefold:

1 The maximum liability of shareholders in respect of the JVC is the amount paid up, or agreed to be paid up.
2 The JVC structure operates within a familiar body of law and practice.
3 JVCs are better placed to raise external financing.

10.7 Consortium

A consortium is similar to a joint venture, i.e. an arrangement between several firms, but in this case each contributes an equity stake in the form of risk capital or payment in kind in order to qualify as a member. Remuneration of consortium members may be calculated as a share of net profits of the consortium. Consortia aim to work together as a team solving problems, reducing costs, lessening risks and addressing quality issues in a shorter period than with traditional procurement methods.

Consortia are particularly attractive on PFI projects where construction and operating companies can be brought together under one organization, combining their skills and sharing the risks.

Both joint ventures and consortia invariably set up special purpose vehicles (SPVs). Under this arrangement a formal accounting and contractual arrangement is set up that is separate from the accounts of the firms involved.

However, research from the University of Reading (Gruneberg and Hughes, 2006) indicated that in practice firms only form consortia where no alternative structure would be feasible. Unlike partnering, it does not seem that consortia offer a more stable and long-term approach to client relations and members do not necessarily go on to work in the same consortium again.

Furthermore, by working in consortia, participants may carry extra risk in the form of liability for the actions of their partners. The University of Reading research identifies that consortia are not ways of delivering best practice, but are largely a marketing device to win business.

10.8 Partnering

Japanese contractors have an international reputation for achieving quality, certainty of outcome and completion on time. This great success is based on long-term relationships based on trust and a sense of brotherhood. Customers, general contractors, suppliers, specialist subcontractors and subcontractors have worked together in tightly knit families of firms for decades. Under this arrangement the general contractors set tough standards but take responsibility for the well-being of their subcontractors (Bennett, 1991).

In the last decade one of the most significant developments in procurement in the UK has been the use of partnering. Essentially partnering promotes improved performance through collaborative business relationships based on best value rather than lowest cost. Contract awards are still subject to rigorous competition but are judged on predetermined combinations of quality and cost. The development of openness and trust is in contrast to the confrontational nature that has increasingly characterized much of the construction industry over recent decades.

Professor John Bennett and his research team at the University of Reading identified partnering best practice within *Trusting the Team* (Bennett and Jayes, 1995) and *The Seven Pillars of Partnering: A guide to second generation partnering* (Bennett and Jayes, 1995).

> Partnering is a management approach used by two or more organisations to achieve specific business objectives by maximising the effectiveness of each participant's resources. It requires that the parties work together in an open and trusting relationship based on mutual objectives, an agreed method of problem resolution and an active search for continuous measurable improvements.
>
> (Bennett and Jayes, 1995)

Contracts have been commonly formed consisting of a partnering arrangement used in conjunction with a suitably amended standard form of contract. The partnering agreement generally defines the provisions of the arrangement such as attitude, partnering performance, allocation of risk and incentives.

In recent years forms of contract have been drafted that incorporate partnering principles and clauses. These include:

- The NEC ECC Secondary Option X12
  This is an agreement between the client and contractor and includes partnering-type obligations such as the need to work together to achieve the client's objectives and the provision of incentives.
- PPC2000 Partnering Agreement
  This contract has been specifically drafted for partnering projects using the Construction Industry Council's *Guide to Project Team Partnering*. It is a contract which integrates the full partnering team, the procurement process and procedures for running the project. The procedures are very prescriptive and the timescales in some cases very short.
- JCT Partnering Charter (Non-binding) (PC/N)
  This enables parties who do not wish to enter a legally binding agreement to create a collaborative working environment.
- JCT Framework Agreement
  This framework agreement can be used with most standard forms of construction and engineering contracts and with subcontracts.
- JCT Constructing Excellence Contract (CE)
  This new partnering contract has been endorsed by the Local Government Association and fulfils the attributes of *Achieving Excellence in Construction* (OGC, 2003).

Figure 10.4 shows the evolutionary stages in the partnering process and identifies appropriate standard forms of contract for each stage.

Partnering is not a soft option because it requires considerable effort to set up and hard work to maintain, but most people who have experienced partnering have found it both satisfying and enjoyable. The Strategic Forum for Construction has developed a useful Maturity Assessment

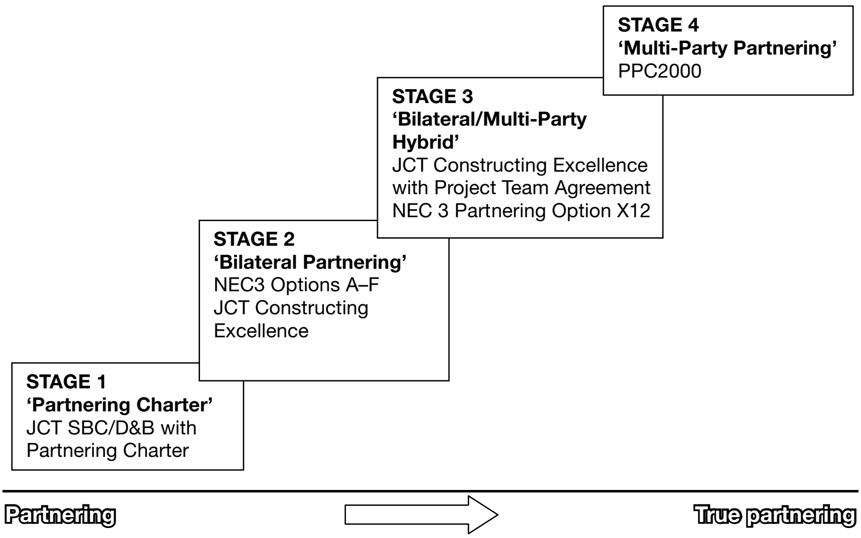


Figure 10.4 Evolutionary stages of partnering

Panel 10.8 Case study: The Highways Agency

The Highways Agency is an Executive Agency of the Ministry of Transport with the responsibility for managing, maintaining and improving the network of trunk roads and motorways in England. It has made considerable progress since its first strategy document was launched in 1997. The latest strategy, embracing the *Rethinking Construction* philosophy builds on the successful initiatives and pilots which have been implemented since then and includes:

- project-partnering arrangements applied to major contracts;
- use of Early Contractor Involvement (ECI) contracts to allow supplier engagement at an early stage on a partnering basis;
- design and build contracts used for all major improvement schemes, where ECI approach is not considered suitable. Typically, this would include larger renewal schemes or schemes where most design decisions are fixed in advance. (The first 'early design-and-build' contract was awarded on the A500 Stoke pathfinder project);
- use of single-point supply Managing Agent Contractor (MAC) and TechMAC contracts for maintaining, operating and improving road network. Contracts are typically for 5 years, based around robust and consistent contractual quality process models, performance measurement and management, and linked to incentivized continual improvement. Suppliers are expected to ensure transparency through all tiers of their supply chain and to operate as an integrated team;
- framework contracts introduced for regional works projects and design services;
- new payment mechanisms linked to the level of service to road users introduced into new private finance DBFO contracts for high-value strategic projects;
- developing contract forms to increase commercial focus, so that contracts have a clear win-win outcome for the whole supply chain;
- improved dispute resolution procedures and reduced numbers of disputes;
- most new contracts awarded on the basis of optimum value, defined in terms of both quality and price;
- a new supplier database implemented together with improvements to supplier performance management and reporting procedures;
- selection of the most capable and best-performing suppliers on the basis of evidence, choosing those who provide value for money through a competitive and effective commercial procurement process, with the Capability Assessment Toolkit (CAT) used as a tool for prequalification.

Source: Highways Agency (2009)

Grid which measures the cultural change required within an organization to move from 'Historic' to 'Transitional' to 'Aspirational' partnering. The grid includes 29 attributes under the three broad headings of 'Supply Chain Integration', 'Project Team Integration' and 'Culture' and can be reviewed on the Strategic Forum's website.

Benefits of partnering include:

- increased customer satisfaction;
- better value for client;

- recognition and protection of profit margin for contractors and suppliers;
- staff development and satisfaction;
- creation of an environment that encourages innovation and technical development;
- better understanding between partners and driving down of real costs;
- design integration with specialists in the supply chain;
- improved buildability through early involvement of the contractors;
- duplication eliminated;
- better predictability of time and cost;
- shorter overall delivery period;
- improved quality and safety; and
- stability which provides more confidence for better planning and investment in staff and resources.

Early partnering arrangements tended to be on a one-to-one basis between combinations of client, main contractor and professional services providers. However, multiple partnering is now common with a number of parties bound under the same agreement, dependent on and cooperating with each other for overall success.

Although normally client-led, there are many examples of contractors and suppliers demonstrating the advantages to their clients, who have subsequently chosen this method of procurement. To gain maximum benefit it is essential to extend the process through the supply chain in order to harness the specialist expertise of subcontractors, material suppliers and manufacturers.

Much of the information in the Partnering section was taken from the *Constructing Excellence Partnering* factsheet (see Constructing Excellence website).

The Strategic Forum for Construction's publication *Profiting from Integration* (SFfC, 2007) identifies that there is a sound underlying business case for working across the industry with an integrated team. The benefits appear in a number of ways – lower capital or operating costs, improved safety, higher margins and adherence to programme. Research by the Construction Client's Group (within SFfC, 2007) identifies that early involvement is seen as the key factor to success regarding working with consultants and main contractors, whereas selection on best value is seen as the key success criterion for working with specialist contractors and product suppliers. The research also identified that consultants and main contractors are most commonly brought into the project team at project inception, whereas specialist contractors and product suppliers are most commonly brought into the project team at the design stage. Benchmarking and project reviews are carried out for the majority of projects (70 per cent and 80 per cent respectively). Panel 10.9 identifies the benefits of integration and collaborative working.

In May 1999 Hampshire County Council moved away from a lowest tender price strategy to a more collaborative approach. This approach has proved so successful that it is now leading the Building Construction Workstream within the South East Centre of Excellence. This framework, which encompasses 74 local councils in the South East of England, can undertake any type of major construction works including schools, civic offices, leisure facilities, and police and fire service buildings. Hampshire's framework experience has demonstrated added value, particularly through joint cost and risk management, and resolving problems across contractors. Feedback and learning across programmes of work has achieved time, resource and construction cost savings (Duggan and Corcoran (2007).

10.9 Alliancing

Alliancing was first used in the energy and mining industries in the early 1990s, with BP being one of the first pioneers on its North Sea Oil Andrew and Hyde Project. Walker *et al*. (2002)

Panel 10.9 Case study: Macclesfield Bus Interchange

The £4 million project awarded by Cheshire County Council involved the construction of a new bus interchange and improved access to the railway station. A contractor was appointed early in the design programme and open book accounting was adopted during construction.

Before	*After*
Traditional design – tender construct	Early contractor selection – contractor involvement in design
Contractor selection on price only	Selection by 80% quality criteria, 20% cost criteria
ICE 5th edition	NEC Option C Target Cost Contract + Option X12 for partnering
Complete separation of council's and contractor's staff	Co-location of key contractor staff within council's office
Closed contractor's accounts	Open book accounts

The council's project management team wanted high-quality construction, increased cost certainty and increased speed of construction. By the end of the project , there were zero snags at the end of the defects liability period; the final cost was close to the estimate, with just 4 per cent over, and the overall construction period was 4 months shorter than time estimated by traditional procurement methods.

Source: SFfC, *Profiting from Integration* (2007)

critically identify that project alliancing is different from partnering in that it is more all-embracing in its means for achieving unity of purpose between project teams.

> The important distinction between partnering and alliancing is that with partnering, aims and goals are agreed and dispute resolution and escalation plans are established, but partners still retain independence and may individually suffer or gain from the relationship. The contractual relationship between the client and contractor is similar to a traditional contract. With alliancing, the parties form a cohesive entity, which jointly shares risks and rewards to an agreed formula.

Dornan and Davis (2009) identify the key characteristics of an alliance as follows:

- a truly integrated team in which owner and service providers operate under a single agreement which encompasses all participants;
- collective assumption of risk;
- a no-fault, no-blame environment;
- a commercial model based on a cost reimbursable payment scheme, which provides equitable rewards;
- unanimous principle-based decision-making.

Panel 10.10 Case study: Partnering Staffordshire County Council/Birse Construction Ltd

This is one of the first projects that the author (Potts) came across which made him appreciate the real significance of the partnering approach.

Staffordshire CC was one of the first clients to implement partnering as an addition to a contract under the ICE 5th Conditions of Contract on the £10.1 million Tunstall Western Bypass – Phase II, with a planned construction period of 15 months.

This project had all the ingredients of a problem contract – a canal, a railway crossing, contaminated ground, underpass under a busy trunk road, tight site and numerous structures.

The bulk earthworks for the scheme presented the greatest difficulties and risks. Because of the heavy industrial use of the site over the previous century, the whole site was deemed to be contaminated.

In the event, the engineer and contractor, in conjunction with the Environment Agency, worked to maximize the amount of earthworks for reuse as acceptable fill. Mark McCappin, the Resident Engineer, admitted that this one issue could have cost the client an extra £6 million, and resulted in a six months' overrun, if it had been administered in the usual adversarial manner.

The project was completed within the 67-week contract period and the final account settled within the budget.

Source: McCappin (1996)

Dornan and Davis (2009) identify that alliancing has shown that it can deliver outstanding results through a payment structure which rewards service providers commensurately with the performance of the alliance as a whole.

Bresnen and Marshall (2000) examine the use of incentives in partnerships and alliances through six construction case studies. Walker *et al*. (2002) describe a case study based on an alliance arrangement – the National Museum of Australia. A further alliance case study – BAA's Heathrow Terminal 5 – in which the alliance partners coalesced into a virtual company, is included at the end of this book.

Partnering seems the way forward for major organizations, and substantial benefits are being realized. At the end of 2004 four groups of companies entered into framework agreements with Yorkshire Water to undertake improvements to the region's water and sewerage systems over a 5-year period; Severn Trent Water have had a similar arrangement in place for several years. In 2005 The National Grid signed a £1.6 billion deal for gas mains replacement using only four partners to carry out the work.

The Welsh Water Alliance is a strategic partnering team – formed between Dwr Cymru Welsh Water, United Utilities (contracted to operate Welsh Water's assets), six strategic design/construction partners, two cost managers, a partnering facilitator and a supply chain advisor – to deliver around 60 per cent of Welsh Water's capital investment programme during the period 2000–2005. The partners are formed into four alliances. The Convivium Partners' website identifies that there are three cornerstones to the Welsh Water Capital Alliance approach:

- "**Mutual Goals** based on a target cost approach with open book accounting, fixed management fees and pain/gain share incentives managed by an independent cost manager within the team, and

- **'People and Relationship Development** through establishing a common culture with agreed to values and behaviours based on collaboration and 'no blame', and developing technical skills for process improvement, value engineering and risk management and behavioral skills for meetings, negotiations and stakeholder management, and
- **'Continuous Improvement** through the elimination of duplication and the establishment and improvement of common processes across the alliances driven by key performance indicators and by using the European Foundation for Quality Management Business Excellence Model."

Panel 10.11 Case study: Birmingham Construction Partnership

Against the backdrop of *Rethinking Construction* and *Achieving Excellence in Construction* and government reports into improving construction provision and procurement in the UK, Birmingham City Council founded the two-tier supply chain Birmingham Construction Partnership (BCP). This arrangement created a unique collaboration of three contractors, Wates Group, Thomas Vale and GF Tomlinson, which together form the first chain of the supply chain. The second tier comprises 61 companies from whom equipment and services are sourced. The supply chain was tasked with delivering every project in the city with a budget over £100,000 over 5 years from 2004–2009 under a £500 million capital-building programme.

The contractor is involved from the very start, at the planning and costing stage, working with the customer, the design team, subcontractors and key suppliers on the development, specification, buildability and delivery of new-build and refurbishment projects.

The contractors organize and manage the supply chain to deliver all projects on time and on budget across all the Council's services including education, social care, leisure, sport and housing.

Latest performance indicators show that, in 2004–2005, the partnership scored above national industry averages for 2004. Key figures include:

- 92 per cent of projects delivered with zero or minimal defects;
- 61.8 per cent of projects delivered within 5 per cent of target cost (national average 38 per cent);
- 62.3 per cent of projects delivered within 5 per cent of target time (national average 60 per cent);
- 77.8 per cent of projects delivered under partnering prinicples, compared to the government's target of 20 per cent.

BCP has been featured on the Constructing Excellence website as 'the first construction collaboration of its kind in the UK'. Its work with the council's Housing Department on improving council homes was selected as a best-practice case study and can be seen on the website.

It has also been hailed as an example of best practice in local authority construction in a landmark report launched by the Local Government Task Force. The report, *Transforming Local Government Construction: The power of framework agreements*, highlights the benefits and efficiencies that councils and contractors can achieve through partnering and collaboration.

Source: Birmingham City Council website

For an in-depth review of project-specific alliancing based on best practice, readers are recommended to consult the European Construction Institute's excellent publication, *Partnering in Europe: Incentive based alliancing for projects* by Bob Scott (Scott, 2001).

Two concepts lie at the heart of partnering and alliancing. One is the idea of *gainshare* and *painshare*. If the approach is to work, an inviting prospect of additional profits through gainshare must be put in place, with a corresponding drop in profits through painshare (usually capped for the contractor).

The second concept is that of performance assessment. The success of projects within an alliancing programme can only be gauged if measures of performance are developed and implemented (MPA seminar, 2002).

On the international stage, successful applications of partnering in construction have been reported in the United States and Australia, whilst in Japan partnering is considered the normal way of working. In Hong Kong the Mass Transit Railway Corporation (MTRC) pioneered the partnering approach on the sixth stage of their metro system.

A case study examination on the Yau Tong Station (Contract 604), one of 13 civil projects on the Tseng Kwan O Extension, identified two key partnering tools: first, the monthly partnering review meeting at which the partnering status was assessed by considering 13 attributes; and second, the Incentivization Agreement, which was signed midway through the contract; this introduced a target cost arrangement for dealing with shared risks using a pain/gain formula (Bayliss *et al*., 2004).

However, in the UK it is considered that, although somewhere in the region of 80 per cent of construction work on new-build projects is undertaken by subcontractors, they are frequently not included in the partnering process. Sullivan (2006) for instance contends that, although

Panel 10.12 Case study: Partnering – health clubs

A programme of constructing health clubs consisted of the roll-out of a large number of 20,000-sq-ft complexes around the UK, with the intention of realizing incremental improvement year on year. Each cost between £1 million and £1.5 million.

In year 1, a core team of industry professionals and constructors was selected, and a generic brief developed. In year 2, the product was developed, formal partnering arrangements were introduced and a collaborative environment developed. In year 3, the team concentrated on improving the product, with a shift of emphasis from cost to the product itself. That enabled them to increase standardization and shorten the construction periods and the process for approvals. A project debriefing process was also set up to build in the lessons learned.

Among the achievements were:

- a 25 per cent reduction in capital cost;
- increased quality;
- a reduction in construction time and time to market;
- approaching 100 per cent predictability;
- approaching zero defects at handover; and
- zero reportable accidents throughout the programme.

Source: Major Projects Association (2002) partnering contracts are being adopted, the real cultural change that this heralds is not embraced. Some main contractors who profess to embrace partnering still use one-sided conditions of contract.

Rudi Klein, chief executive of the Specialist Engineering Contractors Group, also confirms that one of his members received a heavily amended NEC ECC Construction Subcontract whilst part of a supply chain on an NHS ProCure 21 project, in effect mirroring the traditional approach of *dumping risk* on to the subcontractors (Klein, 2004).

For some, the jury is still out as to whether partnering brings the benefits that are claimed. Anecdotal evidence from several senior professionals within the industry tends to confirm this viewpoint.

10.10 Conclusion

This chapter has identified the benefits and weaknesses of the traditional and design and build approaches. The chapter also discusses the advantages of joint ventures for large projects and how and why partnering/alliancing has been identified as the way forward for many clients.

Critical to this choice of procurement route is the allocation of risk to the client. Most clients are averse to risks and require that projects are completed on time and within budget. It is noted that, in February 2007, the Irish Government began replacing all existing public works contracts with a new suite of contracts aimed at providing fixed-price, lump sum contracts. These new contracts are intended to give price certainty and eliminate the potential for claims for extras and overruns that go beyond the original budget. The contracts include severe terms/penalties which preclude the contractor's common law rights and introduce time limitations on the submission of claims and programme contingencies (O'Sullivan, 2007). This approach seems similar to that adopted by the Hong Kong International airport (refer to Panel 10.1) project, against which there were substantial claims.

The traditional approach with both the client and contractor attempting to exploit each other led to the introduction of partnering and the development of long-term alliances. In the public sector there has been a significant expansion in the development of alliances between local authorities in the same district. This approach not only enables the sharing and development of best practice knowledge but also more economic purchasing power due to the increased volumes of sales. However, it seems that all clients are not yet convinced that this approach leads to the holy grail of *best value*. Significantly, BAA's new owner and Spanish contractor Ferrovial has indicated a shift away from the innovative T5 construction management approach (see Chapter 18). It is now expected that most future BAA contracts will be let on a design and build basis (Macdonald and Richardson, 2008).

10.11 Questions

Question 1

Identify the key issues which might persuade a client not to use the traditional procurement route.

Question 2

Critically review the quantity surveyor's role under the design and build procurement method (refer to Kennedy and Akintoye, 1995).

Question 3

Critically review the business case for integrating the team.

10.12 References/further reading

Atkinson, J. (2001) 'The BullRing challenge', *Contract Journal*, 31 October.

Banwell, H. (1964) *The Placing and Management of Contracts for Building and Civil Engineering Contracts*, HMSO.

Barnes, N.M.L. (1983) 'Advanced construction management techniques', *Continuing Engineering Studies Seminar*, Civil Engineering Department, The University of Texas, Austin, Texas, 2–3 November.

Bayliss, R., Cheung, S.O., Suen, H.C.H. and Wong, S.P. (2004) 'Effective partnering tools in construction: A case study on MTRC TKE contract 604 in Hong Kong', *International Journal of Project Management*, Vol. 22, No. 3, April, pp. 253–263.

Bennett, J. (1991) *International Construction Project Management: General theory and practice*, Butterworth Heinemann.

Bennett, J. and Jayes, M. (1995) *The Seven Pillars of Partnering: A Guide to Second Generation Partnering*, Thomas Telford.

Boonham, S. and Nisbet, M. (2004) 'Achieving best value on Bullring: A case study', *Gardiner & Theobold publication, RICS COBRA 2004 Construction Research Conference*, September, Leeds.

Bresnen, M. and Marshall, N. (2000) 'Motivation, commitment and the use of incentives in partnerships and alliances', *Construction Management and Economics*, Vol. 18, pp. 587–598.

Brewer, G.: www.brewerconsulting.co.uk – cited 20 May 2009.

Broughton, T. (2004) Multiplex declares war on Cleveland Bridge, *Building*, 29 October 2004, p. 10.

Broughton, T. (2005) Wembley subcontractors seek £20m from Multiplex, *Building*, 3 June 2005, p. 11.

Broughton, T. (2005) Wembley: Multiplex faces new £25m loss, *Building*, 4 November 2005, p. 12.

Clark, P. (2002) Revealed: Wembley will cost £410m to build, *Building*, 31 May 2002, p. 11.

Conn, D. (2006) Lessons to be learned from Wembley's woes, *The Guardian: Sport*, March 8, p. 9

Constructing Excellence, *Local Government Task Force Case Studies*: www.constructingexcellence.org.uk/sectorforums/lgtf/casestudies.jsp.

Davis Langdon (2012) *Contracts in Use: A survey of building contracts in use during 2010*, RICS.

Dornan, P. and Davis, C. (2009) 'Let's work together', *Building*, 26 June, p. 50.

Duggan, J. and Corcoran, D. (2007) 'Taking the partnership path', *The Journal RICS Construction*, June, pp.16–17.

Gruneberg, S. and Hughes, W. (2006) 'Understanding construction consortia: Theory, practice and opinions', *RICS research paper series*, Vol. 6, No. 1.

Highways Agency (2009) *Delivering Sustainable Value through Supply Chain Management*, procurement strategy: www.highways.gov.uk/publications/corporate-documents-procurement-strategy – accessed 29 October 2012.

H.M. Treasury Central Unit on Purchasing, *Guidance Note No. 36 Contract Strategy Selection for Major Projects*, HM Treasury (since withdrawn).

H.M. Treasury Central Unit on Purchasing *Guidance Note No. 51 Introduction to the EC Procurement Rules*, HM Treasury.

Hodgson, G.J. (1995) 'Design and build – Effects of contractor design on highway schemes', *Proceedings of the Institution of Civil Engineers, Civil Engineering*, Vol. 108, May, pp. 64–76.

Janssens, D.E.L. (1991) *Design–Build Explained*, Macmillan.

Kennedy, S. and Akintoye, A. (1995) *Quantity Surveyors Role in Design and Build Procurement Method*, RICS COBRA Research Conference.

Klein, R. (2004) 'You are the weakest link', *NEC Newsletter*, No. 30, August: www.neccontract.com/PDF_DOC/NEC%20Newsletter-30.pdf – accessed 29 October 2012.

King, B. (2006) *Transforming Local Government Construction: The power of framework agreements*, Local Government Task Force and East Midlands Centre of Excellence.

Lam, B.C.L. (1998) 'Management and procurement of Hong Kong Airport core programme', *Proceedings of the Institution of Civil Engineers, Civil Engineering*, Hong Kong International Airport, Part 1: airport, 126, pp. 5–14.

Leftly, M. (2002) After Wembley, *Building*, 11 October 2002, p. 30.

Lewis, D. (2002) 'Dispute resolution in the Hong Kong international airport core programme projects – Postscript', *The International Construction Law Review*, Part 1, pp. 68–78.

McCappin, M. (1996) Staffordshire County Council/Birse Construction Ltd, 'Partnering on Tunstall Western Bypass – Phase 2', *Wulfrunian Lecture 1996*, Partnering in Civil Engineering, Institution of Civil Engineering Surveyors.

Macdonald, S. and Richardson, S. (2008) BAA to axe 200 staff from its projects division, *Building magazine*, 11, January, p. 9.

Major Projects Association (MPA) (2002) *Alliance/Partnering*, Summary of seminar held at Templeton College Oxford, 17 January.

Minogue, A. (2004) 'Seduced by simplicity', *Building*, 15 October.

Monaghan, A. (2007) Multiplex family sells up after 45 years, *Building*, 15 June 2007, p. 13.

Mylius, A. (2005) 'A game of two halves', *Supply Management*, 6 October.

Office of Government Commerce (OGC) (2003) *Achieving Excellence in Construction, Procurement Guide 06 Procurement and Contract Strategies*, OGC.

O'Sullivan, G. (2007) 'All change in Eire', *The Journal RICS Construction*, September/October, pp. 18–21.

Patterson, l. (1999) 'The trouble with GMP', *Building*, 17 September, p. 84.

Perry, J.G. and Hayes, R.W. (1985) 'Construction projects – Know the risk', *Chartered Mechanical Engineer*, February, pp. 42–45.

Raved, J.E. (Chair) (2003) *Report on Alternative Methods of Public Works Procurement*, Association of the Bar of the City of New York, Committee of Construction Law.

Rawlinson, S. (2007) 'Procurement: Employer's agents', *Building*, 9 February, pp. 58–61.

Scott, B. (2001) *Partnering in Europe: Incentive based alliancing for projects*, Thomas Telford.

Strategic Forum for Construction (SFfC) (2007) *Profiting from Integration*, Final Report, November, Construction Industry Council.

Strategic Forum for Construction (SFfC): http://cecwchampions.co.uk/tools/sfctoolkit/help/maturity_model.html – accessed 29 October 2012.

Sullivan, M. (2006) 'An open relationship', *Construction Journal*, June, pp. 9–10.

Walker, D.H.T., Hampson, K. and Peters, R. (2002) 'Project alliancing vs project partnering: A case study of the Australian National Museum Project', *Supply Chain Management; An International Journal*, Vol. 7, No. 2, pp. 83–91.

Websites

www.birmingham.gov.uk – cited 4 March 2007.

www.constructingexcellence.org.uk.

www.conviviumpartners.com/DCWW%20case%20study.htm – accessed 14 April 2010.

11 Organizational methods (Part 2)

11.1 Management methods

The traditional system is often too rigid and has been used in inappropriate circumstances, e.g. where the design is not complete. Projects have become more complex and demanding, e.g. technically, legally, financially, time-wise, size-wise and logistically. Under these circumstances the management strategies may offer an alternative approach. Under these methods the contractor/construction manager offers the client a consultancy service, based on a fee, for coordinating, planning, controlling and managing the design and construction.

These approaches ensure that the contractor (or construction management consultant) is part of the client's team from the outset and, similar to the other consultants, is paid a fee, ensuring that the maximum construction experience is fed into the design.

The management approach can offer a viable and flexible relationship where:

- The project is large and/or complex.
- A fast-track procurement system is required or there is need for an early start and early completion of the project.
- The client wishes to select the designer separately (e.g. where a competition is used).
- The work is not sufficiently defined prior to construction (which enables the detailed design and technology to be developed in tandem).
- The project is organizationally complex.
- Flexibility is required throughout the project.
- A less adversarial approach is preferred.
- A choice of competitive tendering for each element is preferred.
- A target price (based on a cost plan) rather than a fixed lump sum is accepted.

The principles underpinning this approach are not new. Contractor Bovis introduced the Bovis System into the UK in the late 1920s. Under this system the builder was paid a fixed fee to cover overheads and profit, with the client receiving any savings made during the construction instead of the contractor. In 1927 Bovis signed the first contract with retailer Marks & Spencer, a prime cost fixed-fee contract, with the provision of a bonus to Bovis if the actual cost was lower than the estimated cost. The marriage between client and contractor proved an outstanding success, with well over 1,000 M&S projects completed by the year 2000 (Cooper, 2000).

11.2 Management contracting

Following the success of the Bovis System, management contracting was a logical development for the Bovis Group in the 1970s. This approach offered the same unique relationship between client and contractor, with a negotiated fee, but included competitive tendering for subcontracting packages. Bovis were the pioneer of this approach in the UK. Successful management contracting projects in the 1970s included John Players & Sons HQ in Nottingham, Wiggins Tea HQ in Basingstoke, Norman Foster's iconic Willis Faber Dumas office building in Ipswich, EMI HQ in Tottenham Court Road, London, modernization of the Royal Liver Building in Liverpool and the Royal Liverpool Teaching Hospital (completed under the Bovis System).

In 1980 Bovis was selected as management contractor for Richard Roger's landmark Lloyd's building in London; this innovative project with the building services and glass lifts on the outside was completed in 1986. In 1981 management contracting represented around half the work load of Bovis, whilst in 1984 the majority of Bovis's contracts were carried out under this system (Cooper, 2000). In contrast, in 2005 over 80 per cent of Bovis Lend Lease UK's workload was executed under a negotiated two-stage lump sum design and build approach, mostly under long-term partnering relationships.

Management contracting requires the contractor to be involved in two stages. During the design phase, which will extend into construction, the contractor's role is to advise the employer on the buildability of the design, plan the construction and agree cost estimates with the quantity surveyor. During the construction phase, the contractor is responsible for tendering parcels of work and negotiating subcontracts with subcontractors (known as works contractors) on behalf of the employer.

The management contractor then enters into lump sum contracts with the works contractors after approval by the client. The management contractor is solely responsible for managing the design and construction, and supervises the work on site. For this they are paid a fee, sometimes with a bonus if the project is finished to time and budget. In addition, they are paid for site management, site facilities and administration, either on a cost reimbursement basis or by lump sum. Although management contracting sets out to encourage less adversarial attitudes between the various participants, the objective has frequently been nullified by the tendency of the client to assign more and more risk to the managing contractor, risk which they can neither manage nor reasonably price (Centre for Strategic Studies in Construction, 1991).

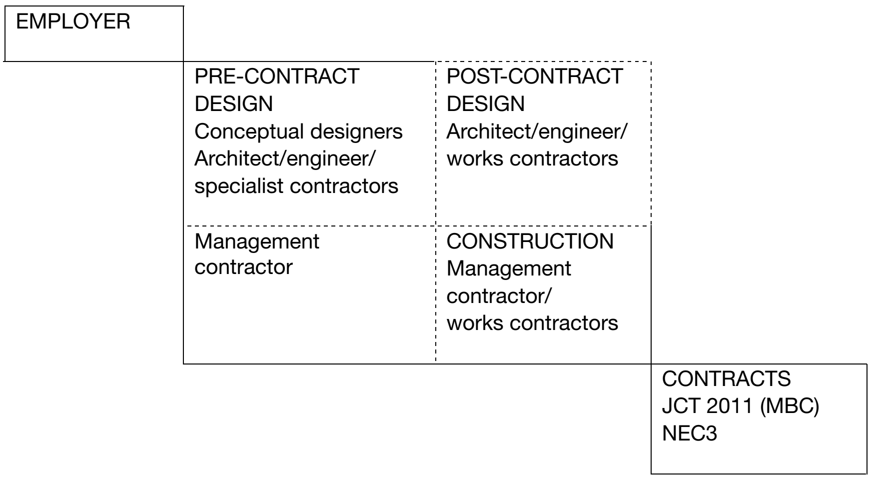


Figure 11.1 The management contracting system

In the 1980s management contracting was used on several major projects, e.g. Heathrow Terminal 4 and Manchester Airport Terminal Buildings, Birmingham Convention Centre and the Headquarters for the HSBC bank in Hong Kong.

Management contracting is closely identified with the 1980s' construction boom; however, it is still encountered, albeit in forms heavily amended from the first recognized standard form, the JCT87 Management Contract. It is noted that the new JCT 2011 suite of contracts contains a Management Building Contract.

The services offered by the management contractor may include those given under the headings below:

Pre-contract

Programming the design, design input on buildability, budget and cost forecasts, advice on financing, cost control, materials procurement and expediting, advising on the works packages, preparation of tender documents, evaluation of tenders, selection of works contractors, insurances and bonds – policy and implementation, construction planning and programming, and formulating methods of working.

Post-contract

Setting out, supervision and control of works contractors, provision of central services and construction equipment, design of temporary works, quality control, industrial relations – policy and monitoring, costing of variations and certification of interim and final payments to works contractors, assessment and monitoring of claims.

Panel 11.1 Case study: Management contracting – HSBC HQ Hong Kong

The HK$5,000 million (£375 million) Headquarters of the HSBC bank in Hong Kong was designed by Norman Foster/Ove Arup and constructed using the management contracting approach with John Lok/Wimpey joint venture as construction manager.

This 55-storey iconic tower block in the Central District of Hong Kong, the structure of which resembles a North Sea Oil drilling rig, was completed within a project cycle of 6 years (design brief 1979; 2 years' pre-contract; 4 years' construction with completion in 1985).

Among the reasons for the client selecting the management contracting approach were:

- The need for an early start and early completion of the project in a situation where the design was not sufficiently defined prior to construction. The circumstance requires good planning and control of the design/construction overlap and careful packaging of contracts.
- There was a need to consider particular construction methods during the design phase.
- In this complex project involving high technology, management contracting would provide greater flexibility for design change than conventional contracts.
- The project was organizationally complex. Typically, this may arise from the need to manage and coordinate a considerable number of contractors and contractual interfaces and several design organizations.
- The client and his advisers had insufficient in-house building management resources for the project.

Source: Archer (1985)

The strengths of management contracting can be summarized as follows:

- It allows an early start and completion.
- Time can be saved by a more extensive overlap of design and construction utilizing the management contractor's expertise in construction planning.
- It allows flexibility particularly where the programme and design are ill-defined and subject to change.
- Cost savings can be achieved through better control of design changes, improved buildability, improved planning of design and construction into packages for phased tendering and keener prices due to increased competition on each package.
- It reduces delays and knock-on effect of claims.
- It is easier to control the selection of construction contractors to those of known ability.
- It avoids adversarial attitudes – leads to a more harmonious relationship between the parties.

The weaknesses of the system can be summarized as:

- A client may be exposed to a greater risk due to: reliance on a contract cost plan prepared on the basis of incomplete information; late information; works contractors failing to complete to time or quality standards (there is no direct contractual link between the client and the construction contractors); and delays and subsequent time and cost overruns.
- There is evidence that the overall cost may be greater under this fast-track approach; however, this is normally offset by early completion and the additional letting income or revenue accrued.
- There is a tendency for duplication of administrative and supervisory staff.
- Roles and responsibilities of designer and management contractor for quality control are unclear.
- In practice the management contractor's ability to ensure compatibility between design and construction methods may be limited.
- The potential for grey areas between works contractors is high.
- If the JCT management contract is used in an unamended format the client is responsible for the knock-on effects of the works contractors, not the management contractor.
- Design may suffer as the architect is under time pressure.

11.3 Construction management

The move towards construction management was led in the 1980s by the larger, more experienced international clients and developers who have skills in project management that they can apply directly to each project.

The projects were often massive (e.g. the £800 million Broadgate complex in the City of London and the £3 billion Canary Wharf development in London Docklands): highly speculative and complex. These developers appointed a strong project management team using American organizational and production methods – in contrast to the traditional UK practices – and encouraged innovation, e.g. fast-track techniques utilizing offsite fabrication, and demanded success! It is claimed that the construction management approach is an ideal process for managing risk, the concept being to identify the risks at the earliest possible opportunity and then proactively manage them.

In recent years in the UK we have witnessed the use of the construction management approach on some high-profile public and private projects, including the £234 million Portcullis House – the accommodation block for MPs at Westminster (1989–2000) designed by Michael Hopkins

Panel 11.2 Case Study: Management contracting – Stoke-on-Trent Cultural Quarter

The NAO Report, *Progress on 15 Major Capital Projects Funded by the Arts Council England*, found that, of the 13 projects then completed, four were finished 12 or more months late and 13 of the 15 projects were over budget with overruns ranging from 1.7 per cent to 58 per cent.

The Cultural Quarter project was an innovative initiative which aimed to regenerate the City Centre in Stoke-on-Trent through the provision of two high-quality arts and entertainment venues.

The two venues to date have been an undoubted success and have stimulated further development. However, the project cost the Council £15 million more than the original budget of £22 million. The additional costs related to: an overspend on the main contract (including professional fees) of £5.6 million; unbudgeted items of £1.7 million; and a further £7.8 million relating to an unsuccessful arbitration involving the Council and the project's architects.

The Audit Commission's Report identified that:

- The Council did not adequately consider the risks associated with the management contract.
- The appointment of each of the major contractors was characterized by poor practice.
- The Council failed to establish effective arrangements for managing the project.
- Reporting to Council members was too shallow to allow a proper consideration of risk.

The Report also noted that:

- The Council's top priority was cost certainty – it was working to a fixed budget.
- The management form was considered the only option that would allow a contract to be procured by the deadline to secure £1 million in ERDF grant.
- There was a poor working relationship on the contract (between the architect Levitt Bernstein Associated Ltd and the management contractor Norwest Holst Construction Ltd).

The NAO Report identifies that the Arts Council has now adopted a new approach – partnership contracting – for a number of building contracts. This approach brings together the design team and the building contractor at an early stage of the project with the aim of reducing costs on the project and securing shared commitment to the project.

Sources: NAO (2003); Audit Commission (2004)

& Partners and built by Laing Management Ltd; the £431 million Scottish Parliament building in Edinburgh (1998–2004) inspired by Enric Miralles and built by Bovis Lend Lease; and the iconic £130 million 'Gherkin' HQ for the reinsurance company Swiss Re in the City of London (1997–2000) designed by Foster and Partners and built by Skanska.

The construction management approach demands a client with commitment and expertise to become involved in the development process, as it is they who would usually appoint the design team, the construction manager and the trade contractors direct. Under this approach the construction manager acts as the client's agent with responsibility for coordinating and controlling all aspects of the project. Construction management is very much a team approach with the client, designers and construction contractors and with the construction manager acting as team leader.

It is recommended that the construction manager is appointed by the client at the same time as the architect/engineer, if not before. The consultant construction manager would normally be required to proactively manage the design team's production of information and the various interfaces between the trade contractors. They would also provide expert advice at both the design and construction stages on construction planning, costs, construction techniques and buildability.

The construction manager has no contractual links with the design team or the trade contractors and provides professional construction expertise without assuming the financial risk; they are only liable for negligence, by failing to perform their role with reasonable skill and care, unless some greater liability is incorporated in the contract.

In the United States there are two alternatives for the 'Professional Construction Management' approach. 'Agency CM', in which a firm is hired to provide the construction management services, is paid a fee, and all construction contracts are between the owner and the construction organizations; and 'CM at risk' whereby a single firm receives a prime contract from the owner, typically a guaranteed maximum price, contracts with all contractors and performs the construction management functions (Maloney, 2009).

The construction management system has the following strengths:

- The construction manager's objectives should be closely aligned to those of the project sponsor – being motivated by the level of the fee and enhancing reputation, not by increasing their own profit.
- As with the management contracting approach, construction management offers a better chance of success, with greater flexibility within a tight timescale on a complex project.
- Changes in design can be accommodated later than in some other strategies.
- Construction management allows the client a full and continuous involvement in the project and a greater degree of control – indeed the client is the ultimate decision-maker between

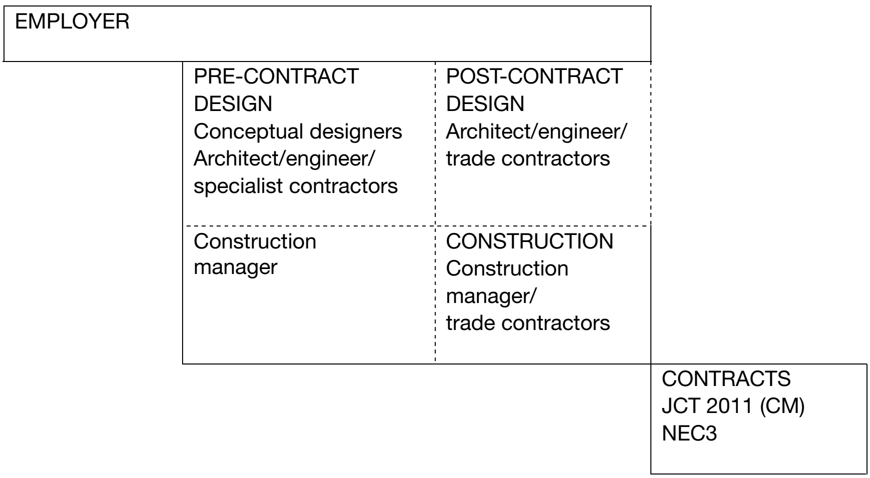


Figure 11.2 The construction management system

Panel 11.3 Case study: Construction management – Great Eastern Hotel, London

The case of *Great Eastern Hotel Company Ltd (GEH) vs John Laing Construction (JLC)* was heard in the Technology and Construction Court in 2005. The case arose after a luxury hotel in London overran by a year and cost £61 million rather than the £38 million budget. JLC were appointed as Construction Manager under an agreement which provided that JLC should exercise reasonable skill, care and diligence expected of a properly qualified and competent Construction Manager and should ensure that each contractor complied with the obligations under their respective contracts. GEH claimed that JLC had caused the overrun by their mismanagement.

Judge Wilcox held that the Construction Management Agreement required the Construction Manager to manage the construction of the project but not to accept the principal risks of time and cost which remained with the Employer. However, while JLC was not the guarantor of the project, it did owe clear professional obligations to the GEH. JLC had an obligation to manage the project so that risks in relation to time and money were minimized. It was held that JLC had breached this obligation in that it failed to manage the contractors with the degree of care expected from a professional in JLC's position. The Court held that GEH was entitled to recover £8.9 million in damages.

Source: Glover (2005)

the designer and manager in order to affect the balance between architecture, technology, time and cost.
- The client has greater flexibility in the appointment of the works contractors; direct payment from the client can result in lower bids; and in theory there is a better long-standing relationship between the parties.
- Early completion is possible because of overlapping design and construction (known as fast-track construction).
- Construction management utilizes a team concept and provides early input on buildability, potential site problems, planning methods and costs.
- Construction management promotes non-adversarial relationships and team-building.

Weaknesses:

- As the client contracts direct with the construction contractors, the total risk in the event of failure or dispute lies with the client, there being no intermediary main contractor. These risks can be substantial and include not only the project's costs for delay and disruption but also the trade contractors' delay and disruption of each other.
- Clients will have to contribute a great deal of expertise when undertaking construction management; this may prove to be a daunting experience for inexperienced users of the construction industry.
- The client does not know the overall price at commencement of the works (often based on cost plan estimate). Indeed, any degree of price certainty may not be achieved until all the construction work packages have been let.
- The construction manager assumes no risk other than for negligence.

Panel 11.4 Case study: Construction management – Portcullis House, London

Portcullis House provides high-quality accommodation for 210 Members of Parliament and 400 staff, together with committee rooms. This challenging project was completed in August 2000 after a construction period of 30 months.

The project was initially delayed for almost a year due to the reconstruction of the Westminster underground station which lies directly beneath Portcullis House and suffered a small further delay of 6 weeks. The project out-turn cost was £234 million, some 18 per cent greater than the original 1992 forecast, but 4 per cent lower than the 1998 budget approved by Parliament.

All main construction contracts were let after competitive tendering. However, the client incurred legal and other costs totalling some £10 million after it was successfully sued by an unsuccessful tenderer (US specialist Harmon) for unfair treatment and contravention of procurement regulations in relation to the contract for the fenestration (prefabricated wall and window units).

The recommendations of the NAO Report on the project make interesting reading, particularly in light of the Scottish Parliament building, which completed 4 years later:

1. Recognise the importance of managing the risks associated with innovative design.
2. Establish at an early stage a board of senior officials, chaired for larger projects at the highest level, to oversee the project.
3. Provide appropriate training, advice and support for senior decision-makers.
4. Carry out investment appraisals or lifetime costing exercises prior to approval.
5. Use value engineering to explore the scope to meet the requirement at lower cost.
6. When monitoring and reporting the likely out-turn cost of projects against forecasts, maintain a clear distinction between forecasts made at the time of the initial decision to undertake the project and later forecasts incorporating agreed changes in costs.
7. Consider regularly publishing information on the cost of major projects.
8. Ensure that liquidated damages clauses are based on sound estimates of likely costs.
9. Ensure that there is adequate control of professional fees and expenses when selecting and appointing professional advisors.
10. Undertake a review of the building in use.

Source: NAO (2002)

For further information on the construction management procurement route, including its successful use on the £100 million refurbishment of Peter Jones' department store in Chelsea, London see Simon Rawlinson's excellent review (2006b).

11.4 Management contracting or construction management?

The CIRIA Special Publication 81 (Curtis et al., 1991) identifies the key factors to be considered by the client in choosing between construction management and management contracting:

- Does the client have the desire and ability to exercise direct contractual control over works contractors?

- In which system is the management organization better able to use its skills and experience for the benefit of the client?
- Are the works contractors likely to respond better under one system than they would under the other?

The *Construction Management Forum Report* confirms that the construction management approach is the preferred method for those clients who have the capability and confidence to follow the management path of procurement (Centre for Strategic Studies in Construction, 1991). The Report offers practical guidance in implementing the construction management methodology.

11.5 Reflections on the Scottish Parliament building

'The selection of Construction Management was the single factor to which most of the misfortunes that have befallen the project can be attributed', was the quote which hit the headlines after the publication of Lord Fraser's *The Holyrood Inquiry* into the new Scottish Parliament building.

Lord Fraser took evidence from Colin Carter of Gardner Theobold, who set out seven *must haves* for the Construction Management procurement route to work effectively:

1 an experienced and informed client with an understanding of construction and construction processes;
2 an experienced and sufficient team with good leadership not forced down the route of just trying to keep the project going and managing change;
3 well-defined roles and responsibilities from the start;
4 an architect who can envisage the whole and the detail at the same time, if retrospective change is to be avoided without resultant ripple effect on trade packages;
5 sufficient time up front in planning, to foster a no-surprises culture and to avoid crisis management;
6 a very good construction instruction, approval and change process;
7 an effective and well-managed risk management process.

Building magazine contains an interesting series of articles debating the merits or otherwise of using construction management on public projects. Ashley Piggott identifies the failed projects in the Arts sector, including Sadler's Wells Theatre, where the costs went out of control, and argues the case for a variant of the design and build approach. He considers that construction management should not be used on the £100 million rebuilding of the Shakespeare Theatre in Stratford-upon-Avon and dissects each of Colin Carter's seven *must haves*, arguing that 'nobody is ever accountable under the CM route and that cost escalation should come as no surprise' (Piggott, 2004).

Colin Carter, partner at Gardner Theobold vigorously defends his corner, stating:

> In my view Fraser did not condemn CM *per se* – among his many recommendations he identified two key elements. The first was the flawed decision to choose CM, as he believed the decision was not fully considered, especially the risk element. Secondly, he does recommend that in future the public sector does not use CM, but he does not rule out CM in other sectors.
>
> (Carter, 2004)

Lawyer Ann Minogue concludes the debate on the use of construction management at the Scottish Parliament building stating:

> Assuming speed remained a priority; most of us would conclude that construction management was the proper choice of procurement route and no other route would predictably have offered a better solution. But the client should be alive to the risks and manage the project accordingly.
>
> (Minogue, 2004)

11.6 Design and manage

This approach combines some of the characteristics of design and build and the management approach. It allows the client more opportunity to be involved in the design process and to make changes to the design and specification. The approach may be desirable on follow-on contracts, on fast-track projects or where the contractor has some specialized expertise. The contractor is often appointed early, often in competition based on a quoted fee with a build-up of the required preliminaries. All construction work is undertaken by specialist construction contractors.

Two variants of design and management are noted: Contractor – in which the project design and management firm takes on trade contractors; and Consultant – in which the project management and design firm acts as the client's agent with the trade contractors directly contracted to the client.

The Birmingham BullRing shopping centre, which opened in 2003, was constructed by Sir Robert McAlpine under a design and manage guaranteed maximum price (GMP) contract. Significantly McAlpine had previously completed the West Quay retail development in Southampton for the same developer – Hammerson – using the same approach. The contractor tendered for the £247 million shell and core development on the basis of a set of employer's requirements and a set of concept drawings. Bidders were not required to do any design work for the tender submission, but instead submitted proposals covering such aspects as the management methodology, resourcing and pricing of the job. McAlpine were selected as the preferred bidder under a form of two-stage appointment mainly due to the detailed cost plan which they had developed to justify the GMP. Under this open book contract the contractor was responsible for the design of much of the services and the detailing of the cladding and structures, with all the subcontract packages let in open competition with the exception of the crucial £20 million steelwork package (Atkinson, 2001).

11.7 EC procurement rules

The Public Contracts Regulations 2006 and The Utilities Contracts Regulations came into force in England, Wales and Northern Ireland on 31 January 2006. These were amended by the Public Contracts (Amendment) Regulations 2009 which became effective on 20 December 2009. The regulations set out the procedures to be followed at each stage of the procurement process and are intended to ensure that public bodies award contracts in an efficient and non-discriminatory manner and with a view to securing value for money and transparency.

All building and civil engineering works executed by public authorities above €5 million (or £4,348,350 – as from 1 January 2012) must be the subject of a call for competition by publishing a contract notice in the *Official Journal* of the EC. The regulations seek to modernize the rules, provide for new procurement arrangements such as framework agreements and e-auctions and take into account social and environmental considerations.

Panel 11.5 Case study: Management contracting became design and build – Welsh Assembly building, Cardiff

The decision to locate the National Assembly for Wales on the present site in Cardiff Bay was taken in April 1998. An international design competition was held with a brief setting out a functional specification for the building and expressing a clear desire for an open and democratic building. The competition jury considered designs from six architects and recommended a concept design from the Richard Rogers Partnership (RRP).

The specifics of the brief included the stipulation that the building be exemplar for access, that sustainable strategies and renewable energy systems be implemented throughout, that the building have a minimum 100 years' life span and that, wherever possible, Welsh materials be used throughout. Other elements included a 610-square-metre debating chamber for 60 to 80 members, three committee rooms, offices, a media briefing room, tea room, members' lounge, public galleries and a main hall to act as reception and exhibition space.

The initial price limit set for the new Assembly debating chamber was £12 million including fees, and completion was scheduled for early 2002. However, by January 2000 the cost estimate had increased to £22.8 million.

The Welsh Assembly considered that the design and build route was inappropriate because of the novelty and complexity of the design and the need to retain client control. In December 2000 the Assembly appointed Skanska Ltd as the management contractor with responsibility for managing the construction of the building; they would also assist the architect with buildability and constructional issues, and let the works to sub-contractors.

Concerns arose over cost increases leading to fundamental disagreements between the Assembly and the RRP. In July 2001 the Assembly terminated the RRP employment to design the building because of a loss of confidence in the firm's ability to deliver the project within budget and the project was suspended. Francis Graves, construction project managers and cost consultants, were appointed to review the whole building and propose a way forward.

In November 2001 the Assembly decided to change the management arrangements for the project. In May 2002 Schal International Management Limited were appointed as project managers. In July 2003 Taylor Woodrow Construction Ltd were appointed design and build contractor with the remit to develop the existing design and complete the construction work for a fixed price of £41 million excluding VAT. Work recommenced in August 2003, with completion in September 2005 at a final cost of £60 million.

Postscript: In February 2002 the adjudicator considered that the RRP were entitled to payment of invoices and interest totalling £448,000 (not the full amount of £529,000 which had been claimed). The total legal fees and expert costs incurred by the Assembly in this matter was £267,000.

The Welsh Assembly has escaped the furious rows surrounding the runaway costs of the Scottish Parliament. Even so, it needs to be remembered that Rogers was taken off the job for 2 years before winning reinstatement. 'We were pushed out as we worked through the critical equation of time, cost and quality,' says Harcourt (Rogers's Director in Charge of the project). 'The brief kept expanding, the cost implications were serious and rebounded on us.'

Sources: Wakefield *et al*. (2004); Bourn (2002); Binney (2006)

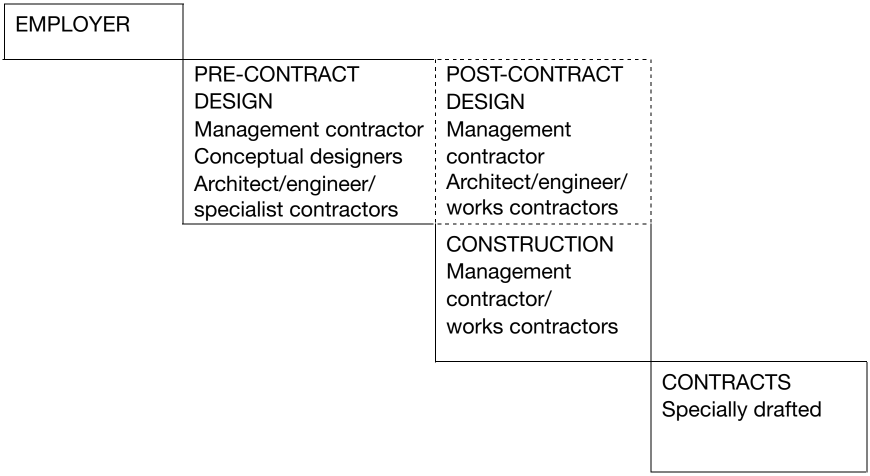


Figure 11.3 The design and management system

Panel 11.6 Case study: Property developer MEPC

Property developer and manager MEPC's assets comprise eight sustainable business communities around the UK – six business parks outside large towns and two strategically located in city centres with a total value exceeding £1.1 billion.

MEPC uses the procurement route best suited to the needs of a project. For schemes that are well defined, it uses negotiated, lump sum, design and build contracts. This route is taken for the vast majority of its work.

For projects that are more difficult to define, and where there is a need to react to change or the tenant has particular needs, the company will use construction management contracts. This procurement route is also applicable for buildings requiring complex laboratories and research facilities.

Source: *Building*, Supplement, Febrary 2003

The regulations provide for four procurement procedures:

- The open procedure – all interested parties may tender.
- The restricted procedure – contracting authority can select whom it will invite to submit tenders from those giving initial responses.
- The competitive dialogue procedure – the notice in this case invites requests to participate; a minimum of three participants is required.
- The negotiated procedure with notice – contracting authority can negotiate with one party after giving notice.
- The negotiated procedure without notice – in exceptional circumstances, the negotiated procedure may be used without any prior publication of the contract notice.

A contracting authority must award a public contract on the basis of the offer which is either the most economically advantageous from the point of view of the contracting authority or offers the lowest price. The criteria to be used to determine that an offer is the most economically advantageous include: quality, price, technical merit, aesthetic and functional characteristics, running costs, cost effectiveness, after-sales service, technical assistance, delivery date, delivery period and period of completion. Where the contracting authority intends to award a public contract on the basis of the offer which is most economically advantageous, it must state the weighting given to each criterion in the notice or contract documents (Oakes, 2006).

For an extensive 315-page review of EU Procurement law see *EU Public Procurement Law: An Introduction* (ed. Professor Sue Arrowsmith at the University of Nottingham). For a review of construction works procurement in the public sector see Simon Rawlinson's article in *Building* magazine (2006a).

11.8 Achieving Excellence in Construction

In 2003 the Office of Government Commerce issued the Achieving Excellence in Construction series of Procurement Guides. This series of guides replaced the Construction Procurement Guidance Notes series and reflects developments in construction procurement over recent years. The new series is endorsed by the NAO who recognize that proactive client leadership and robust project management are successful requisites to successful delivery of construction projects and that procurement of construction should be on the basis of 'whole-life value for money'.

Procurement Guide 06 *Procurement and Contract Strategies* identifies the need to demonstrate a significant improvement in performance against quality, cost and time targets. In order to achieve these, it is essential that all procuring bodies move towards proper integration of design, construction and operating functions. This will require a move to integrated teams, early supply team involvement, incentivized payment mechanisms, continuous improvement processes and joint commitment to achieving best whole-life value. Three preferred procurement routes are recommended to which Framework arrangements may also add value.

Public Private Partnerships (particularly Private Finance Initiative)

This approach is only recommended for projects whose capital cost is likely to exceed £20 million and has been created for the provision of services and not for the exclusive provision of capital assets such as buildings.

Design and construct (and where appropriate maintain and operate)

In a design and build contract, the integrated project team is responsible for the design and construction of the facility. The supply team is likely to deliver the greatest performance benefit through innovation, standardization and integrated supply chains, where appropriate output specifications are used.

There may be some circumstances where the design and build procurement route should be extended to cover maintenance and also possibly operation of the facility for a substantial period.

Prime contracting

The prime contracting procurement route is mainly practised in the UK, where the major supporter is the Ministry of Defence. It generally features the equal collaboration of all stakeholders, to the extent that all contractors, consultants and client representatives work together in partnership to ensure that a cost-efficient and suitable project design solution is achieved.

Prime contracting requires there to be a single point of responsibility (the prime contractor) between the client and the supply team. The prime contractor needs to be an organization with the ability to bring together all the parties (the supply team) necessary to meet the client's requirements effectively.

It is common that long-term alliances are formed between all contracting parties and down the supply chain. These alliances are designed to allow a longer-term view to be taken for the different projects undertaken. This is particularly important since many of the projects under this arrangement also involve maintenance obligations which often last for 5 to 7 years after the project has been completed.

Prime contracting usually includes such features as pain/gain share (where the prime contractor as well as the client gains financially by reducing the project costs), target cost pricing (where prices are agreed on the basis of a reasonable profit for the supply team and value for money to the client) and open book accounting (where costs are made transparent to the client).

11.9 NHS ProCure 21

The NHS spends in excess of £1.4 billion a year on capital investment and has the largest capital procurement programme in the UK Government. In 2002 the NHS introduced ProCure 21 – an innovative approach to procurement of construction projects in excess of £1 million embracing the principles of *Rethinking Construction*.

In October 2010 the NHS launched a follow-on initiative called ProCure 21+ which will run for 6 years. It aims to simplify the process for procuring a construction company for hospital refurbishments or new builds.

Six companies were approved for the ProCure 21+ framework, meaning that NHS Trusts do not need to go through the European Union procurement process during the life of this framework when appointing a contractor. The Government said that this will also usher in a more transparent system, where detailed data on performance outcomes will be provided by each company and published online, so that the NHS can make informed choices about the companies it employs.

Performance for the new framework will be measured on the following outcomes:

- client satisfaction with the product
- client satisfaction with the service
- safety, based on incident rates
- problems with the scheme, based on defects
- whether the scheme was to budget
- whether it was delivered on time.

The new system builds on the ProCure 21 framework, which the Government said had become the most popular procurement route for NHS capital schemes and had delivered projects with a value of almost £2 billion. ProCure 21+ stands alongside the Private Finance Initiative and the Local Investment Finance Trust initiative to deliver the future of NHS facilities.

Under the new framework, the Government said work can start on projects within 6 weeks, saving the NHS at least 6 months in the pre-construction period.

11.10 Highways Agency – overlying principles for future procurement

In addition to the need to comply with legislation and government policy there are a number of basic principles which can be applied to all categories of work to achieve best value. To be

Panel 11.7 Case study: Prime contracting: Building Down Barriers

The Building Down Barriers project, set up in 1997 by the Defence Estates and the Ministry of Defence (MOD), was an initiative aimed at establishing the working principles of supply chain integration into construction.

The idea of supply chain management (SCM) in construction is to harness the full potential in the entire 'chain' of suppliers of construction services, products and materials to deliver best value to the client. The value is measured in terms of performance and cost of the facility over the whole of its life, and the aim is to achieve this whilst at least maintaining – or enhancing – the profit margins of all involved.

Two projects were selected, at Aldershot and Wattisham, with prime contractors AMEC and Laing, and involved the provision of indoor sports and swimming pools for army garrisons. A research and development group, led by The Tavistock Institute and the Warwick Manufacturing Group, developed and evaluated the supply chain process with its supporting tools and techniques.

The whole concept was based on the concept of setting up long-term relationships aimed at improving value, improving quality and reducing underlying costs; it was based on trust, openness and teamwork.

The project started from the client's statement of need in output terms. The design was then developed by the design team involving the key design constructors and component suppliers with the work managed in clusters. Design solutions were assessed using the through-life cost approach, rather than capital price alone, which was expressed as the net present value and also as a target through-life cost profile over time.

The approach incorporated risk management used in conjunction with value management and whole-life costing principles. Payment was made based on the target cost approach.

The Building Down Barriers project was highly successful in delivering a range of benefits to customers, including:

- enhanced functionality for clients and facility users
- savings in whole-life costs
- delivery ahead of programme
- predictability of cash flow during design and construction
- improved collaborative relationships within the project team.

Additionally, benefits to the supply chain included more efficient working processes, a positive atmosphere of team collaboration and greater confidence in design information. The project was also highly influential in changing the MOD's approach to construction procurement so that it began to place strong emphasis on supply chain integration and single-point responsibility. The work had been taken forward via a series of workshops and training programmes and is a good example of a joined-up approach to generating change in line with the principles of *Rethinking Construction*.

Source: Holti *et al*. (2000)

fully effective all the principles need to be applied as a package when procuring a product or a service. Each of the principles could be adopted in isolation, but in total they provide suppliers with the structure within which to identify optimal solutions and the incentives to deliver continual improvement over long-term periods. The principles are set out below:

- early creation of the delivery team;
- an integrated and incentivized supply chain;
- maintaining a competitive and sustainable supply chain;
- clear points of responsibility with no unnecessary layers of supervision;
- e-procurement;
- selection of suppliers on the basis of best value, i.e. the optimal combination of quality and price;
- fair allocation of risks;
- high-quality design;
- partnership approach based on long-term relationships;
- performance measurement with continual improvement targets.

Source: Highways Agency (HA) website

In November 2007 the UK Parliament Select Committee on Public Accounts reported that the Highways Agency had concluded that traditional forms of contracting and design and build contracts do not offer value for money and that it now relies on Early Contractor Involvement (ECI) contracts, although it sometimes uses the Private Finance Initiative for larger schemes.

The ECI form of procurement requires a collaborative approach using the New Engineering Contract. The contracts are procured using a two-stage process, requiring two separate contracts. In the first stage, a Professional Services Contract (PSC) is used to appoint the suitable contractor, who is selected following a tender based on the quality/price model using the Most Economically Advantageous Tender (MEAT) approach with assessment of a company's track record based on the HA's Capability Assessment Toolkit.

Individual prices for labour, plant, overheads and profit would all be required for the evaluation of the initial part of the tender process. These prices, along with material costs, would also be incorporated into the second stage after the design is completed. The contractor is initially engaged to input into the design process and be involved with planning, assessing buildability and value engineering, identifying the various risks inherent in the contract and cost estimating in order to establish a target price for the second stage, the construction phase.

In the second stage, if the target price is acceptable to the employer then the contractor is appointed to construct the scheme under an NEC target contract. The contractor is incentivized to design and construct the scheme within this target price, based on a pain/gain share formula. Should an acceptable target not be agreed, or sufficient funding not be available, then the employer can, under the terms of the contract, terminate the overall contract.

Steve Rowsell, who as procurement director of the HA introduced ECI, identified the key benefit: 'The biggest saving comes from having the contractor ready to start without having to go through the procurement process after public inquiry. That saves approximately two years' (reported in Bishop, 2007). Sheffield City Council reported that £1.5 million net savings were identified on the Inner Relief Road as a result of implementing the ECI approach. They found benefits of the ECI approach to include: input to design, more time for planning and programming the construction works, better quality and value for money and better risk management (Sheffield City Council website).

David Mosey (2009) also cites an early contractor involvement case study on the £43 million A30 dual carriageway road from Bodmin to India Queens in Cornwall. Contractor Alfred

McAlpine (now Carillion) was appointed to undertake joint design development, including the choice of route to take account of buildability and traffic flow, as well as joint risk management of early archaeological investigations, compulsory-purchase proceedings, ecological strategy and access issues. The contractor worked closely with the Highways Agency in preparing for the necessary public inquiry. Specific benefits of this approach included early agreement of access arrangements with local landowners, early construction of side roads for use as traffic diversions and scheduling construction activities so that the excavated material was used to the maximum extent on site with very little landfill.

However, the National Audit Office's analysis showed that, up to 2007, final target costs for the ECI contracts had been on average 11 per cent higher than initial target costs. Consequently, in 2008 a spokesman for the Highways Agency confirmed that ECI had failed to work on all road schemes and would therefore no longer be the de facto means of major project procurement (Owen, 2008).

Postscript: The 2005 NAO report *Case Studies: Improving Public Services through Better Construction* describes the ECI experience of the University of Cambridge in the building sector. In 1998 on Contract 1 it used a single-stage approach, selecting the contractor based on lowest price and it achieved costs 2 per cent over budget with an 8-week delay. In 2002 on Contract 3 its costs were 3 per cent below budget and there were no delays after it had changed to an ECI approach based on a two-stage NEC contract with a PSC used for the first stage and with the contractor and principal contractor involved in the design.

David Mosey (2009) identifies further potential benefits of ECI in the case of possible disputes. On two projects in Bahrain and Dubai based on the ECI approach he reports that the detailed cost and time data obtained through an open book build-up of price and programme, as well as clear points of interface between consultants and contractors, allowed the parties to step away from an adversarial position and settle their differences without going to court.

11.11 2012 London Olympics

The 2012 London Olympics was one of the biggest challenges facing the UK construction industry for a generation; in terms of scale it was at least twice the size of BAA's Heathrow Terminal 5. The project is located in the Lower Lea Valley in the East of London and required a massive cleanup of 200 hectares of contaminated land, the removal of pylons and the relocation of power lines underground.

In September 2006 the Olympic Development Authority (ODA) appointed CLM – a consortium comprising Laing O'Rourke, Mace and US consultant CH2M HILL – as delivery partner with the primary role of overseeing the rest of the supply chain. Significantly both Laing O'Rourke and Mace were involved in the construction management of the flagship Terminal 5 project.

CLM also provided resource management, technical capability and systems to manage the planning, design, procurement and delivery of the construction for the venues and infrastructure. It also managed the risk and opportunity but the ODA always remained the contracting authority (*Building*, 2006).

After the appointment of CLM the next stage of procurement was the design and build of the main stadium on which a consortium including Sir Robert McAlpine and HOK were appointed as the preferred bidder.

The construction project for the London 2012 Olympic and Paralympic Games was delivered by the ODA on time and on budget. In October 2011 the ODA introduced a learning project website in which it shared knowledge and lessons learned from the construction of the Olympic Park, to help raise the bar within the sector and act as a showcase for UK plc. This is the first time a construction project in the UK has sought to capture the intellectual capital on this scale.

Panel 11.8 2012 London Olympics Construction Commitments

On 3 July 2006 the Strategic Forum for Construction introduced the *2012 Construction Commitments*. The aim of the document, developed by industry with the strong support of Government, was to maximize the opportunity to showcase the very best of British construction practices, using the Olympics as a live example.

The *2012 Construction Commitments* covered six key areas of the construction process and the document was designed to promote collaborative working and best practice, ensuring the successful delivery of the Games infrastructure, buildings and subsequent legacy. The document did not involve any new initiatives but strove to make the most of existing initiatives, tools and talent in the industry.

The Commitments document was developed by the Strategic Forum for Construction's 2012 Task Group in conjunction with the Department of Culture, Media and Sport and the Department of Trade and Industry and covered six areas, including:

- client leadership
- procurement and Integration
- design
- sustainability
- commitment to people
- health and safety.

The Commitment on Procurement and Integration is as follows:

> A successful procurement policy requires ethical sourcing, enables best value to be achieved and encourages the early involvement of the supply chain. An integrated project team works together to achieve the best possible solution in terms of design, buildability, environmental performance and sustainable development

- Procurement decisions will be transparent, made on best value rather than lowest cost, use evaluation criteria and where appropriate, specialist advisors, whilst encouraging the contribution of smaller organisations
- All members of the construction team will be identified and involved at an early stage, particularly during the design process, and encouraged to work collaboratively
- Supply chain partners will be required to demonstrate their competency, their commitment to integrated working, innovation, sustainability and to a culture of trust and transparency
- To ensure effective and equitable cash flow for all those involved, all contracts will incorporate fair payment practices, such as payment periods of 30 days, no unfair withholding of retentions, project bank accounts, where practicable and cost effective, and will include mechanisms to encourage defects free construction
- The duties of each project team member will be identified and shared at the outset of the project and appropriate insurance policies, such as project insurance, put in place
- Risks will be clearly identified, financially quantified and allocated in line with each party's ownership and ability to manage the risk
- All contracts will have an informal and non-confrontational mechanism to manage out disputes
- The employment practices of all organisations, including subcontractors and the self employed, will be scrutinised by the client and the supply chain to avoid abuses

Source: Strategic Forum for Construction website

Paul Morrell, Chief Construction Advisor at HM Government considered that 'The ODA has provided a model for success that is transferable to other UK construction projects.'

Two of the ten themes into which the lessons from the London 2012 projects have been organized on the Learning Legacy website, Procurement and Project and Programme Management are further analysed in micro reports, case studies, champion products and research summaries. The full extent of these two themes should be compulsory reading for all students and professionals concerned with construction cost management.

11.12 Selecting the procurement route

Selecting the most appropriate procurement route is one of the most crucial decisions taken on any construction project. All routes have their advantages and disadvantages. What is needed is an objective appraisal of the alternatives.

The Achieving Excellence in Construction initiative recommends that the following questions are asked about the contract strategy:

- What resources and expertise does the client have?
- What influence/control does the client need to exert over design?
- Who is best able to carry out the design?
- What influence/controls does the client wish to exert over the management of:
  a) planning (project, construction)?
  b) interfaces (project, end users)?
  c) risk?
  d) design?
  e) construction?
- What can the market provide and what framework agreements are already in place?

The *Achieving Excellence Procurement Guide 06 Procurement and Contract Strategies* (OGC, 2003) also includes the following checklist for assessing the procurement route:

- Is this the right procurement route for the project, backed up with a contract in which the roles and responsibilities are clearly defined?
- Are choices about allocating risk and control tailored to the circumstances of the project and reflected in the procurement strategy?
- Has the most appropriate integrated procurement route been chosen – PFI, design and build or prime contracting?

and for assessing the contract:

- Have improvement targets and measurement arrangements been agreed with the integrated project team and quantified?
- Have incentives been included in the contract to encourage the integrated project team to perform well and achieve the client's objective?
- Have the required benefits been quantified before incentive payments will be paid?

11.13 Achieving Excellence in Construction methodology

Table 11.1 shows the methodology recommended by the OGC's *Achieving Excellence in Construction* (2003). The challenge is to select a procurement route which delivers best value for money to the client. The evaluation criteria is selected which is appropriate to the client and

Table 11.1 Illustrative example of procurement route VFM evaluation mechanism

Project title: University of Metropolis student accommodation											
Procurement route		*Traditional*		*Design and construct*		*Design, build and maintain*		*Design, build, maintain and operate*		*Prime contracting*	
Evaluation criteria (Appropriate to the client and project)	*Criteria weight,%*	*Score*	*Weighted score*	*Score*	*Weighted score*	*Score*	*Weighted score*	*Score*	*Weighted score*	*Score*	*Weighted score*
Opportunity for supplier to innovate to yield the most cost effective combination of capital construction, maintenance and operation	15	5	0.75	50	7.50	70	10.5	90	13.5	80	12.0
Least disruption in project flow due to perceptions and procedures to meet public accountability – minimization of disputes	15	5	0.75	50	7.50	70	10.5	90	13.5	70	10.5
Certainty of whole-life costs	10	5	0.5	50	5.0	70	7.0	90	9.0	80	8.0
Flexibility for future changes in client requirements and post-completion change	10	90	9.0	75	7.5	60	6.0	50	5.0	70	7.0
Speed of project delivery to occupation/first use	5	25	1.25	50	2.5	60	3.0	70	3.5	25	1.25
Control over detailed design and design quality (a detailed output specification is still required)	10	95	9.5	70	7.0	60	6.0	50	5.0	90	9.0
Control over whole-life health and safety issues	5	5	0.25	50	2.5	60	3.0	70	3.5	60	3.0
Reduction in disputes and in-house costs through single-point responsibility	5	5	0.25	50	2.5	70	3.5	90	4.5	80	4.0
Control of sustainability issues	25	95	23.75	70	17.5	60	15.0	50	12.5	90	22.5
Requirement to optimize whole-life cost (incl. above)											
Total scores	100		46		59.5		64.5		70		77.25
Order of how well the procurement route fits the evaluation criteria			5		4		3		2		1
Overall order of priority (i.e. combination of total score and best fit)			5		4		3		2		1
Members of evaluation panel	*Panel member 1 . . . . Signature*			*Panel member 2 . . . . Signature*							

Source: Developed based on OGC (2003)

the project; such issues as supplier innovation, whole-life costing and sustainability should be considered.

Each criterion is then given a weighting out of a total of 100. Each procurement route is then assessed in turn by the client's project management team awarding a score against each criterion. The individual scores are then multiplied by the criteria weightings to arrive at the final scores for each procurement route.

11.14 Which form of contract to choose?

In 2008 the OGC commissioned Arup Project Management to undertake a critical review of the three main partnering contracts, namely NEC3, PPC2000 and JCT Constructing Excellence. The Arup Report, entitled *Partnering Contract Review*, concluded:

> Each contract reviewed satisfies OGC's Evaluation Criteria. Each contract reviewed would enable parties, using them correctly, to achieve OGC's Achieving Excellence in Construction standards from which the Evaluation Criteria are derived. This report sets out the analysis of how the Evaluation Criteria are satisfied and exceeded.
>
> No single contract is superior to the other two in all respects – each has its own strengths and weaknesses and each is highly adaptable. The difference in the way that each contract is applied by users will be at least as significant as the differences in the processes or terms and conditions provided within the contract.
>
> Ove Arup & Partners Ltd (2008)

However, it is noted that the PPC2000 seems to come ahead of the other two forms on the detailed scoring.

Under the NEC's Option C – *Target Contract with Activity Schedule* – reimbursement is made based on the defined Schedule of Cost Components (SCC), or Shorter Schedule (SSCC). Items not included in this schedule are deemed to be included within the 'fee'. Compensation events are considered based on actual cost/time. The fee is based on actual costs, as a percentage. The difference between the target cost and the actual cost + fee is shared at the agreed percentage. Under this contract there is a requirement for an audit of the contractor's costs and a mechanism for disallowing costs if the strict procedures and timescales are not adhered to. Chapter 16 in this book includes a comprehensive review of the NEC3 contract, focusing on those issues relevant to the cost manager. See also the NEC website.

The PPC2000 contract is published by the Association of Consultant Architects and drafted by Dr David Mosey at the international law firm Trowers & Hamlins. This contract provides for a price framework. It leaves the parties to devise their own payment mechanism. Flexibility allows a cost reimbursable with target cost to be used. There is a provision for including an agreed maximum price in the Form of Commencement Agreement. The flexibility in this form of contract provides clients with the opportunity to devise their own preferred cost mechanisms. 'Some clients have found this openness to be a problem and have drafted cost management handbooks that closely reflect the NEC's approach' (constructionsite.org website).

For a full review of the Association of Consultant Architects' contract PPC2000, see the PPC2000 website. The document '*10 years of Partnering Contracts PPC/TPC2005*' includes an excellent review of 28 case studies in a wide range of sectors including asset management, education, health and care, housing and regeneration, leisure and hotel, offices and public health, Public Private Partnerships and transport.

JCT CE, formerly the BE form of contract, was originally published by Constructing Excellence. This was adopted by JCT after a review of the partnering forms of contract available and subsequently integrated into the JCT suite of contracts. In the JCT contract, the target cost option includes the actual cost being recorded following agreement between parties. It operates on an open book basis. All details and processes, including the sharing of excesses etc., are outlined in the contract particulars. The supplier's margin is fixed unless stated otherwise. (See JCT Contracts and NBS websites.)

The search for improvement and the desire to secure best value from the supply chain is a never-ending theme in procurement. In May 2011, the UK Government's Cabinet Office report *Government Construction Strategy* recommended that three common features should be included in the procurement method: *early contractor involvement, transparency* and *integration*. The report went on to recommend three procurement methods: Method 1 – Cost-led procurement; Method 2 – Integrated project finance; and Method 3 – Two-stage open book. A group of experts drawn from the legal sector and the RICS have identified the following suitable forms of contract: Method 1 – NEC3 Option C; Method 2 – PPC2000; Method 3 – JCT Constructing Excellence. The report recommended implementing trial projects and reviewing their performance. For further reading, see the NBS website.

11.15 Conclusions

This chapter has reviewed the two main management methods of procurement – management contracting and construction management. The strengths and weaknesses of each have been clearly identified. The success of the construction management approach in the private sector, for example, the Honda car plant at Swindon and the Peter Jones retail store in London, clearly demonstrates that this strategy has a future in the hands of expert clients. By contrast, the Scottish Parliament building and the Stoke-on-Trent Cultural Quarter projects have highlighted the potential problems that might occur if these strategies are used in the public sector.

The chapter has also highlighted the significance of the *Achieving Excellence in Construction Procurement Guides*. The chapter also discusses two public sector employers, the NHS and the Highways Agency, who have embraced these recommendations with considerable success.

The chapter also includes a case study requiring the selection of an appropriate procurement route for a university building using the Achieving Excellence in Construction guidelines. In the example (Table 11.1) the recommended strategy is the prime contracting route as this scores highest based on the client's chosen evaluation criteria.

The chapter concludes by identifying the three chosen conditions of contract now recommended for use in the construction sector.

11.16 Questions

Question 1

The University of Metropolis is keen to replace its whole portfolio of student accommodation. The new requirement is for a mix of modern accommodation for 10,000 students on three campuses built over a 7-year period. The Pro Vice Chancellor is particularly keen that the project demonstrates value for money and embraces the key sustainability issues.

As the client's project manager, recommend a suitable procurement strategy for this project.

In the solution shown in Table 11.1 the *Prime Contracting* option scores 77.25 and is the recommended strategy.

Question 2

A major international car manufacturer wishes to extend its existing car plant with a second, 50,000 square-metre car plant.

The project comprises a combination of heavy civil engineering involving deep excavations, steel sheet piling, bored concrete piling, heavy reinforced concrete foundations, a steel frame with hanging conveyor plant and extensive infrastructure works. The work also comprises a complex array of mechanical, electrical and process services machinery.

The challenge of the project is the coordination of numerous parallel activities on a fast-track programme, whilst achieving the flexibility of finalizing many automotive processes and robotic installations at the latest possible time.

The client wishes to be actively involved in the project and to secure best value.

Recommend an appropriate procurement strategy and identify the key issues required to be considered in order to achieve a successful outcome for the client.

This question is based on the paper 'Insights from beyond construction: collaboration – the Honda experience' by Richard Bayfield and Paul Roberts presented to the Society of Construction Law in Oxford in 2004.

Question 3

Critically review the major differences between the NEC3 Option C, PPC2000 and the JCT Constructing Excellence contracts.

Question 4

Identify the tools and techniques used on the London Olympic 2012 project to ensure completion on time and within budget (see Learning Legacy website).

11.17 References/further reading

Archer, F.H., Project Director John Lok/Wimpey JV (1985), private correspondence with the author (Potts).

Arrowsmith, S. (ed.) *EU Public Procurement Law: An introduction,* University of Nottingham: www.nottingham.ac.uk – accessed 18 May 2012.

Atkinson, J. (2001) 'The BullRing challenge', *Contract Journal*, 31 October, pp.16–17.

Audit Commission (2004) District Auditor's Report, *Cultural Quarter Stoke-on-Trent City Council*, 22 January.

Bayfield, R. and Roberts, P. (2004) 'Insights from beyond construction: collaboration – the Honda experience', paper presented to the Society of Construction Law in Oxford on 15 June: www.scl.org.uk/node/570 – accessed 2 November 2012.

Bennett, J. (1986) *Construction Management and the Chartered Surveyor*, RICS.

Binney, M. (2006) 'A vision of sea, sky and cedar', *The Times*, Monday 13 March.

Bishop, P. (2007) 'Roads: client focus: early contractor involvement', *Contract Journal*, 8 August.

Bourn, J. (2002) *The National Assembly's New Building: Update Report*, prepared for the Auditor General for Wales by the National Audit Office Wales.

Building (2003) '50 top clients a building directory', *Building*, Supplement, February: www.mepc.com/AboutUs/Introduction.aspx – cited 20 March 2007.

Building (2006) 'Delivering 2012', *Building*, Supplement, 17 November.

Carter, C. (2004) 'Don't twist my words', *Building*, 22 October.

Centre for Strategic Studies in Construction (1991) *Construction Management Forum Report and Guidance*, University of Reading.

CIRIA (1983) *Management Contracting*, *CIRIA Report 100*, CIRIA.

Cook A (1999) 'Why Harmon won at Portcullis House,' *Building*, Vol. 44.

Cooper, P. (2000) *Building Relationships, the History of Bovis 1885–2000*, Cassell & Co.

Curtis, B., Ward, S. and Chapman, C. (1991) *Roles, Responsibilities and Risks in Management Contracting, CIRIA Special Publication 81*, Construction Industry Research and Information Association.
Egan, J. (1998) *Rethinking construction: The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction*, London, Department of the Environment Transport and Regions Construction Task Force.
Fraser, Rt Hon Lord of Carmyllie (2004) *The Holyrood Inquiry*, SS Paper No 205, Session 2, Astron, Edinburgh.
Glover, G. (2005) 'Whatever happened to those fearless construction managers?', *Building*, 11 March.
HM Treasury, Central Unit on Purchasing (1992) *Guidance Note No. 36 Contract Strategy Selection for Major Projects* (since withdrawn), HM Treasury.
HM Treasury, Central Unit on Purchasing (1992) *Guidance Note No. 51 Introduction to the EC Procurement Rules*, HM Treasury.
HM Treasury (1997) *Procurement Guidance No. 1 Essential Requirements for Construction Procurement*, H.M. Treasury.
HM Treasury (1997) *Procurement Guidance No. 2 Value for Money in Construction Procurement*, H.M. Treasury.
Holti, R., Nicolini, D. and Smalley, M. (2000) *The Handbook of Supply Chain Management: The essentials Building Down Barriers*, C546, CIRIA.
Maloney, W.F. (2009) 'United States of America', in: Langford, D. and Hughes, W. (eds) *Building a Discipline: The story of construction management*, Association of Researchers in Construction Management.
Minogue, A. (2004) 'Seduced by simplicity', *Building*, 15 October.
Mosey, D. (2009) 'How to be good when times are bad', *Building*, 13 March.
Nahapiet, J. and Nahapiet, H. (1985) *The Management of Construction Projects: Case studies from the USA and UK*, CIOB.
National Audit Office NAO (2002) *Construction of Portcullis House, the New Parliamentary Building*.
National Audit Office (NAO) (2003) *Progress on 15 Major Capital Projects Funded by the Arts Council England* by the Comptroller and Auditor General, HC 622 Session 2002–2003, 2 May.
National Audit Office (NAO) (2005) *Improving Public Services through better Construction,* Report by the Comptroller and Auditor General, HMSO.
NHS ProCure 21 (2012) *NHS ProCure 21*, NHS Estates: www.procure21plus.nhs.uk – accessed 18 November 2012.
Oakes, R. (2006) 'The Public Contracts Regulations bring in new rules for public procurement', *Building*, Housing and Regeneration Supplement, February.
Office of Government Commerce (OGC) (2003) *Achieving Excellence in Construction, Procurement Guide 06 Procurement and Contract Strategies*, OGC.
Ove Arup & Partners Ltd (2008) *Partnering Contract Review*: www.cewales.org.uk/cew/wp-content/uploads/partnering_contract_review.pdf – accessed 13 November 2012.
Owen, E. (2008) 'Highways Agency to drop ECI', *New Civil Engineer*, 9 April.
Pigott, A. (2002) 'To D&B or not to D&B?', *Building*, 18 January.
Pigott, A. (2004) 'He knew he was right', *Building*, 8 October.
Rawlinson, S. (2006a) 'Procurement public sector projects', *Building*, 24 November, pp. 52–56.
Rawlinson, S. (2006b) 'Procurement construction management', *Building*, 1 September pp. 62–67.
Wakefield, S., Oag, D., and Burnside, R. (2004) *The Holyrood Building Project*, SPICe briefing, The Scottish Parliament.

Websites

www.constructionsite.org.uk – accessed 17 May 2012.
www.highways.gov.uk/publications/corporate-documents-procurement-strategy – accessed 29 October 2012.
www.hm-treasury.gov.uk.
www.jctcontracts.com – accessed 17 May 2012.
http://learninglegacy.independent.gov.uk/ – accessed 2 November 2012.
www.neccontract.com – accessed 17 May 2012.
www.ppc2000.co.uk – accessed 17 May 2012.
www.sheffield.gov.uk/roads/works/schemes/completed/irr/project-news.html – cited 2 November 2012.
www.strategicforum.org.uk/2012CC.shtml – accessed 2 November 2012.
www.thenbs.com/topics/contractslaw/articles/jctconstructingexcellence.asp – accessed 17 May 2012.
www.thenbs.com/topics/contractslaw/articles/newprocurementmethods.asp – accessed 16 May 2012.

12 Payment systems and contract administration

12.1 Introduction

The selection of appropriate payment systems within the contract conditions can significantly influence the allocation of risk between the parties as well as the motivation of the contractor. Furthermore, the payment systems can affect the initial selection of contractors as well as dictating the contract administration terms, e.g. interim payments and valuing changes. Ward and Chapman (1994: 217) consider that ‘The nature and size of contract payments is the primary means of motivating the contractor, and the manner in which payment levels are determined can be an important aspect of contractor selection’.

Payment systems can be classified in a variety of ways, and any classification is unlikely to be exhaustive. Contract strategies can be broadly categorized as either price-based or cost-based.

- Price-based – lump sum or remeasurement with prices being submitted by the contractor in their bid.
- Cost-based – cost reimbursable or target cost; the actual costs incurred by the contractor are reimbursed together with a fee to cover overheads and profit.

A key consideration in the choice of payment system is the allocation of the risk to the parties. Figure 12.1 shows the different payment systems, identifying the risks attached thereto.

Under a lump sum fixed-price contract, the client pays a fixed price to the contractor, regardless of the contractor’s actual internal costs. The contractor carries all the risks associated with higher than expected costs, but benefits if the costs turn out to be less than expected. Awarding a contract to the contractor with the lowest competitive fixed-price bid is a common practice and contractors are often under increasing pressure to reduce their prices in order to win work.

> Faced with the difficulty of earning an adequate return, such contractors may seek to recover costs and increase earnings by cutting back on the quality of materials and services supplied in ways, which are not visible to the client, or by determinedly and systematically pursuing claims a practice common in the construction industry.
>
> (Ward and Chapman, 1994: 217)

> More generally, a tentative conclusion is that fixed-price contracts are most efficient for the client when there is low uncertainty or when risks are controllable by the contractor. This

> suggests that fixed-price contracts should be avoided in the early stages of a project when specifications may be incomplete and realistic performance objectives more difficult to set. A more appropriate strategy might be to break the project into a number of stages, and to move from cost-based contracts for early stages (negotiated with contractors that the client trusts), through to fixed-price competitively tendered contracts in later stages as project objectives and specifications become better defined.
>
> (Ward and Chapman, 1994: 217–218)

Ian Duncan Wallace considers that his advice to owners must be 'to require lump sum contracts in any normally pre-planned project, at the very least for the superstructure element (which normally of course is by far the greater part of the contract in money terms' (Wallace, 1986: 379).

Thomas Telford, one of the greatest early civil engineers in Britain, designed and supervised the construction of over 900 miles of new roads and bridges in the remote Scottish Highlands in the early 1800s. Papers deposited in the Institution of Civil Engineer's library indicate that this 20-year-long project was split into sections based on lump sum fixed-price-based contracts with the contractors taking all the risk. The papers indicate that, after encountering considerable unforeseen ground conditions, several of the contractors claimed for additional expenses, explaining that without this they would be forced into bankruptcy with their workforce and families reduced to starvation. Telford allegedly was unmoved and refused to pay any extra.

> As a general principle, it cannot be denied that, as the contracts were voluntary, eventual loss ought to fall on the party to whom the gain, if any, would have accrued; and it is also certain that these losses have in many instances been owing to the negligence and unskillfulness of the contractors; perhaps even (in some few) from a culpable determination to undertake the work at any price for the chance of gain, although they were conscious of their own inability to make good deficiencies, should they arise. But after all these allowances, cases of great distress and hardship have occurred.
>
> (Telford, 1838: 402)

Over the past two decades in the UK the building sector has been moving away from the use of the lump sum approach based on a BofQ towards the lump sum plan and specification approach, in which each tenderer evaluates the work using their own builders' quantities.

Likewise, the civil engineering sector has moved away from admeasurment approach to Priced Activity Schedules linked to the construction programme or the target cost approach as contained within the NEC Engineering and Construction Contract.

The bill of quantities system had been in use for over 100 years and correctly used had many positive features. The BofQ approach demanded that the works were substantially designed prior to tender. However, in practice, the BofQs were often prepared based on incomplete information, a situation that created a false sense of security for the client who carried the risk for any errors or omissions in the original measurement. Furthermore, on these contracts, if the contractor was failing to perform, the main sanction available to the client was the incorporation of liquidated damages where the whole or specified sections, of the work are completed late. This sanction is often too late to have an effective influence on the contractor's performance where delays are occurring, as they frequently do, during mobilization and ground works which occur early in the programme for construction.

12.2 Price-based – lump sum plan and specification

Under the lump sum system contractors are required to estimate the quantities and subsequently calculate the tender sum based on the client's design drawings and specification. The design should therefore be completed prior to tender with little or no changes to the design anticipated after tender. Lump sum contracts should thus provide a client with maximum price certainty before construction commences.

The payment to the contractor can either be on fixed instalments or linked to the progress of the works. A schedule of rates may be used under this system to facilitate valuation of variations. The schedule seldom attempts to be comprehensive and, if the rates are not made part of the tender, can be unreliable.

Seeley (1997: 76) considers that plan and specification contracts are suitable for small works where BofQs are not considered necessary. He highlights the potential danger of using the plan and specification approach. 'On occasions this type of contract has been used on works that were extremely uncertain in extent and in these circumstances this represents an unfair and unsatisfactory contractual arrangement.'

Seeley (1997) further observes that the NJCC have also identified the following difficulties which are likely to arise when using this system:

- effectively comparing and evaluating tenders when each contractor prepares their own analysis;
- accurately evaluating monthly payments;
- accurately valuing variations;
- maintaining proper financial management of the contract.

Despite the potential disadvantages in using this system, it has become the most popular arrangement used in the building sector, accounting for 52 per cent by number of all building

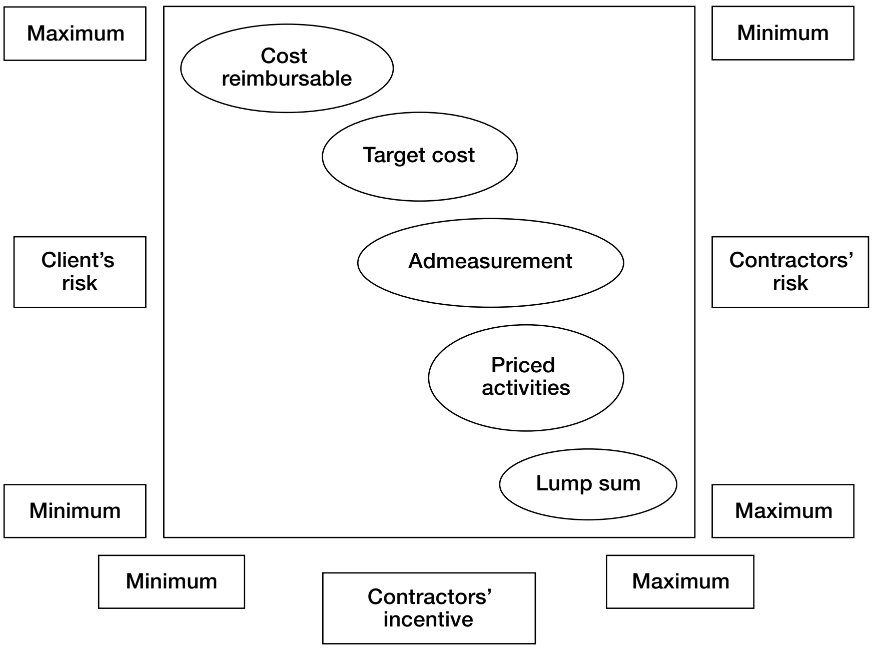


Figure 12.1 Relationship between types of payment systems (Developed based on Ridout, 1982)

contracts according to the RICS *Contracts in Use* survey of building contracts in use during 2010 (Davis Langdon, 2012).

12.3 Price-based – bills of quantities

The traditional procurement system in the UK requires the production of a bill of quantities, which is normally executed by the client's quantity surveyor. These detailed bills of quantities are prepared in accordance with the rules as stated in the appropriate Method of Measurement and reflect the quantities of designed permanent work left by the contractor on completion. 'The bills of quantities is designed primarily as a tendering document, but it also provides a valuable aid to the pricing of variations and computation of valuations for interim certificates' (Seeley, 1997).

When a bill of quantities is used it usually forms one of the contract documents and the client carries the risk of errors. In contrast, where the contractor computes the quantities, the contractor takes the risk of errors in the quantities.

Within the building sector the BofQ was prepared in accordance with the highly detailed rules contained with the *Standard Method of Measurement of Building Works Seventh Edition* (SMM7). This system is classified as a lump sum contract and is not subject to remeasurement: it is only subject to adjustment in the case of variations, claims, fluctuations, prime cost and provisional sums, etc. In 2010, it was estimated that approximately 19 per cent by value of all

Panel 12.1 Payment on St Paul's Cathedral, London

In 1666 the Great Fire of London virtually reduced everything in the old city walls to smoking ruins – including the old St.Paul's Cathedral. Over the next 40 or so years, Sir Christopher Wren was responsible for designing and supervising the construction of 53 churches in London as well as The Royal Observatory at Greenwich, Trinity College Library Cambridge, Chelsea Hospital, Hampton Court Palace and the Greenwich Hospital. However, his crowning achievement was the rebuilding of St Paul's Cathedral, which was completed after 36 years in 1711 at a cost of £1.1 million (equivalent to approximately £1 billion at today's prices).

In a letter of 1681 to the Bishop of Oxford concerning the construction of Tom Tower in that city, Sir Christopher Wren described three methods of contracting:

1. By day – purchase of labour on a daily basis with the building owner purchasing the materials.
2. By trade or by task – purchase from a tradesman for an agreed lump sum payment of a piece of work for which the tradesman provides all the materials, labour and scaffolding.
3. By measure – purchase by the building owner of materials and labour on a piecework basis, i.e. based on the works actually completed, calculated on a predetermined schedule of prices.

On St Paul's, Wren favoured the 'by measure' method, with the work measured twice a year by independent measurers (the forerunners of modern quantity surveyors).

Source: Campbell, 2007

building work is executed using bills of quantities prepared based on the rules contained in the SMM7. New Rules of Measurement (NRM) have now been introduced by the RICS and it is expected that this will provide the framework for all measurement activity in the building sector in the future.

In contrast, in the civil engineering work sector the BofQ is prepared based on one of two methods of measurement – the Method of Measurement for Highway Works (MMHW) for Highway Works and CESMM (now in its fourth edition) for other civil engineering works. Due to the unforeseen nature of ground conditions, the BofQs were based on estimated quantities with the whole work subject to remeasurement based on the finalized drawings or, in the case of rock, agreed site levels.

The administration of major projects based on the admeasurement process is extremely staff-intensive, with teams of quantity surveyors/measurement engineers (representing both parties) typically involved for more than 3 weeks in each month in the remeasurement required for the interim valuations. Indeed, the effort in site measurement and valuation diverts the commercial team from what should be considered the most important tasks – those of valuation of variations, early resolution of claims, final measurement and ascertainment or accurate prediction of the total cost of the contract (Gryner, 1995).

Ian Duncan Wallace (1989) takes an even stronger view against admeasurement contracts when he states:

> On this view, remeasurement of the whole of the work in building or civil engineering contracts has few advantages and very serious disadvantages for employers, while greatly increasing the administrative and professional costs of such contracts, as well as fostering a burgeoning claims industry which serves no useful or economic purpose, with claims proficient contractors and the various practitioners in the industry as the beneficiaries, and public and private owners, together with cost-efficient but not claims-efficient contractors its victims. Any careful public or private cost-benefit-analysis would, it is submitted, come down in favour of lump sum or fixed price contracts in the great majority of cases.

The Scottish Office's Roads Directorate were one of the first major clients in the civil engineering sector to react to the growing adversarial and commercial reality of the remeasurement approach

Table 12.1 Example of bill of quantities prepared using CESMM4

Number	*Item description*	*Unit*	*Quantity*	*Rate*	*Amount*
	IN SITU CONCRETE Provision of concrete				
F142	Designed concrete C20/25, maximum aggregate size 20 mm Placing of concrete Reinforced	M^3	840		
F734	Suspended slab thickness: exceeding 500 mm; voided bridge deck	M^3	462		
F754	Columns and piers cross-sectional area: 0.25–1m^2	M^3	96		
F765	Beams cross-sectional area: exceeding 1 m^2	M^3	38		

when using the ICE 5th *Conditions of Contract*. In the early 1990s the Scottish Directorate introduced an alternative tendering initiative for their roads and bridges projects based on a design/refine and build partnering approach.

Langford *et al*. (2003) investigated the construction costs of 11 motorway projects upgrading the A74/M74 in Scotland. All projects were designed with an identical specification and encountered similar climatic, geographical and geological conditions. They identified an 11 per cent saving on the construction cost per kilometre of roadworks when comparing the costs under the lump sum fixed-price approach based on the alternative tendering initiative with the measure and value approach based upon the traditional *ICE Conditions of Contract* 5th edition. Furthermore, the research showed that lump sum projects were much more likely to be completed within budget, delivered more harmonious working relationships and required less management by the client organization.

Comments on the perceived merits of the bill of quantities system

- *Prompts the client and design team to finalize the design before the bill can be prepared*
  One of the main advantages of the BofQ system is that in theory it should force the design team to identify ambiguities in the contract documentation prior to tender. However, in practice, the BofQ may be prepared from partially completed design information. In effect, the BofQ may conceal an absence of pre-planning and investigation. Indeed, the quantities may be overestimated if the design is incomplete.

  The employer could be exposed to additional risk if there are errors or omissions in the BofQ (e.g. see ICE 7th clause 56(2)). Essentially the employer guarantees accuracy of quantities in the BofQ. If the drawings are not fully defined, then the contract should not be based on a BofQ.

  Research by Odeyinka *et al.* (2009) into the reliability of quantities on four types of building projects in Northern Ireland produced a comparison of the tendered bill of quantities with the final account figures. Their investigation indicated that the budgetary reliability of bills of quantities seemed to vary depending on project types. Housing projects showed a deviation of –3 per cent to +4 per cent, with educational projects varying between –4 per cent and +17 per cent and commercial projects varying between –20 per cent and +20 per cent, whilst refurbishment projects showed a deviation between –11 per cent and +37 per cent. This seemed to suggest that the more complex the project is, the less reliable is the guaranteed cost certainty when using the bill of quantities approach.
- *Avoids the need for all contractors to measure the works themselves before bidding and avoids duplication of effort with resultant increase in contractors' overheads which are eventually passed onto clients*
  BofQs are extremely detailed, particularly under SMM7. However, 80 per cent of the cost is usually contained in 20 per cent of the items (Pareto rule). Despite being detailed, few BofQs deal satisfactorily with mechanical and electrical work, which can equate to 30–50 per cent of the total value of the building. Preparing BofQs also increases the time to prepare the tender documentation.
- *Provides a commonality in tenders, thus providing the opportunity for realistic tender evaluation*
  The BofQ system allows contractors the opportunity to identify those items which are under- or over-measured and then load or lighten the appropriate rates. Additionally, contractors may front-end load the rates in the early work sections (in order to improve cash flow). Indeed, the learned QC Ian Duncan Wallace considered that:

> the premium for survival as an engineering contractor today must rest as much upon skill in exploiting the profit opportunities afforded by the contract documents (generally known as 'loop-hole engineering') as in the efficiency of the control and management of the project itself.
>
> (Wallace, 1986)

The employer may attempt to reduce high rates in the lowest tenderer's bid prior to finalizing the contract, thus breaching the parity of tender guidelines. In practice the lowest bid may in fact be too high a risk for the employer.

- *The unique coding system identified in the method of measurement against each item enables contractors to utilize computers efficiently for estimating bills of quantities*
  Again, this is true in theory but one contractor may be bidding for work with BofQs based on many different methods of measurement e.g. SMM7, NRM, CESMM4, MMHW and international methods, etc. Furthermore, the same BofQ description may be required to be priced differently due to different cost considerations, e.g. due to different temporary works.
- *Can be used as a basis for monthly interim valuations*
  In practice interim valuations may become too detailed and thus require a vast number of man-hours to produce (particularly on remeasurement contracts). Interim valuations can be based on a typical 'S' curve prescribed by the client in the contract documentation – as with GC/Works/1 which was based on the analysis of over 500 projects by the Property Services Agency (PSA). However, Klein (1995) noted that the GC/Works/1 system tends to get into difficulties when applied to subcontracts, where the throughput of work and materials can vary from trade to trade.
- *Rates contained in the bills can be used as a basis for the valuation of variations*
  Indeed, many standard forms, e.g. JCT 2011 and ICE 7th positively require this. However, before even the simplest pro-rata rate is calculated, the employer's quantity surveyor needs to have a detailed breakdown of the contractor's unit rates, which is not normally available in the UK. It is understood that contractors are required to submit a complete analysis of their tender rates, including all preliminary or general items, under the German VOB and the Singapore SIA private sector contract (Wallace, 1986: 379).

  In practice there are many occasions when the BofQ rates are not appropriate for valuing variations. Variations can involve: delays, interruptions, loss of productivity, out of sequence working, uneconomic use of labour and plant, additional supervision, etc.

  The employer's quantity surveyor looks to impose BofQ rates, while the contractor's quantity surveyor looks for full recovery based on cost – implying a significant chance of dispute. The best approach is for parties to agree the value of variations before the work is executed – including the costs of delay and disruption (this method is now becoming the standard approach following its introduction into the NEC3 ECC contract and the JCT 2011 contracts).
- *Can assist the parties in the control and financial management of the works*
  Pre-contract estimating: on building works the client's quantity surveyor uses data from previous projects to establish the budget price. However the Building Cost Information Service (BCIS) format requires the BofQ to be in elements. This approach is not favoured by contractors as they require sections in trade format for subcontractors' enquiries.

  Post-contract contract control: BofQ describes the permanent works or materials left on completion; these do not reflect the contractor's significant items of cost, e.g. labour gangs and construction equipment retained on site for continuous periods (tower cranes, scaffolding). Contractors often have a monthly cost-monitoring system (costs compared to

> value) – often too late to do anything about identified variances. The BofQ system may in fact divert contractors from developing effective cost control systems.

There has been much research work on the post-tender use of BofQs. Skinner (1981) considered that, although the existing bills of quantities make a substantial contribution to post-tender work, they are not ideally suited, either in format or content to the needs of tendering or production. He considered that the principal reason for the inadequacy of the BofQ, both as a tender document and as an information source to contracting, lies in the fact that the requirements of production are not considered. Critically, contractors must consider both the time and methods reflecting their use of heavy plant and mechanical equipment. However, Skinner (1981) found that the most widespread criticism concerned the use of prime cost sums to cover nominated subcontractors – the contractor having no involvement in their selection, although contractually responsible for them.

Indeed BofQs might lull clients into a false sense of security and provide contractors with an opportunity for increasing profits. However, the BofQ has been used satisfactorily on many major projects and is still used as the basis for calculating the bids by design and build contractors.

Ian Duncan Wallace in his advice to owners considers that they should 'avoid incorporating any Standard Method (of Measurement), and instead use a relatively few large *composite* items for the purpose of simple remeasurement'. He further comments 'naturally a much more detailed breakdown, which will take account of the successful contractor's detailed make-up, may be needed for any Schedule of Rates function for the separate purpose of valuing variations or changes' (Wallace, 1986: 380).

Significant research by Hamish Lal (2002) casts serious doubts on the effectiveness of BofQs. He considers that there are too many low-value items and argues the importance of focusing on the significant items. He further identifies the inappropriateness of the BofQ for contractors' site planning and evaluation of disruption claims. Lal cites earlier research by Martin Barnes (1971) in which Barnes stated 'The conventional BofQ appears to be imposing an unrealistic model of the factors influencing construction costs upon financial control due to its adherence to the quantity-proportional hypothesis'. Barnes went on to report that the estimator man-hours in manipulation and assignment procedures could be significant, and stated 'This conversion process would have been unnecessary if the bill items had themselves been operationally grouped' (Lal, 2002: 32).

12.4 Standard schedule of prices

World War II created huge challenges for the UK construction industry, during a period of severe shortages of skilled labour, materials and construction equipment, with a vast range of major projects needing to be undertaken, including ports, factories, airfields, barracks and military defences and the floating Mulberry Harbour – a little-known project but one of the industry's greatest achievements of the twentieth century (Potts, 2009). During 1939–1945 the use of bills of quantities was largely abandoned by the UK government departments and they were replaced by various types of contracts based on prime cost and schedule of rates.

> Initially bills of quantities were replaced by prime-cost contracting but in 1941 Government policy shifted towards lump sum awards. However, in practice there was usually no time for the tendering process, and the authorities appointed the contractor on the basis of an agreed schedule of rates. The final lump sum did not generally emerge until completion of the project.
>
> (Cooper, 2000: 73)

The letting of fixed-price contracts was made easier by the use of the Ministry of Works' Standard Schedule of Prices, a list containing prices of work in each of the customary trades. Kohan (1952: 146) confirms that 'A small committee worked out the actual cost of work based on an efficient contractor applying the system of payment by results and including all profit and overheads etc.' Such prices were fixed with reference to stated rates of pay for tradesmen, labourers and navvies, and to basic prices of principal materials. Using these constants, with various allowances, rates were built up to ensure uniform overhead charges and profit in each trade. The schedule was then used for the pricing of bills of quantities to be issued to contractors as a basis for tenders quoting on or off percentages. It could also be used where no bill of quantities was prepared, but where a bill of preliminaries or some similar arrangement was made to cover charges.

> Several departments used schedules of this sort freely during the war in order to enable them to place work promptly before particulars had been worked out and, therefore, before a bill of quantities in its proper sense could be prepared.
>
> (Kohan, 1952: 469)

In these ways the schedule obviated the use of cost plus form of contract for specified categories of work and simplified the preparation of bills of quantities. The schedule became universally used and was an effective check on prices.

> A contract could be let without plans simply by a contractor quoting plus or minus against the Schedule of Prices. Its use was a powerful force in extending payment by results, because the prices could not be achieved without payment by results.
>
> (Kohan, 1952: 146)

In modern times, Chanter and Swallow (2007: 227) identify that the former Property Services Agency (PSA) of the DoE made great use of a standard pre-priced schedule with the work measured at completion, or interim stages, by using the relevant rates. It is noted that a version of this procurement arrangement is still in use today by Wolverhampton City Council for minor repairs to social housing.

Chanter and Swallow (2007: 228) concur that schedule contracts do fulfil a useful role for many types of maintenance contracts. However, they identify a number of reasons why the process of allowing contractors to state their offer in terms of a percentage on or off schedule rates is in fact a flawed concept that is unlikely to allow recovery in line with those normally charged by the contractor.

> In order to arrive at a realistic estimate, a contractor should estimate the likely proportions of schedule items in the job at hand, and then determine a percentage adjustment that will equate the cost based on the schedule of rates to the cost he would obtain through his normal rates.
>
> (Chanter and Swallow, 2007: 228)

It is interesting to note that payments based on standard schedules of prices have been widely used throughout the communist world, e.g. in Eastern Europe and The People's Republic of China.

12.5 Operational bills

In the 1960s the Building Research Station (BRS) (later known as the Building Research Establishment) identified that the traditional BofQ essentially described the completed works i.e.

labour and materials. Bills of quantities did not consider some of the main elements of the contractor's costs, e.g. construction plant and temporary works, and interim payments made based on work completed were thus arbitrary.

The Building Research Station thus introduced an alternative form, called operational bills, which is much more closely related to the process of construction and would thus provide effective communication between design and production (BRS, 1968).

The development started from the consideration that, if the process cost, the part of the tender on which the builder's offer is usually won or lost, is to be realistically priced, labour, plant and overhead costs must be estimated on a time basis by reference to an online construction programme (Skoyles, 1968). In this format the BofQ was subdivided into two main sections:

1 site operations described in the form of schedules of materials, labour and plant requirements; and
2 work prefabricated adjacent to site or offsite.

Although a precedence diagram was provided, it was not an instruction on how the work should be carried out (BRS, 1968). The contractor remained free to adopt any method of construction in relation to his resources (Skoyles and Lear, 1968). It was also noted that the precedence diagram giving the operations could be quickly converted into critical path analysis by the successful contractor (BRS, 1968).

Operational estimating required the architect to produce operational drawings, prejudging the contractor's methods and order of working. The operational bills were both bulky and costly to produce and radically changed the estimating process, resulting in increased work for the contractors' estimators.

Shortly afterwards a half-way house version of the operational bill was introduced by the BRS, initially called *Activity Bills* (Skoyles, 1968) but later renamed *Bills of Quantities (Operational Format).* This approach followed the philosophy of the operational bills except that the operations were detailed in the bill in accordance with the rules of the Standard Method of Measurement rather than labour and materials (Skoyles, 1968).

These were essentially experiments aimed at searching for ways in which the bill of quantities could become more useful as a key financial document of control. By linking the analysed price to the construction programme these innovative bills highlighted the need to link the two key documents. In practice this approach might have created more problems than it solved, particularly in relation to the client's responsibility for the accuracy of the operational bill and network programme!

On reflection this approach was way ahead of its time. However, the idea does seem remarkably similar to the concept of priced activity schedules under the NEC Engineering and Construction Contract introduced nearly 30 years later, the key difference being that the contractor prepares this information – not the client's quantity surveyor.

12.6 Price-based – method-related bills

Method-related bills were first recommended by Barnes and Thompson (1971) in their research, *Civil Engineering Bills of Quantities*. The authors identified that shortcomings of the traditional BofQ stem primarily from its failure to represent the effect of the methods of working and timing upon costs and the subsequent difficulty in financial control.

When using the Civil Engineering Standard Method of Measurement (now CESMM4) the BofQ included a method-related charges section – in practice several blank pages. This allowed the tenderers the opportunity to insert those major items of construction equipment/temporary works/supervision/accommodation, etc., which were not directly quantity related. Method-related charges were identified as either *time-related charges* (e.g. operate tower crane during the project) or *fixed charges* (e.g. bring tower crane to site and set up).

It is claimed, that when the method-related charges approach is used correctly, payment is more realistic and there are fewer disputes regarding changes. However, in practice many contractors chose not to reveal their method-related charges in their tenders, thus cancelling out any advantages of this approach with a preference to continuing the commercial games.

12.7 Price-based – BofQ with milestone payments

In 1994 the Latham report recommended that all contracts have an 'express provision for assessing interim payments by methods other than monthly valuation i.e. milestones, activity schedules or payment schedules'.

The Hong Kong Mass Transit Railway Corporation (HKMTRC) had long recognized the advantages of linking payments to the achievement of milestones. Under their approach on the HK Island Line (1979–1984) the BofQ was split into major cost centres (between four and six per project) including one covering the mobilization/preliminaries items.

Each contractor was required to submit an *interim payment schedule* (IPS) with his bid detailing the percentage of each cost centre value they wished to receive during each month of the project. Subject to satisfactory progress, measured by achievement of milestones predetermined by the client, payments were made in accordance with the schedule.

Milestones are clearly defined objectives usually on the critical path for each cost centre and are usually set at every 3 months for each cost centre. The milestone schedule was included in the Particular Specification for the project. In the event that a milestone was not achieved, payment was suspended on that cost centre until achievement of the milestone was achieved; there were therefore compelling financial reasons for adherence to the programme.

The HKMTRC's bespoke contract on this project followed the general principles contained within the *FIDIC Conditions of Contract for Works of Civil Engineering Construction* (fourth edition – 1987). The modified Conditions allowed changes to be made to the cost centre values during the course of the works for interim payment certification purposes to take account of:

- remeasurement of the works;
- valuation of variations;
- claim for higher rate or prices than original rate;
- deduction or reintroduction of the value of goods and materials vested in the employer;
- works instructed against prime cost Items and provisional sums.

Table 12.2 Extract from a typical completed interim payment schedule (months 1–5 in a 36-month contract)

Month	*Cost Centre A*	*Cost Centre B*	*Cost Centre C*	*Cost Centre D*
1	1.00	1.00	2.00	0.00
2	2.00	3.00	5.00	0.00
3	3.50	5.00	10.00	0.00
4	5.00	9.00	15.00	1.00
5	7.00	12.50	20.00	2.00

Source: Potts, 1995

Russell (1994) reports that on the Hong Kong Airport Railway project the conditions of contract allowed the engineer to make a review of the milestone schedule or IPS if:

- Approval of a revision to the programme involved a significant change to the sequence and timing of the works.
- Award of an extension of time or notification of an earlier date for achievement of a completion obligation or milestone was made.
- The engineer instructs delay recovery measures in accordance with the provisions of the contract.
- The works or part of the works are suspended.
- There is significant change to the value of the cost centre.

By using this system the HKMTRC gained the following benefits:

- the ability to compare the true amount of tenders by using the discounted cash flow method by evaluating tenders on a net present value basis – in effect penalizing contractors who had front-end loaded their tenders;
- identification of the project cash flow liability;
- ability of senior management to monitor progress simply by monitoring the anticipated and actual cash flows;
- obtaining contracts which positively motivated contractors to meet key milestone dates and complete the work on time – thus providing a link between performance and payment and rewarding the efficient contractor;
- reduction in quantity surveyor staff needed to prepare monthly valuations;
- greater likelihood of completion within time and cost, thus obtaining best value for money.

Under this type of contract the construction programme is of paramount importance, specifying the level of detail required and the frequency of submissions and reports. The contract also requires the engineer's approval, rather than merely consent, to each programme. Gryner (1995) further identified the increasing trend of employer specifying the type of software to be used (Primavera P3 on the HKMTR) and the programme logic from which the cost centres and milestones are derived. Any contractor tendering on the basis of different logic could provide alternative milestones and dates for their achievement, but these should be agreed before the award of the contract.

Potts and Toomey (1994) identified that the HKMTR IPS system worked better on *linear* projects and had limitations on complex building work. They also identified that the success, or otherwise, of alternative payment systems can be directly attributable to the reasonableness and promptness of the client and the client's contract administrator in operating the scheme.

David Sharpe, the former Chief Civil Engineer of the HKMTRC considered that 'This payment system and its link with the Milestone Dates provided everyone (and particularly the construction management) with a clear and unequivocal measure for progress, and assisted management efforts towards the aim of completion on time' (Sharpe, 1987).

It is noted that this same IPS payment system was used on the £3.5 billion London Underground Jubilee Line Extension (JLE) which was completed in 1999. Mitchell (2003) identifies that the milestone system worked well for the early stages of the contracts, but the milestones became somewhat *toothless* as the contractors submitted working programmes substantially different from their tender programmes.

Bob Mitchell further identifies that there were so many changes to programmes caused by delay and disruption, coupled with the award of extensions of time and acceleration measures, that the milestones had to be revised anyway. Despite this, payments still had to be made to contractors regardless of their progress against the milestones and many have commented that the JLE system fell into disrepute.

In the building sector the closest to the milestone approach has been the provisions within the JCT98 With Contractor's Design, which provides for payments to be made at the completion of certain stages of the work. However, Klein (1995) identified two possible difficulties in stage payments: scope for dispute over whether the work has been completed; and risk that completion of each stage may be delayed by others, which could mean no payment at all, particularly for specialist contractors.

12.8 Price-based – activity schedules

Historic use

The use of activity schedules for payment purposes is not a new concept. The author (Potts) recollects that the HKMTRC used this approach on Stage 1 (Modified Initial System, 1975–1980). These major contracts comprising the Nathan Road underground metro stations and tunnels were let on a design and build basis. Contractors were required to submit a lump sum tender broken down into major activities listed in the tender documentation.

Interim payments were made against completed activities or pro-rata thereto based on a percentage approach calculated based on a simplistic measurement; a brief schedule of rates was also submitted by the contractors with their tenders which were to be used for the valuing of any variations. For interim payments the scheme worked well but was found lacking when valuing variations, particularly for items not on the schedule.

The NEC3

The Engineering and Construction Contract (NEC3) requires the client to choose one of six main options. Option A: priced contract with activity schedules is the preferred approach when the client can provide the contractor with a complete description of what is required at the outset, so that the contractor can price it with a reasonable degree of certainty. This does not necessarily mean a complete design, but could be a full and unambiguous statement of what is wanted, e.g. as performance specification or scope design and a statement of the purpose of the asset.

Broome (1999) states that bills of quantities are the normal payment mechanism for work procured under the traditional/sequential procurement method, where the works are substantially designed by or on behalf of the employer before being put out to tender by the contractors. However, bills of quantities have some fundamental flaws, the biggest being that construction costs are rarely directly proportional to quantity. The effect of this flaw may be minimal if changes in the scope of the works are few, as the difference between the contractor's costs and income will remain small.

Use of method-related charges, separating fixed- and time-related charges from quantity-related costs, increase the change in scope that can be accommodated. However friction often results when significant changes in scope or methods occur, as the contractor struggles to justify any additional entitlement and to show where his extra costs come from. The situation is not helped by the lack of programming provision in traditional conditions of contract.

Activity schedules are an attempt to move away from the problems associated with bills of quantities. In concept an activity schedule is similar to a series of bars on a bar chart (Gantt chart). The difference is that each bar/activity has a price attached it and the contractor is paid for each completed activity at the assessment date following its completion. The activity schedule is therefore closely linked to the programme and, as the contractor prepares the construction programme, the contractor would normally prepare the activity schedule. He would then also know his expected cash flow**.** Lal (2002: 50) concurs with this approach, stating *inter alia* that:

> resource/labour productivity is at the centre of estimating, the planning process, site control and the evaluation of delays and disruption. The proposition is that resource productivity should be used to develop a new approach to modeling cost and time. In short, a cost model composed of work packages related to site operations, linked to a time model composed of the identical work packages, would form a tangible link between cost and time.

The value of the critical path method, especially when it is developed into a full network analysis, has long been recognized on major projects as an increasingly important tool in the control of the project. Dr Eric Cole's prediction in the *Civil Engineering Surveyor* in 1991 that network analysis could replace the traditional BofQ is moving a step closer (Cole, 1991).

Broome's research found that the theoretical advantages, which the use of activity schedules should give, appeared to materialize in practice. Broome listed the advantages and possible disadvantages of activity schedules:

General advantages:

- Under performance-based contracts any significant level of contractor design is more easily accommodated, as design itself can become an activity.
- In order to receive payment as planned, the contractor has to complete an activity by the assessment date. Consequently he has to programme realistically and is motivated to keep to that programme during construction. Throughout the contract the activity should mesh with the time, method and resource document (the NEC accepted programme).
- Assessment of the amounts due to a contractor with an activity schedule is easier and involves many less man-hours than with a bill of quantities.

Table 12.3 Activity schedule for earth fill dam for new reservoir (part only)

Ref.	*Activity*	*Price (£)*
A001	Mobilize excavation plant	7,500
A002	Set up site offices	25,000
A003	Site clearance	10,000
A004	Drainage to dam	45,000
A005	Divert steam	2,000
A006	Excavate abutment and inlet	20,000
A007	Excavate culvert	15,000
A008	Excavate discharge channel	5,000
A009	Excavate stilling basin	15,000
A010	Excavate spillway	20,000
A011	Excavate cascade channel	30,000
A012	Place fill to dam (core)	50,000
A013	Place fill to dam (clay fill – phase 1)	60,000
A014	Place fill to dam (clay fill – phase 2)	60,000
A015	Place fill to dam (clay fill – phase 3)	60,000
A016	Place loam and dress	30,000
A017	Construct road on top of dam	30,000
A018	Reinstate quarry	2,000

- As payment is linked to completion of an activity or group of activities, the cash flow requirements for both parties are more visible.
- Contractors are not paid for changes in the quantity of permanent work, unless an instruction changing the original specification is issued, thus transferring the risk to the contractor.
- The assessment of the effect of a compensation event is easier with activity schedules than with bills of quantities.

Potential disadvantages:

- Contractors have to plan the job before they prepare their activity schedule. Because they start from a blank sheet, rather than being given a detailed bill of quantities, contractors are forced to prepare a more thorough tender; this, however, is time-consuming, increasing the man-hours needed to prepare a tender and is ultimately charged to the employer. Employers may thus wish to put potential work out to fewer tenderers.
- While the assessment is easier and fairer, because any change in resources or methods associated with an activity can be compared with those in the accepted programme before the compensation event occurred, it is a more rigorous process than using bill rates and therefore takes longer. For this reason, both parties may be happy to use the bill rate for the assessment of a simple compensation event. However, this approach ignores the delay and disruption costs associated with any change, which research has shown cost on average approximately twice the direct costs.

Broome found that because of the practical advantages there had been a definite shift particularly by experienced users of the NEC Contract away from Option B: (bill of quantities) to Option A: (activity schedule). However, where a contractor's costs are much more quantity related (e.g. in some building work) and/or variations in quantity are expected (e.g. in refurbishment projects), a method-related BofQ approach should be more appropriate.

Klein (1995) agreed that the activity schedule found within the NEC provided a better approach for fair payment. He considered that the NEC schedules include items of work in smaller packages than the amounts normally comprised within milestone payments, so there should be fewer arguments over whether the activity has been completed.

12.9 Cost-based – cost reimbursable contracts

Cost reimbursable contracts, particularly when incentives are incorporated, have many advantages both for client and contractor. These include flexibility to change, fair apportionment of risk, potential saving in time and cost of tendering, open book accounting and a reduction in resources expended on claims (Perry and Thompson, 1982). Under cost reimbursement contracts the contractor is paid a fee for overheads and profit based on the actual cost of construction. These types of contracts can provide a valid alternative to the traditional approach in certain circumstances:

- where the risk analysis has shown that the risks are unconventional in nature or in magnitude;
- where the client is unable to define clearly the works at tender stage, substantial variations are anticipated, or there is an emphasis on early completion;
- where an increased involvement of the client and/or contractor is required or desirable;

- where there exists exceptional complexity, e.g. in multi-contract projects or where a high degree of technical innovation is demanded;
- emergency situations *where time is of the essence*;
- where new technologies or techniques are involved;
- where there is already an excellent relationship between client and contractor, e.g. where there is trust.

Generally cost reimbursement contracts eliminate a large number of risks in the project for the contractor and place them with the client. It is recognized that the client gains greater flexibility in a cost reimbursement contract and the contractor can be confident of an equitable payment for changed and unforeseen events.

Cost reimbursement contracts allow contractors early involvement at the design stage and allow client participation in the contract management. This approach identifies with the philosophy that it is cheaper in the long run for the employer to pay for what does happen rather than for what the contractor thought might happen in those areas of doubt, which the contractor cannot influence.

The disadvantage of prime cost contracting from an employer's point of view is usually stated to be loss of competitive edge of tendering and the lack of certainty and control of cost. Bishop (1989) identifies that these disadvantages can substantially be overcome by:

- target cost/ceiling cost clauses;
- ensuring that subcontractors are chosen competitively;
- ensuring that the contractor has an interest in economy, e.g. by making his fee dependent on an estimate rather than actual cost;
- selecting a contractor with a reputation in prime cost contracting; and
- ensuring that the prime cost is accurately defined and regularly monitored by the employer's quantity surveyor and that the likely final cost is reported regularly by contractor and quantity surveyor independently.

The Simon Committee Report (1944) contains a 10-page in-depth review of cost reimbursement contracts for the building sector. The committee investigated the different methods of fixing the contractor's fee, the relationship of the parties, the supervision and control required, the proper charges for construction equipment, subcontracting and subletting and the definition of cost and responsibilities of the contractor. Three different methods of cost reimbursement contracts were identified:

1 Cost, plus percentage on cost
  'A most unsatisfactory form of contract. Its essential weakness is the fact that the more profligate the contractor is in the employment of labour and purchase of material, the more profit will be earned by him.'
2 Cost, plus fixed fee
  'We consider that the fixing of a fee to be paid to the contractor on the basis of an estimate, however broad that estimate may be, is infinitely preferable to the payment of a fee based on the cost of the work.'
3 Cost, plus fluctuating fee based on estimate of cost (now called target cost)
  'We have no hesitation in saying that a contract in which the normal fee is based on an estimate of cost but fluctuated in inverse ratio according to whether the cost exceeds or is less than that estimate, is the best type of cost reimbursement known to us.'

12.10 Cost-based – target cost contracts

Today there are three main standard forms of contract for target cost contracts:

1. NEC3: Option C – Target contract with activity schedule, or Option D – Target contract with bill of quantities (for construction or engineering work);
2. IChemE 'Burgundy Book' (for process plant work); and
3. ICC Target Cost Version First Edition February 2011 (for civil engineering work).

In addition, the JCT Constructing Excellence Contract may also be used as a target cost contract. The introductory notes within the IChemE *Burgundy Book* (2003) offers further useful guidance on target cost contracts:

> In many respects the Target Cost approach is seen as perhaps providing the best of both worlds, where most of the advantages of cost reimbursable contracts are available along with some degree of tension borne of the target element. Experience of many purchasers shows that a well-structured Target Cost contract is much more likely to be a vehicle for significant savings in overall costs, despite increased resource necessary to manage the day-to-day cost monitoring, than are possible under a lump sum remeasure contract.

David Trench's book *On Target: A design and manage target cost procurement system* published in 1991 was a pioneering work way ahead of its time. Trench considers the book a manual which describes a new system of target cost building procurement whereby:

> a more equitable balance is set between employer's risk and contractor's risk than by other common procurement systems; the quality of design is improved because trade contractors can contribute to the design philosophy and detailing early in the project and perhaps before the main contractor is appointed, and the contractor appointed to manage the final design and work of the sub-contractors has an incentive to complete the project to an agreed target cost.
>
> (Trench, 1991: 1)

Trench (1991: 6) agrees that a reduction of cost is a common objective if the cost remains in the incentive region. Trench also confirms that under target cost contracts there is a considerable opportunity for an early start on site and contractors are encouraged to contribute ideas for reducing the actual cost. However, he considers that, as the tender cost is usually increased by variations, the cost at tender is uncertain, but effective joint management can reduce final payment to below target cost.

The IChemE introductory notes also identify that the target cost approach has the advantage of flexibility while retaining the incentive to the contractor to contain costs, which manifests itself in two areas:

1. The contract can be structured so that the target cost is not agreed until part way through the contract period, i.e. at a time when the parties have agreed the detailed scope of the work, the technical specification and all other key items prior to the commencement of construction.
2. Any variations that are later required can be costed and agreed with more ease than on a lump sum contract, because of the openness between the parties.

Nevertheless, if there is an urgent need to make an early start on the works, that can be accommodated and the cost of such advance work agreed prior to the overall agreement of the target cost. Alternatively, if the detailed scope has been decided prior to contract formation, the target cost can be tendered in the first instance.

Incentives

Traditionally very few construction contracts within the UK have included positive incentives for performance; most rely on damages for non-performance, e.g. liquidated damages, maintenance periods, retentions, bonds and warranties. Other clients may require contractors to provide a *parent company guarantee*, though this might not be as effective as a guarantee bond from a bank or other financial institution. In the building sector *collateral warranties* are often required, which enable the client to claim damages directly from the supplier in the event of their defects. By contrast, in the USA, it is not unusual to find construction contracts with some form of positive incentive.

The first incentive contracts in the UK were the so called *lane rental contracts* for motorway reconstruction. Under these contracts, a contractor is offered a bonus to complete works early, but is charged for each day it overruns the contract period. Under this arrangement contractors have consistently demonstrated that they are able to improve on the Ministry of Transport minimum performance standards.

Target contracts require a different approach when compared to traditional contracts. Target contracts demand that the promoter, contractor and project manager are all involved in the management and joint planning of the contract. The promoter furthermore is involved directly in the costing and influencing decisions made on risk.

Panel 12.2 Case study: East River tunnels, New York (1904)

The concept of target cost is not new. In 1904 The Pennsylvania, New York and Long Island Railroad Company wished to link up its Long Island system with Manhattan Island and its main terminal on 7th Avenue.

This major tunnelling project required four tunnels each 23 feet in diameter to be constructed under the East River. The job was anticipated to be difficult and dangerous – a real high-risk project. The client came to a private agreement with Yorkshire contractor Weetman Pearson without putting out to public tender; indeed, no other contractors were interested. The agreement specified a payment of 18 million gold dollars (£3.5 million) with a project duration of 5 years, controversially on a cost-plus-percentage basis with a target cost. Pearson agreed to pay half of any excess cost up to US$ 2 million and to take half of any savings as a bonus. He was thus backing his judgment up to $1 million or £200,000.

Pearson decided to work from each side to the middle. Eight tunnelling shields were thus required, for the ground conditions varied from quicksand, requiring compressed air working, to hard rock, requiring drilling and blasting. Despite tremendous difficulties including fires in the tunnels the last of the tunnels were joined up 3.5 years from the sinking of the first shaft. Pearson was greatly relieved; the use of his eight shields had earned him a time bonus and established his name in the USA.

Source: Young, 1966; Middlemas, 1963

Thus a target cost contract, when combined with a partnering/alliance approach, enables the supply chain to be fully involved in the design and planning stages. Target contracts can operate well under partnering contracts. However, the key to success with this open book accounting approach is twofold. First there should be a clear definition of acceptable and unacceptable costs included in the contract. Second, there should be robust procedures in place within the contractor's processes and systems which can provide sufficient confidence to the client's audit team (Curran, 2010).

Target contracts have two main characteristics: they are cost reimbursable contracts, and positive incentives are employed. A target contract is thus a means of sharing the risk between the employer and contractor, with the latter being encouraged to maximize his performance. Similarly, overexpenditure is usually apportioned so that the contractor suffers most by receiving a reduction in the fee covering head office costs and profit.

The concept of bringing all the parties together early and managing the costs during the design development was embraced by the Ministry of Defence in their two pilot prime contracting projects at Aldershot and Wattisham known as the *Building Down Barriers* initiative.

The contractor's progress can be monitored against three targets: performance, time and cost, although combinations of different categories can be applied.

Performance targets

Performance targets have been used in the process plant industry, particularly where the contractor is responsible for design. The contractor either earns a bonus or incurs a penalty that adds or subtracts from his earned fee, or earns an *award* fee, which is added to a minimum or base fee.

The performance is measured against the parameter, which has the most significant influence on construction cost and programme, e.g. quality, safety, technical management and utilization of resources. However, as the payment is invariably based on the client's subjective judgment of a contractor's performance, incentive adjustments made by the client are likely to be disputed by the contractor.

Table 12.4 Traditional construction costing and target costing compared

Traditional construction costing	*Target costing*
Costs determine price	Price determines costs
Performance, quality and profit (and more rarely waste and inefficiency) are the focus of cost reduction	Design is the key to cost reduction, with costs managed out before they are incurred
Cost reduction is not customer driven, nor project/design team driven. It is driven by separate, 'commercial' people	Customer input guides identification of cost reduction areas
Quantity surveyors advise on cost reduction	Cross-functional teams manage costs
Suppliers involved late in design process	Early involvement of suppliers
No focus on through-life cost	Minimizes cost of ownership for client and producer
Supply chain only required to cut costs – regardless of how it is done	Involves supply chain in cost planning

Source: Holti *et al*. (2000)

Time targets

Time targets operate in much the same way as for motorway reconstruction work; a bonus or penalty is awarded, depending on whether the contractor is ahead of, or behind, the construction programme. The bonus is generally a monetary amount per day and the penalty an amount per day or loss of fee on work done past the completion date.

Cost targets

A typical cost incentive system involves the sharing of target project cost overrun and underrun. Usually cost targets are set for the combined construction costs with an agreed separate fee for overheads and profit. Other cost incentives that have been used more commonly in the process plant industry involve the sharing of target man-hour cost overrun and underrun or involve a bonus/penalty system based on the average man-hour cost.

The target price comprises four elements: the unit costs, the risk, the overheads/management fee and the profit. Depending on the amount of information available, the target cost for a building project could be established using cost per unit (e.g. car park) or cost per square metre of floor area, or could be built up on an elemental basis or based on detailed quantities.

Perry and Barnes (2000: 202) identify three significant components of payment in target cost contracts.

Panel 12.3 Case study: Crossrail payment system

Crossrail is the biggest engineering project in Europe. When it opens for use in 2018, Crossrail will connect 37 stations, including Heathrow airport and Maidenhead in the west with Canary Wharf, Abbey Wood and Shenfield in the east. It is expected to be delivered fully within a funding envelope of £18.4 billion. Enabling works commenced in December 2008 and it is expected that the main civil works will be completed in 2017. Design and construction are taking place concurrently.

Fair payment principles underlie the payment system implemented on Crossrail projects. CRL has adopted a cost-based approach under NEC3 ECC Option C, the main operating contract for the project.

This implies that on a typical project contractors are paid defined cost, which the project manager forecasts will have been paid by the contractor before the next assessment date plus a fee. This approach ensures that as far as possible contractors are kept in a cash-neutral position.

Project bank accounts are also used to support this approach. These are trust bank accounts funded by CRL from which payments are made for certified work across the supply chain. They provide a secure means of payment along the supply chain, negating the need for contractors and subcontractors to price the insolvency risk, ultimately benefiting the project and employer.

The contractual incentive mechanism to support the delivery of the key project objectives is an equitable share of savings which provides a real incentive to control costs to deliver within the target price. Crossrail Ltd has also deleted entitlement to the payment of fee on costs incurred above the target (similar to the Channel Tunnel Rail Link).

Sources: Crossrail procurement policy (Crossrail website)

> The first is the actual cost incurred by the contractor. The costs eligible to be included in actual cost are defined in the contract and are usually restricted to those which the employer can measure relatively easily and over which he may be able to exert some control. Second, there is a fee paid to the contractor to cover profit and all costs not included in the definition of actual cost, mainly offsite overhead costs. This fee may be a fixed amount or a percentage applied to the actual cost.
>
> Thirdly, target cost contracts include a share arrangement in which the contractor and the employer share the final difference between the target amount set at the beginning and the final total actual cost set by the contractor. The share of the cost overrun or saving may be a constant proportion or may vary depending on the size of the departure of the actual cost from the target.

Perry and Barnes (2000: 202) identify that there is scope for manipulation of tenders in target cost contracts and propose methods of evaluation that will reduce the scope of manipulation and increase the likelihood of the contract being awarded to the tenderer whose final price will be the lowest. 'The analysis reveals a strong case for setting the contractor's share of cost over-run or under-run at a value that is not less than 50%.' Other recommendations which would reduce the number of variables include the employer setting the fee and only tendering out the target, but with the fee built into it.

Targets should not be fixed until the design is 40–60 per cent complete. The most common method of target setting appears to involve the use of a crude priced BofQ (reflecting the major cost-significant items – Pareto rule: 80 per cent of the cost in 20 per cent of the items). However, in order for the incentive to be maintained, the target cost must be adjusted for changes in the scope of the work and matters outside the control of the contractor, e.g. major variations and inflation. Rawlinson (2007) identifies that the target cost and the contractor's reimbursement are not linked until the end of the project, when the pain/gain share mechanism is applied. 'What the contractor recovers through regular payments is the actual cost incurred along with the percentage fee.' The Engineering and Construction Contract (NEC3) identifies 19 compensation events; under this contract all compensation events give rise to an extension of time and adjustment to the target.

In 2002 the quantity surveying guru James Nisbet noted that 'target cost contracts are not new and have been used intermittently during the 20th century. Their lack of popularity may have something to do with their inability to meet the target.' This echoes comments by the like of Middlemas (1963) who stated that 'After 1919 . . . when the Government paid for public works, they wanted better terms than the contractors' 5% cost plus profit, and increasingly developed their own Public Works Departments.' According to Nisbet (2002) the use of target cost contracts was seen by one of the major UK construction clients – the Defence Estates – as 'the strongest incentive for industry to improve performance and innovate thereby reducing costs to Defence Estates and maximizing profit for the Prime Contractor.' Six years after the publication of Nisbet's book it was confirmed by Simpson and Dye (2008) at the RICS COBRA research conference that in order to overcome the risk of exceeding the target the Ministry of Defence were to use maximum price target cost (MPTC) for all works under the Prime Contracting operating framework.

A most significant review on the practical issues involved in operating a target price contract has been produced by Simon Longley (2006) and published in the *Journal of the Chartered Institution of Civil Engineering Surveyors*. In this review he identifies that a target price contract can produce the classic 'win-win' situation for both client and contractor in a project-partnering scenario but requires a completely different mindset from a more traditional contract.

Longley (2006) further states, 'the greatest challenge with respect to a Target Price contract is the Actual Cost. Not only what it means, but what it includes, how it is recorded, how it is managed and how it is reimbursed' and 'the issue of disallowed costs is one of the most contentious matters of a Target Price contract'. Longley (2006) also identifies that value engineering is at the heart of target price contracts.

> "Confusion can arise from determining whether a change is actually a genuine value engineering 'initiative' or whether in fact it is a variation. The distinction is critical because a value engineering initiative should not adjust the Target Price whereas a variation should."

Simon Longley (2006) identifies ten golden rules for target price contracts:

1. Define and quantify the scope of works as accurately as possible in order to provide a robust basis for the target price and for subsequent evaluation of variations.
2. Identify and define in detail what 'actual cost' is truly to mean and what costs will be permitted as actual cost and those that will not.
3. Identify and define in detail what management procedures and processes are to be implemented to administer the contract in the most cost-effective way.
4. Chose the most appropriate form of gainshare/painshare mechanism. Remember, keep it simple and keep it realistic.
5. Arrange pre-contract workshops to educate staff to the concept of the target price contract, how it works, how it is to operate, by whom and when, the management procedures and processes that are to apply and lines of responsibility and authority.
6. Ensure that the defined procedures for the procurement of labour, plant, materials and subcontractors are applied effectively and consistently.
7. Set up a joint financial management system that is accessible and viewable by both the employer and the contractor.
8. Ensure that costs are captured as they arise. Record, code, authenticate and approve such costs and allocate as required. Set up final account files at day 1 and populate progressively during the currency of the contract.
9. Agree variations as they arise.
10. Have in place an appropriate mechanism for the speedy resolution of disputes that will likely arise between the parties.

For a detailed investigation into the use of incentives in a broad cross section of sectors covering utilities, transportation, civil infrastructure, building and heavy and light process manufacturing based on 20 projects see the CIRIA Report C554 *Construction Contract Incentive Schemes – Lessons from experience* (Richmond-Coggan, 2001).

Ian Heaphy, a partner with E.C. Harris, asks the pertinent question '*Do target cost contracts deliver value for money?*' (Society of Construction Law website, paper D126, dated July 2011). In his conclusions he states that:

Target cost contracts can and will deliver value for money only when:

1. The target cost is set at a level which requires the contractor and the employer to work together to create efficiencies beyond those normally expected on such projects.
2. The target cost is actively managed and maintained so as to remain valid and to continue to drive performance.
3. The gain share/pain share mechanism drives the right behaviours in the parties to seek savings and avoid pain.
4. The contractor performs in an efficient manner, mitigating risk.

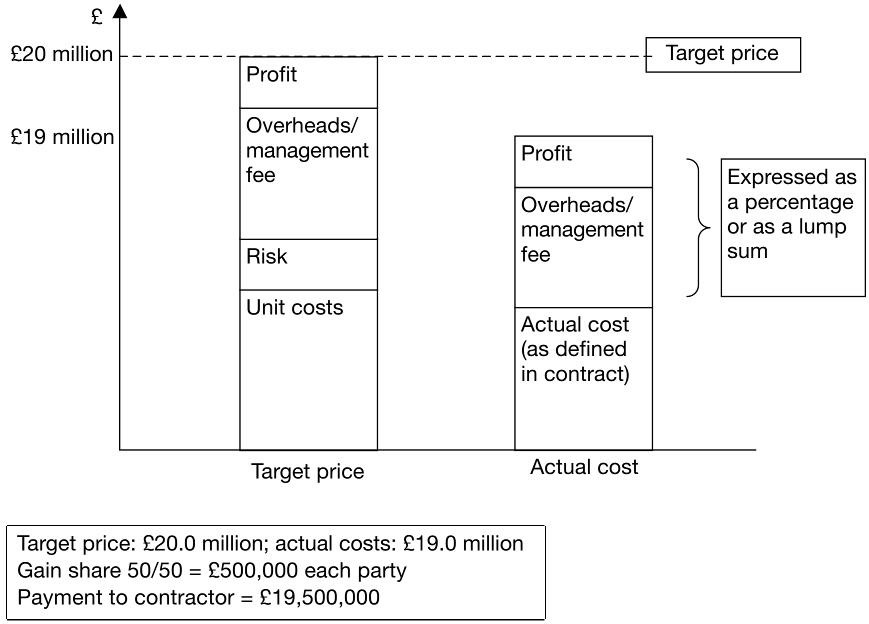


Figure 12.2 Calculation of gain share

Unless all these aims are achieved, value for money will not be achieved.

As part of their search for 'best value', many large public sector employers have moved to partnership arrangements with integrated teams of consultants and contractors. Often the partnership is incentivized by the operation of a gain/pain payment mechanism linked to KPI data. Further discussion on KPIs is provided in section 2.7.

For detailed case studies on the use of framework partnerships using KPIs see Aggus and Hiscocks (2007) – Coventry Framework; Gullick *et al.* (2007) – roads in Northern Ireland; Cunninghan and Pomfret (2007) – capital works in Blackpool; and Rankin *et al*. (2007) – Worcestershire Highways.

Relevant observations?

Renzo Piano, one of the most eminent architects of our time and joint designer with Richard Rogers of the iconic Pompidou Centre in Paris, makes a relevant observation concerning the new Pierpont Morgan Library in New York:

> I hate the idea that the architect, because he is an artist (which he is), may forget about little duties, such as money and function. To be on budget is not a miracle. It's the result of a lot of work and fighting. We have done 4,000 drawings for this job. I am the son of a builder. I love builders but I also know they are sharks. Well for them it is a game.
>
> (Binney, 2005)

Many would have agreed with these sentiments in the pre-Latham era. However, since then there has been a dramatic change in a significant part of the industry. Central and local government and some commercial clients are now embracing the new philosophies and strategies of partnering/alliances and PFI/PPP relationships, which require openness and trust. This post-Egan-era approach requires a radical new way of thinking and an understanding of the philosophy and cultural aspects, and the legal and financial frameworks that underpin the design, construction and operation process. The new approaches demonstrate a rejection of the short-term potentially adversarial models in favour of more transparent, longer-term and collaborative ways of working. However, we know that many of those who are involved in these approaches have yet to embrace the true philosophy of creating a win-win scenario for all the participants.

For example, how many PFI consortia currently building the nation's hospitals can honestly state that they are not knowingly designing obsolescence into the schemes? Harris, McCaffer and Edum-Fotwe (2006: 161) consider that on target cost contracts 'unscrupulous contractors continue to enjoy scope to hide from the client details of transactions with suppliers unless vigilance is strongly upheld'. This sceptical view is confirmed by an alarming survey conducted by the Chartered Institute of Building of over 1,400 senior construction professionals (CIOB, 2006). The results of the survey identified that corruption is still prevalent in the UK construction industry; 60 per cent of the correspondents felt that fraud within the industry was prevalent and 41 per cent had been personally offered a bribe. Furthermore there was a concerning level of people who thought, for example, that producing a fraudulent invoice was not corrupt or that using a bribe to obtain a contract was also not a particularly corrupt practice (CIOB, 2006). In 2010 a major worldwide survey by Pricewaterhouse Coopers found that accounting fraud in the engineering and construction industries had increased significantly, with 38 per cent of companies experiencing accounting fraud.

> The survey respondents report that the two most important issues contributing to the increasing pressure and incentive to commit fraud in the current economic environment are: targets have become more difficult to achieve (50%) and fears over job loss (40%).
>
> (Pricewaterhouse Coopers, 2010)

12.11 Conclusions

It is observed that the selection of a suitable payment system is dependent on the nature of the works and the degree of completion of the design.

Where high certainty of cost is desired, price-based systems should be useful not only for tender evaluation and interim payments but also for valuing variations and claims. Price-based systems are more suitable for projects of which design is completed or insignificant changes are envisaged. Lump sum contracts are particularly suitable for completed design. In the event that a client wishes to retain the flexibility in making changes in the design, or ground conditions are uncertain, admeasurement contracts should be appropriate.

The common characteristics of the various cost-based systems is the high uncertainty in actual cost. Risk sharing, with a high degree of trust between the parties, is the essence in a cost-based system. Ward and Chapman (1994) offer useful advice stating that:

> from a risk-management perspective, it is important to identify categories of risk which are (a) controllable by the contractor, (b) controllable by the client, and (c) not controllable by either party. Different payment arrangements should be used for each of these categories of risk.

The chapter has also identified that the traditional bills of quantities have many shortcomings – not least that they expose the client to the risk of errors in the bill of quantities. The lump sum plan and specification approach also has limitations and is only considered suitable for smaller projects. In comparison, priced activity schedules have many advantages, particularly when linked to programmes through powerful computer software.

12.12 Questions

Question 1

On a multi-million pound interdisciplinary project based on a BofQ, the client has suggested that, to ease the task of interim valuations, payment should be made based on overall percentage progress against the construction programme. Discuss the implications, advantages and/or disadvantages of this suggestion (RICS, Direct Membership Examination, 1985, Project Cost Management Paper).

Question 2

The use of bills of quantities as a contract document may be considered outmoded practice. Discuss this point of view (CIOB Member Part II, Contract Administration, 1987).

Question 3

Compare and contrast the use of priced bill of quantities with priced activity schedules under the following headings:

1 For the client
  - a) budget estimating/cost planning
  - b) selecting contractor
  - c) interim payments
  - d) valuing variations.

2 For the contractor
  - a) estimating
  - b) purchasing
  - c) programming
  - d) site management.

Question 4

On a target cost open book project give actual examples of those costs which might be 'disallowed' in the 'actual cost'. (Disallowed costs might include those which are not substantiated, are to remedy defects not in accordance with the specification or are for excessive wasted materials; they might also include discounts and annual rebates).

12.13 References/further reading

Aggus, S.R. and Hiscocks, E.J.S. (2007) 'Coventry Framework Partnership', *Proceedings of the Institution of Civil Engineers, Municipal Engineer*, 160, March, pp. 37–44.

Barnes, N.M.L. (1971) *Civil Engineering Bills of Quantities*, CIRIA Report No 98, CIRIA.

Barnes, N.M.L. and Thompson, P.A. (1971) *Civil Engineering Bills of Quantities*, CIRIA Report 34, CIRIA.

Binney, M. (2005) 'Notebook architecture', *The Times*, Monday, October 17.

Bishop, J. (1989) 'Management of finance', in: Uff, J. and Capper, P. (eds) *Construction Contract Policy: Improved procedures and practice*, Centre for Construction Law and Management, King's College, London, pp. 239–247.

Broome, J. (1999) *The NEC Engineering and Construction Contract: A user's guide*, Thomas Telford.

Broome, J. (2001) 'Activity schedules v bills of quantities', *The NEC Users' Group Newsletter*, No. 22, p. 8.

Broome, J. (2002) *Procurement Routes for Partnering: A practical guide*, Thomas Telford.

Building Research Station (BRS) (1968) *Tendering Documents with a Production Bias*, Digest 97 (2nd series), London, HMSO.

Campbell, J.W.P. (2007) *Building St Paul's*, Thames & Hudson.

Carrick, D. (1991) 'BofQs and networks exist', *Civil Engineering Surveyor*, September, pp. 25–26.

Chanter, B. and Swallow, P. (2007) *Building Maintenance Management*, 2nd edition,
Wiley-Blackwell.

Chartered Institute of Building (CIOB) (2006) *Corruption in the UK Construction Industry Survey 2006*, CIOB; survey results: www.ciob.org.uk/resources/research – cited 6 November 2012.

Cole, E. (1991) 'The future for quantity surveying', *Civil Engineering Surveyor*, May, pp. 10 and 17.

Cooper, P. (2000) *Building Relationships: The history of Bovis 1885–2000*, Cassell, London.

Cunningham, L.S. and Pomfret, M.A. (2007) 'Partnering contracts in practice at Blackpool, UK', *Proceedings of the Institution of Civil Engineers, Municipal Engineer*, 160, March, pp.17–21.

Curran, N. (2010) 'More than a buzzword: how open book accounting can help maintain successful partnerships', *RICS Construction Journal*, February–March, pp. 24–26.

Davis Langdon (2012) *Contracts in Use: A survey of building contracts in use during 2010*, RICS.

Gryner, D.I.B. (1995) 'The linking of programme and payment through milestone contracts', *First International Conference on Construction Project Management*, Singapore, January.

Gullick, G., Cairns, R. and Pearson-Kirk, D. (2007) 'Application of partnering principles to a framework contract', *Proceedings of the Institution of Civil Engineers, Municipal Engineer*, 160, September, pp. 127–133.

Harris, F., McCaffer, R. and Edum-Fotwe, F. (2006) *Modern Construction Management*, 6th edition, Blackwell Science.

Heaphy, I. (2011) 'Do target cost contracts deliver value for money?', *Society of Construction Law Paper D126*, July: www.scl.org.uk – accessed 24 May 2012.

Hoare, D.J. and Broome, J. (2001) 'Bills of quantities v activity schedules for civil engineering projects', *Journal of Construction Procurement*, Vol. 7, No. 1, May, pp. 11–26.

Holti, R., Nicolini, D. and Smalley, M. (2000) *The Handbook of Supply Chain Management: The essentials Building Down Barriers*, C546, CIRIA.

Institution of Chemical Engineers (IChemE) (2003) *The Burgundy Book Form of Contract, Target Cost Contracts*, December, IChemE.

Klein, R. (1995) 'Payments at fair stages', *Building*, 17 March, p. 38.

Knowles, R. and Gregson, M. (2005) 'The target price on cost reimbursable contracts', *Civil Engineering Surveyor*, September.

Kohan, C.M. (1952) *Works and Buildings: History of the Second World War*, HMSO.

Lal, H. (2002) *Quantifying and Managing Disruption Claims*, Thomas Telford.

Langford, D.A., Kennedy, P., Conlin, J. and McKenzie, N. (2003) 'Comparison of construction costs on motorway projects using measure and value and alternative tendering initiative contractual arrangements', *Construction Management and Economics*, December, Vol. 21, pp. 831–840.

Longley, S. (2006) 'Target price contracts and how to make them work', *Civil Engineering Surveyor*, September: (http://sl-consulting.co.uk/articles/downloads/Target%20Price%20Contracts.doc) – accessed 7 May 2009.

Middlemas, R.K. (1963) *The Master Builders, Thomas Brassey; Sir John Aird; Lord Cowdray; Sir John Norton-Griffiths*, Hutchinson of London.

Mitchell, B. (2003) *Jubilee Line Extension: From concept to completion*, Thomas Telford.

NEC (1995) *New Engineering and Construction Contract, 2nd edition Guidance Notes*, Thomas Telford.

Nisbet, J. (2002) *A Turbulent Transition: Building contracts 1980 to 2001*, Stoke Publications.

Odeyinka, H., Kelly, S. and Perera, S. (2009) 'An evaluation of the budgetary reliability of bills of quantities in building procurement', *RICS COBRA Research Conference*, University of Cape Town, 10–11 September, pp. 435–446.

Perry, J.G. and Thompson, P.A. (1982) *Target and Cost-reimbursable Construction Contracts*, CIRIA Report R85, CIRIA.

Perry, J.G. and Barnes, M. (2000) 'Target cost contracts: an analysis of the interplay between fee, target, share and price', *Engineering, Construction and Architectural Management*, Vol. 7, No. 2, pp. 202–208.

Potts, K.F. (1987) 'An alternative payment system for major fast track construction projects', *Construction Management and Economics*, Vol. 6, pp. 25–33.

Potts, K. (2009) 'Construction during World War II: Management and financial administration', in: Dainty, A. (ed.), *Proceedings of the 25th Annual ARCOM Conference*, 7–9 September, Nottingham, UK, Association of Researchers in Construction Management, pp. 847–856.

Potts, K.F. and Toomey, D. (1994) 'East and West compared: a critical review of two alternative interim payment systems as used in Hong Kong and the UK on major construction works', *CIBW92 Procurement Systems Symposium*, 4–7 December, Hong Kong.

Pricewaterhouse Coopers (2010) *Global Economic Crime Survey,*

Engineering and construction sector summary: www.pwc.com/gx/en/economic-crime-survey/index.jhtml – accessed 14 April 2010.

Rankin, J., Jameson, P. and Yarwood, N. (2007) 'NEC X12 at the heart of Worcestershire Highways', *Proceedings of the Institution of Civil Engineers, Municipal Engineer*, 160, March, pp. 31–36.

Rawlinson, S. (2007) 'Procurement – target price contracts', *Building*, 14 September, pp. 62-65.

Richmond-Coggan, D. (2001) *Construction Contract Incentive Schemes – Lessons from experience*, CIRIA Report C554, London.

Ridout, G. (1982) 'Target cost takes the risk out of contracting', *Contract Journal*, 14 October, pp. 16–18.

Russell, P.J. (1994) 'Hong Kong's Airport Railway – part 2', *Civil Engineer Surveyor*, Dec/Jan, pp. 15–17.

Seeley, I.H. (1997) *Quantity Surveying Practice*, Second Edition, Palgrave Macmillan.

Sharpe, D.J. (1987) 'Completing on time – construction management', *Conference, Urban Railways and the Civil Engineer*, ICE, London, September/October, pp. 165–180.

Simon, Sir Ernest (1944) *The Placing and Management of Contracts*, HMSO, London.

Simpson, Y. and Dye, J. (2008) 'A review of target costing for major capital projects on regional prime contract central', *RICS Construction and Building Research Conference*, COBRA, September 4–5, Dublin.

Skinner, D.W.H. (1981) 'The contractor's use of bill of quantities', *Occasional Paper No. 24*, CIOB.

Skoyles, E.R. (1968) 'Introducing bills of quantities (operational format)', *Quantity Surveyor*, Vol. 24, No. 6, pp. 139–146.

Skoyles, E.R. and Lear, R.F. (1968) 'Practical applications of operational bills', *The Chartered Surveyor*, Vol. 101, No. 2, pp. 70–76.

Telford, T. (1838) *Life of Thomas Telford, Civil Engineer*, James & Luke G. Hansard and Sons.

Trench, D. (1991) *On Target: A design and manage target cost procurement system*, Thomas Telford.

Wallace, I.N.D. (1986) *Construction Contracts: Principles and policies in tort and contract*, Sweet and Maxwell.

Wallace, I.N.D. (1989) 'Contract policy for money', in: Uff, J. and Capper, P. (eds) *Construction Contract Policy: Improved procedures and practice*, Centre for Construction Law and Management, King's College, London, pp. 202–238.

Ward, S. and Chapman, C. (1994) 'Choosing contractor payment terms', *International Journal of Project Management*, Vol. 12, No. 4, pp. 216–221.

Young, D. (1966) *A Biography of Weetman Pearson, First Viscount Cowdray, Member for Mexico*, Cassell, London.

Websites

www.crossrail.co.uk.

www.scl.org.uk.

13 Contractors' cost control and monitoring procedures

13.1 Introduction

Contractors generate small percentage profit margins, between 2 per cent and 7 per cent, from large annual turnovers. For example, the 2011 Annual Report of the UK's largest contractor Balfour Beatty indicates underlying pre-tax profit of £332 million on an annual turnover of £11,035 million, i.e. 3 per cent (Balfour Beatty website). Indeed, for construction services alone, the report indicates an even lower underlying margin of 2.4 per cent. Without an effective company-wide cost control system this would result in substantial risk to any contractor's slender margins.

Cost management is very much more than simply maintaining records of expenditure and issuing cost reports. Management means control, so cost management means understanding how and why costs occur and promptly taking the necessary response in light of all the relevant information. Keeping a project within budget depends on the application of an efficient and effective system of cost control. From the information generated it should be possible not only to identify past trends but also to forecast the likely consequence of future decisions, including final out-turn cost, i.e. the final account.

Bennett (2003) identifies that there are three purposes of a contractor's cost control system:

1. to provide a means of comparing actual with budgeted expenses and thus draw attention, in a timely manner, to operations that are deviating from the project budget;
2. to develop a database of productivity and cost performance data for use in estimating the costs of subsequent projects;
3. to generate data for valuing variations and changes to the contract and potential claims for additional payments.

Two related outcomes are expected from the periodic monitoring of costs:

1. identification of any work items whose actual costs are exceeding their budgeted costs, with subsequent actions to try to bring those costs into conformance with the budget;
2. estimating the total cost of the project at completion, based on the cost record so far and expectations of the cost to complete unfinished items.

Barnes (1990) reinforces these concepts, identifying two critical factors, which should be considered in the financial control of any construction project:

1 The methods of control of a project should be appropriate not only to its objectives and size, but also to the uncertainties inherent in predicting its cost, timing and risk of changes. Uncertainty is inevitable on all projects and could include interest rates changes, client changes, low productivity output, unforeseen ground conditions, failure of specialist contractors and the weather.
2 Control must include action. We cannot control the past so our effort and energy in managing any project should be focused on controlling the present and future and taking necessary corrective action. It will be necessary to consider alternative actions and the consequences of each must be forecast.

Oberlender (1993) concurs, identifying that cost control is far more than controlling expenditure. Cost control also includes the control of revenue, making sure that all possible and justifiable income is recovered from the client and that no preventable wastage of money or unauthorized increase in costs is allowed to happen. The external valuation, which is an important process in the control of revenue, is considered next.

13.2 The external valuation

As a project progresses, it is necessary that contractors (and subcontractors) are paid for work done. All the standard forms of contract include provisions for such periodic or 'interim' payments to be made. A 'valuation' of work done including any items specified by the contract must thus be prepared. A variety of reports may be generated in this regard depending on the intended use of this valuation or the requirements of the form of contract used. For instance the reports could set out the actual costs incurred or the amounts claimable.

Although different standard forms of contract have different requirements, typically in practice the valuation process is undertaken by the contractor's quantity surveyor on a monthly basis in conjunction with the client's quantity surveyor. The valuation amount is calculated using a combination of preliminaries appraisal, measured work schedules and subcontractor invoices, which are all summarized in the valuation summary. Work schedules are updated and completed regularly for each trade in preparation for the valuation. Similarly, the relevant subcontractor invoices are also compiled for presentation to the client's quantity surveyor. Appraisal of preliminaries involves an analysis of fixed and time-related costs incurred over the valuation period in respect of temporary works and services, plant, supervisory staff, etc.

Although the client's quantity surveyor may not examine every item of work thoroughly, a number of random checks will be carried out in order to ascertain how much confidence can be had in the value of works being claimed. These checks can take the form of a site visit or verification of works claimed against labour records, subcontractor invoices and material requisition orders. These activities will be carried out jointly between the client's quantity surveyor and contractor's quantity surveyor.

Once the client's quantity surveyor is confident in the accuracy of the claimed amount, and the valuation summary has been checked for formulaic errors, the payment certificate and corresponding invoice can be raised.

Where the project is based on an activity schedule, for instance under an NEC3 ECC Option A contract, the preparation of the interim valuation is more straightforward, involving an assessment of only activities on the activity schedule that have been fully completed by the assessment date (Clause 11.2 (27)). An example of this can be seen in Tables 13.1 and 13.2.

Panel 13.1 Example of simple interim valuation

The contractor's quantity surveyor is required to prepare the monthly interim valuation for work done up to the end of month 15 (week 64) on the Metropolis Sewage Works project. The project is on programme and the following invoices have been received from the nominated subcontractors:

- Filter Equipment Ltd £720,000
- L.D. Pumps Ltd £275,000
- Sparks Electric Ltd £350,000.

The quantity surveyor has also measured and valued the following sections:

- Sedimentation tanks £925,000
- Secondary digester tanks £1,100,000
- Secondary humus tanks £35,000
- Filter beds £1,125,000
- External works £125,000.

The unfixed materials on site have been valued at £52,000 and there is an invoice from the Metropolis Council for sewer connection amounting to £12,500. Agreed amounts for variations are £125,000, for claims £250,000 and for dayworks £57,890 to date.

The previous month's gross total to date was £ 5,500,000.

Contract Information:

- conditions of contract: ICE 7th
- period for completion: 78 weeks
- tender total: £7,774,250
- percentage of the value of goods and materials to be included: 95 per cent
- rate of retention: 5 per cent
- limit of retention: 3 per cent.

The interim valuation may be set out as follows:

Metropolis Sewage Works – interim valuation no. 15

Bill No. 1

General Items

Accommodation x 64/78	14,769	
Telephone charges x 64/78	1,641	
Testing (assume complete)	6,000	
Temporary road (allow £1,000 for cleanup)	19,000	
Pumping (assume excavation complete)	15,000	
Dewatering (assume complete)	55,000	
Contractor accommodation x 64/78	28,718	
Telephone charges x 64/78	4,102	
Electricity/water x 64/78	36,923	
Site security x 64/78	18,051	
Hoarding/fencing (allow £2,000 for removal)	30,000	229,204

Plant			
(i) Tower crane (assume last 60 weeks)			
Bring to site	7,500		
Maintain 46 weeks @ £800	36,800		
(ii) Earthmoving (complete)			
Bring to site/remove	18,000		
Maintain	144,000		
(iii) Concrete mixing (assume lasts 60 weeks)			
Bring to site	3,000		
Maintain 46 weeks @ £650	29,990		
(iv) Other plant (assume lasts 50 weeks)			
36 weeks @ £1,500	54,000		
Transport 46 weeks @£350	16,100		
Site supervision 15 weeks @ £1,000	15,000		
49 weeks @ £4,000 (allow 14 weeks to complete)	196,000		
Remove rubbish	4,000	524,300	753,504
Bill No. 2			
Sedimentary tanks		925,000	
Secondary digester tanks		1,100,000	
Secondary humus tanks		350	
Filter beds		1,125,000	
External works		125,000	3,625,000
Bill No. 3			
Filter equipment	720,000		
Profit + 2.5%	18,000		
General attendance + 5%	36,000		
Special attendance	15,000	789,000	
L.D. Pumps	275,000		
Profit + 2.5%	6,875		
General attendance + 5%	13,750		
Special attendance	10,000	305,625	
Sparks Electric	350,000		
Profit + 2.5%	8,750		
General attendance + 5%	17,500	376,250	
Existing sewer connection		12,500	1,483,375
Bill No. 4			
Dayworks		57,890	
Variations		125,000	
Claims		250,000	432,890
	Gross value		6,294,769
	Less: Retention	3% limit	(233,227)
			6,051,542
	Materials on site	52,000	
	95% to be included	49,400	49,400
			6,100,942
	Less: Last month		5,500,000
	AMOUNT DUE		**£ 600,942**

Table 13.1 West Metropolis Storm Water Relief Tunnel activity schedule

West Metropolis Project
NEC3 Option A – priced contract with activity schedule
Project details at assessment date

Ref	*Activity*	*Price (£)*	*Percentage complete*
A001	Mobilization	5,000	100%
A002	Site clearance and establish at shaft B worksite	10,000	100%
A003	Sink shaft B	63,000	100%
A004	Set up pipe jack equipment in shaft B	6,500	100%
A005	Pipe jack shaft B to A	47,500	100%
A006	Site clearance and establish at shaft A worksite	3,000	100%
A007	Sink shaft A	51,000	100%
A008	Site clearance and establish at shaft C worksite	4,000	100%
A009	Sink shaft C	48,000	100%
A010	Set up pipe jack equipment for drive B to C	3,500	100%
A011	Pipe jack shaft B to C	102,000	95%
A012	Establish worksite in the Dell	2,500	100%
A013	Construct outfall to river – excavation and concrete works	7,500	50%
A014	Take delivery of employer-supplied pipes to the Dell	150	90%
A015	Construct 600mm-diameter drain in the Dell – open cut portion	6,000	-
A016	Construct heading for drain to shaft A	17,500	-
A017	Gas diversion by others – liaison	50	-
A018	Take delivery of employer-supplied pipes at shaft C worksite	200	90%
A019	Construct 600mm-diameter drain between shaft C and existing sewer	39,000	-
A020	Remove pipe jack equipment from shaft B	1,000	-
A021	Air tests	1,500	-
A022	Benching, ladders, miscellaneous internal works to shafts	10,500	-
A023	Connect to existing sewer	7,500	-
A024	Demobilize	4,000	-
	Total	**434,150**	

The employer has selected Option X16 Retention and has entered 2.5% against the retention percentage in the contract data.
The contractor wishes to include the following additional items:
* Design work £15,000
* Materials on site £25,000.
The value of the 'previous payments' (after retention) for Interim Valuation No. 5 was £175,000.
Source: Developed based on Broome (1999)

13.3 Budget forecast update report

An important element of any cost control system is the ability to make projections regarding future cash flow requirements, the final account and out-turn costs based on the status quo. This involves updating on a monthly basis the cash flowcharts to produce budget forecast reports. This is particularly useful for estimating the total revenue and expenditure on a particular contract within the financial year. The forecast values for each section of work are updated to reflect major variations and the net cost of each section (i.e. the payments made to subcontractors and suppliers) is also recorded. Alongside the cost-value reconciliation (Method 1 – see section 13.5), this report helps identify the extent to which a profit/loss is being made so that necessary action can be taken. Thus, it provides an effective tool for monitoring purposes. Figure 13.1 provides an example of a simple updated cash flow diagram showing the original cash flow

Table 13.2 Interim valuation based on West Metropolis project activity schedule

West Metropolis Project			
NEC3 Option A – priced contract with activity schedule			
Interim Valuation No. 6			
A001	Mobilization	5,000	
A002	Site clearance	10,000	
A003	Sink shaft B	63,000	
A004	Pipe jack equipment to B	6,500	
A005	Pipe jack B to A	47,500	
A006	Site clearance at A	3,000	
A007	Sink shaft A	51,000	
A008	Site clearance	4,000	
A009	Sink shaft C	48,000	
A010	Set up pipe jack equipment	3,500	
A012	Pipe jack B to C	2,500	244,000
	Less: 2.5% retention		(6,100)
			237,900
	Less: previous payment		(175,000)
	Amount due		**£ 62,900**

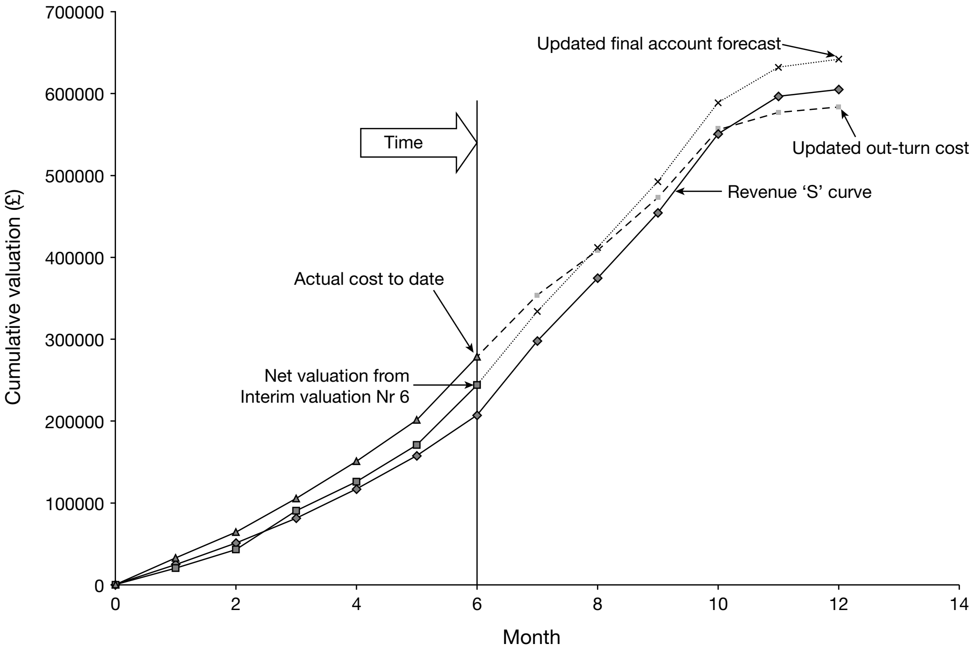


Figure 13.1 Project cash flow projections – updated 'S' curves

forecast (cumulative monthly valuation and cumulative expenditure forecasts), the valuation and expenditure to date, and the projected valuation and out-turn costs at completion based on the current position.

The budget forecast report will include adjustments from the preliminaries appraisal report, whether this is a net loss or gain, and for the direct labour and subcontractor elements generated from the valuation report. It provides a quick snapshot of progress on the project. However, for detailed insight into specific sections of work that is underperforming, reference needs to be made to the unit costing report (Method 2 – see section 13.6). Using such cash flow projections contractors can make an assessment of future working capital requirements by taking account of payment delays and retention arising from the contract terms. Cooke and Williams (2009) provide a comprehensive discussion on cash flow planning which is a must read for all cost management students.

13.4 Developing a cost control system

The type and sophistication of any cost control system will be determined by the resources available to operate the system and the use made of the system by the relevant management personnel. Pilcher (1994) considers that a wide variety of issues need to be considered when developing a contractor's cost control system, namely the size of company, the type of work – building or civil engineering – and the different contractual arrangements. He also notes the two main approaches and highlights the potential problems.

1. An integrated reporting system (integrating time and cost)

Pilcher (1994) considered that integrated systems had the disadvantage that either simplicity or attention to level of detail was sacrificed. In other words this approach was good for understanding the big picture – was the project ahead of/behind programme?; what was the internal cost?; and what was the earned value, i.e. the project variances?

An example of this approach is the earned value analysis that is identified in BS 6079 *Project Management*. The big advantage of this approach is that one integrated system can be used for the control of time and cost. Nowadays, with the rapid development of sophisticated computerized databases, e.g. ORACLE, it is possible to further analyse the project costs and identify the financial trends within the various sections or components of the project.

2. Separate schedule and cost control systems

According to Pilcher (1994) it is the experience of many practitioners that separate schedule and cost control systems provide a cheaper means of good control and the output from the two systems is more easily understood. However, he notes a word of caution that the processing of the data for separate systems does, of course, need to be integrated.

This approach should enable the project team to identify the problem areas and take the necessary action – if possible.

Harris and McCaffer (2006) recommend that cost control should be exercised before the costs are committed. They point out that most cost control systems have an inordinately long response time. Even the best current system provides information on what was happening last week or last month. Cornick and Osbon's (1994) research found that, traditionally, contractors' quantity surveyors only monitored costs rather than controlled costs, which made their role reactive rather than proactive.

In conclusion, an effective cost control system should contain the following characteristics:

- A budget for the project should be set with a contingency figure to be used at the discretion of the responsible manager.
- Costs should be forecast before decisions are made to allow for the consideration of all possible courses of action.
- The cost-recording system should be cost effective to operate.

- Actual costs should be compared with forecasted costs at appropriate periods to ensure conformity with the budget and to allow for corrective action if necessary and if possible.
- Actual costs should be subject to variance analysis to determine reasons for any deviation from the budget.
- The cost implications of time and quality should be incorporated into the decision-making process.

There are two main types of contractors' cost control systems:

1 the big picture monthly review of the project; and
2 a more detailed analysis of the sections within the project in order to identify those sections of the works which are underperforming.

The three main types of contractors' project cost control systems are as follows:

1 cost-value reconciliation (used by building contractors);
2 contract variance – unit costing (used by civil engineering contractors); and
3 earned value analysis (US approach/used on major projects).

13.5 Method 1: Cost-value reconciliation (CVR)

Cost-value reconciliation (CVR) brings together the established totals for cost and value to illustrate the profitability of a company. Its intention is to ensure that the profits shown in the company accounts are accurate and realistically display the current financial position.

The CVR serves two purposes: first, it forms the basis of statutory accounts, which is a legal requirement. The guidelines of Standard Statement of Accounting Practice number 9 (SSAP9) (ICAEW, 1998) must be followed. The main thrust of SSAP9 is that financial statements should be prudent, that losses or potential losses should be recognized immediately and essentially that the business should not claim to be more profitable than it actually is.

Second, the CVR provides management information to assist in the identification of problems, the need for reserves, the reasons for loss and information to prevent repetition of such losses. It should also show the original budget figures and expected profit, together with an assessment of the final position of the project, i.e. the final account.

At each interim valuation date, normally the end of each calendar month, the total costs to date are compared with the total valuation. Care has to be taken to compare like with like and make necessary adjustments for overvaluation/undervaluation. This approach suffers from the disadvantage that there is no breakdown of the cost/profit figures between the types of work or different locations within the project; it therefore only provides guidance on which project requires senior management attention. This approach is suitable for use on building projects where there are a large number of complex components.

The CIOB *Cost Valuation Reconciliation* approach (described in detail in Barrett, 1992) is the standard recommended approach, a similar version of which is used by most contractors.

The cost-value comparison, or reconciliation, is usually completed by the contractor's quantity surveyor on a monthly basis following agreement of the interim valuation. The process will require liaison with other departments in its completion and considerable discussion with the rest of the project team, e.g. the contracts manager and the site manager.

The starting point of any CVR must always be the gross certified value, which must be supported by the architect's interim certificate. This is the external valuation and not the contractor's quantity surveyors' assessment or internal valuation of the works. It is generally necessary to adjust the external gross certified value for sundry invoices, i.e. work carried out on or off the project using labour/plant/materials/subcontractors that do not form part of the contract works.

An external valuation may require adjustments for many reasons, not least arithmetical errors found in the external valuation after agreement with the client's quantity surveyor. Common areas of adjustment are as follows:

- adjustments for external preliminaries claimed in valuations against the internal preliminary schedule;
- adjustments for elements included within costing but not in the external valuation, e.g. materials brought to site on the same day as the valuation but after materials on site were recorded;
- items of overmeasurement not picked up by the client's quantity surveyor;
- any adjustments necessary to bring the cost cut-off date and the on-site valuation date together;
- variations which have not been agreed with the client's quantity surveyor;
- contractual claims for loss and/or expense which have not been agreed by the client's quantity surveyor;
- possibility of liquidated damages being charged by the employer;
- provision for future known losses.

The general principle for the contractor's quantity surveyor to remember must be that of caution. Any figures included in the valuation adjustment must be capable of substantiation and wherever possible should have been agreed with the client's quantity surveyor.

Once the gross adjusted valuation has been assessed, three further elements are deducted from the figure to arrive at a final residual value or margin.

The first of these is subcontract liabilities, which should cover all disciplines of subcontractor, i.e. nominated/named or domestic subcontractors, but excluding labour-only subcontractors, the cost of which should be considered with the labour section of the main contractor's costing.

The subcontract liability is essentially a comparison between what the contractor has been paid and what the contractor is liable to pay to any given subcontractor. The liability should include not only those matters listed on the external valuation, such as contract works, variations and materials on site, but also any works that the main contractor is due to pay the subcontractor but for which he would not receive reimbursement through the main works contract provisions.

The second deduction is for snagging and defects, which can be subdivided into two sections:

1 snagging required at the end of the project to achieve handover;
2 a levy to be used to cover costs that may be incurred in the making good of defects in the period before the certificate of making good of defects is issued.

Both these figures are highly dependent on the type of project involved. On housing projects, an allowance per unit may be adopted. Many contractors will have standard allowances, e.g. 1.5 per cent of the contractors' gross value (excluding subcontract figures), building up over the contract period and then reducing to 0.5 per cent after practical completion is achieved.

The third and final element of deduction is that of the *main contractor's core costs*, i.e. labour, material and plant and other associated costs. In general, these will be supplied to the contractor's quantity surveyor by a separate cost department within the contractor's company.

Once all these figures are known the residue is the profit generated from the main contractor's works section of the project. When added to the profit on other sections, i.e. the subcontract liability schedule, this indicates the profit to date for the project. The figure can then be compared with the original contract profit included in the contractor's tender.

In order to complete the *time analysis* (in weeks) section of the report it will be necessary to consider the following: the original period, any extension of time awards, the present position and time to complete. If the contract period will be exceeded, the contractor should include for: the cost of *preliminaries* in the overrun period, any liquidated and ascertained damages, under-recovery of fluctuations, and claims from subcontractors and suppliers.

There is no room in cost-value reconciliation for historical costing only. Without a clear vision of the completed project, financial reporting at an intermediate stage of the project does not produce accurate profit and loss statements.

The preparation of CVRs is not an exact science, particularly when completing Section 4: Provisions (see detailed example); these figures are estimated based on the quantity surveyor's best current knowledge and experience. However, it is important that there is a consistent approach taken by all the company's quantity surveyors. The author (Potts) recollects that the Chief Quantity Surveyor of Holland Hannen & Cubitts (North West), who were later taken over by Carillion, held regular communication meetings with all the company surveyors present. It was at these meetings that the monthly cost reports were discussed in detail and a standard company policy established.

Research by Stephenson and Hill (2005) noted that some contractors, mainly the larger ones, proposed the application of CVR in conjunction with an IT-based Budget Monitoring System (BMS). A sophisticated BMS enables the incurred costs to be linked to the progress as shown on the programme. Costs to complete and the anticipated financial out-turn costs can also be established.

More recent research by Lee Chun Hoong (2007), which was based on a return of 33 per cent of the top 100 UK contractors, identified that the most popular cost control system was the monthly CVR approach (58 per cent), followed by standard costing by sub-variances (18 per cent). The time frame for the final preparation of the CVR was 14 days after the valuation date (73 per cent). This research also showed that cost control systems were used to compare the actual expenses versus the budget (100 per cent); to forecast project completion cost and potential profit or loss for the project (100 per cent); to analyse performances of the project (actual progress versus planned programme) (89 per cent); to generate data for valuing variations (32 per cent); to notify potential future claims (32 per cent); and as basis for the valuation for subcontractors' interim payments (32 per cent).

Example of monthly CVR

Prepare the contractor's cost-value reconciliation (internal valuation) for work done up to the end of November 2008 on the following project:

High Street development with ground floor shops and three storey offices above

Contract particulars:	JCT05 with Quantities
Fluctuations:	Schedule 7 Option A applies (only changes in contributions, levy and tax fluctuations reimbursed)
Accepted tender:	£2,555,000
Contract period:	15 months
Date of commencement:	1 January 2008

Particulars appertaining at end of November 2008

Cost to end of November 2008:	£1,850,000
Contractor's interim valuation:	Gross total £2,055,000
Claims disputed by architect/quantity surveyor:	£255,000
Separate invoice to employer:	£7,500 (building a garage at client's home)
Undervalue of materials on site:	£10,000
Overvalue on preliminaries:	£7,750
Overmeasure:	£17,850.

Other issues:

- M&E s/c's application only includes for work up to 20 November 2008 (main contractor's application includes an extra £15,000)
- vandalism/theft likely
- higher than anticipated rate of inflation
- project running 3 weeks behind master programme (liquidated damages of £5,000 per week)
- 1-week extension of time awarded (due to late issue of instructions).

Solution

At first sight this project would seem to be showing a profit of £205,000, with an interim valuation of £2,055,000 against an internal cost of £1,850,000. However, further analysis is required in order to establish a more prudent assessment in accordance with SSAP9 standard accounting practice. We need to ensure that we are comparing like with like (valuation and costs) and also make further allowances for anticipated problems.

Valuation

1	**Application and certificate**		
	(a) Total payment application (net of discount and VAT)		2,055,000
Deduct	(b) Disputed items, claims not agreed in application		(255,000)
	(c) Anticipated gross certificate	1,800,000	1,800,000
Add	(d) Additional agreed contract invoices	7,500	7,500
2	**Adjustments**		
Add	(a) Sub-contractors' adjustments		
	(b) Preliminaries		
	(c) Valuation before close of accounting period		
	(d) Materials on site	10,000	
	(e) Variations not agreed		
		10,000	10,000
3	**Overvaluation**		
Deduct	(a) Preliminaries		7,750
	(b) Valuation after end of month		
	(c) Weighted items		
	(d) Materials on site		
	(e) Overmeasure	17,850	
	(f) M&E subcontract	15,000	
		40,600	(40,600)

4 Provisions			
Deduct	(a) Remedial works		5,000
	(b) Winter working		5,000
	(c) Foreseeable risks		
	(d) Unprofitable future work		
	(e) Defects liability period		2,000
	(f) Shortfall in increased costs recovery		5,000
	(g) Vandalism/theft		5,000
	(h) Late completion:		
	Liquidated damages, 2 weeks at £5,000	10,000	
	Preliminaries, 2 weeks at £3,800	7,600	
	Increased costs, 2 weeks at £500	1,100	
	Claims from subcontractors	5,000	23,700
		(45,700)	(45,700)
5 Internal valuation			1,731,200

Summary

So, after making the necessary adjustments, a more realistic financial comparison emerges. This shows that the project is actually making a loss of £118,000 (adjusted internal valuation of £1,731,200 against an internal cost of £1,850,000).

13.6 Method 2: contract variance – unit costing

In this system costs of various types of work, such as driving piles or concrete work, are recorded separately. The actual costs are divided by the quantity of work of each type that has been done. This provides unit costs, which can be compared with those in the tender.

The report is prepared on a monthly basis following the interim valuation agreed with the client. The report requires a comparison to be made between the value of the work done and the cost of doing it, i.e. the variance. The aim of the report is to identify the problem areas and trends as well as forecasting the final profit/loss situation on the project. Corrective action should be taken on any cost centres showing a loss if at all possible. This form of cost report is most effective on a contract with repetitive operations, but is less so on non-repetitive contracts. This approach is appropriate for civil engineering work where there are a small number of high-value components in the project.

Example of monthly unit costing method

This case study relates to the construction of a new marina in Merrythorpe on the coast of the North East of England. In the mid-1930s the site was used for gravel extraction. These operations ceased in 1939 and after this the site was used as a tip. The tipping ceased in the late 1950s and in the early 1960s the local authority constructed an incineration plant, which was revamped with increased capacity in the late 1990s.

The time for completion of the project is 100 weeks with a contract value of £14.9 million. The cost report reflects the financial situation at the end of week 75 and it is noted that the project is 10 weeks behind the tender programme, the finishing date being week 110.

The general items or preliminaries have been split into two items representing:

1 fixed charges – cost of mobilization and demobilization of construction equipment, together with the contractors' facilities;
2 time-related charges – representing the weekly cost of running the site, including costs of all staff, maintaining the construction equipment and fuel.

Of the *fixed charges* within the general items, 90 per cent has been paid to date (£450, 000) and this is considered a realistic assessment of the situation; however, the actual costs are shown as £500,000, thus showing a loss to date of £50, 000.

All the estimated final costs for each cost code have been calculated pro-rata to the actual costs to date. The final valuation figure is based on the initial tender figure adjusted if necessary for any variations, i.e. both the final cost and valuation are calculated representing the final estimated quantity.

The client's contract administrator has paid for only 65 weeks *of time-related* costs – reflecting the actual progress to date. The report shows a final valuation of £1,000,000 (as the tender), with the final costs based on 110 weeks, i.e. £1,354,000 – an anticipated final deficit of £354,000.

Overall the project is showing an anticipated loss of £1,115,000. Two major issues have occurred on this project which have affected progress. First, more contaminated material has been encountered than was envisaged from the borehole reports available at tender; this has caused a 6-week delay. Second, whilst constructing the lock cofferdam, granite boulders were encountered. In order to overcome this latter problem the contractor had to devise a revised working method, which included drilling and blasting the rock, resulting in an additional delay of 4 weeks.

Under a traditional contract (e.g. ICE or FIDIC) these two items would be dealt with as claims for both costs and extension of time under the unforeseen ground conditions clause in the conditions of contract (e.g. ICE clauses 12 and 44). These two items would obviously have a significant impact on the contractor's cash flow and the contractor's commercial team would be under considerable pressure to evaluate and justify the claims submitted. The contract variance cost-reporting approach should allow the contractor to establish the broad financial figures involved.

If the contract was let based on an NEC ECC contract, the two items would be considered to be compensation events and the contractor would be required to submit quotations for the work. If the quotations were accepted, it is suggested that the valuation figures shown on the monthly cost report should include the accepted amounts.

Identify the final estimated contract variance if the valuation was the same, but the estimated costs (in £1,000s) to date (on week 65) were as follows:

010 General items: fixed	425
010 General items: time-related	700
020 Excavate over site and remove	2,100
030 Concrete piling to marina walls	900
040 Marina excavation and remove	2,150
050 Lock construction cofferdam	350
060 Lock construction gates	
070 Piling to pontoons	
080 Puddle clay bed	
090 Flood marina	
100 Install pontoons	
110 Finishing work.	

Mighty Build Construction Company **Monthly cost report** **Programme as tender: 100 weeks**

Contract: Merrythorpe Marina, N.E. England **Date: end of month** **To date: 75 weeks; Actual: 65 weeks**

					QUANTITY					COST	(£1,000)		
Cost code	Description of work	Unit	B of Q	To date	Estimated final total	To complete	B of Q	Cost to date	Valuation to date	+/- To date	Estimated final cost	Final valuation	Final +/-
010	General items	Item	Fixed	90%		10%	500	500	450	(50)	556	500	(56)
		Weeks	Time-related	75		25	1,000	800	650	(150)	1,354	1,000	(354)
020	Excavate over site and remove	M³	450,000	500,000	500,000	Complete	2,250	2,200	2,500	300	2,200	2,500	300
030	Concrete piling to marina walls	Nr	250	255	255	Complete	1,000	950	1,020	70	950	1,020	70
040	Marina excavation and remove	M³	700,000	350,000	700,000	350,000	4,900	2,800	2,450	(350)	5,600	4,900	(700)
050	Lock construction cofferdam	M²	5,000	2,000	5,000	3,000	1,250	650	500	(150)	1,625	1,250	(375)
060	Lock construction gates	Nr	2		2	2	500						
070	Piling to pontoons	Nr	400		405	405	800						
080	Puddle clay bed	M³	100,000		100,000	100,000	1,000						
090	Flood marina	M³	600,000		600,000	600,000	600						
100	Install pontoons	M	2,000		2,000	2,000.	1,000						
110	Finishing work	Item					100						
							14,900	7,900	7,670	(330)	12,285	11,170	(1,115)

Figure 13.2 Monthly cost report based on the contract variance – unit costing method

13.7 Method 3: earned value analysis

Traditional earned value analysis is defined by Howes (2000) as 'an established method for the evaluation and financial analysis of projects throughout their life cycle'. Earned value management (EVM) is a fully integrated project cost and schedule control system which allows, through trend analysis, the formation of 'S' curves and determination of cost/schedule variances.

The technique can be applied to the management of all capital projects in any industry, while employing any contracting approach. EVM is superior to independent schedule and cost control for evaluating work progress in order to identify potential schedule slippage and areas of budget overruns. In the USA from 1997 onwards private industry started to adopt the EVM technique as it represented a viable, best practice tool that project managers could actually use (Fleming and Koppleman, 2000).

The concept of earned value was initially conceived at the start of the twentieth century by industrial engineers in an attempt to improve production methods. Later it was utilized by the US Air Force. The UK construction sector has been reluctant to embrace the concept of earned value analysis. However, it has been used with some success by the major players, including WS Atkins on the Channel Tunnel and Tarmac Construction (now Carillion) on the £80 million widening of the M6 at the Thelwell Viaduct, near Manchester. The Thelwall Viaduct project was based on the traditional ICE 5th Conditions of Contract with bills of quantities. Tarmac Construction spent £28,000 reconfiguring the costs in the BofQ into a Work Breakdown Structure (WBS) database in order to operate the earned value approach.

Other major users of the earned value approach include Taylor Woodrow Construction, Skanska UK (Civil Engineering), Balfour Beatty and Edmund Nuttall Ltd (Wiggin, 2005).

EVA gives the project manager the tools to consider the position of the project accurately and what remedial measures are necessary to recover any lost time.

> Preparation for running EVA commences in the planning stage of the project. Estimated costs and resources are added to each activity defined in the programme of works. Percentage completion of each activity is regularly assessed, usually weekly, and entered into the planning software which calculates planned and earned value data automatically. Actual labour used is imported from daily labour returns and actual costs to date from existing commercial systems.
>
> (Kidston, 2005)

Calculating the earned value

Earned value management involves calculating three key values for each activity in the WBS:

1. The planned value (PV), formerly known as the *budgeted cost of work scheduled* (*BCWS*) – that portion of the approved cost estimate planned to be spent on the given activity during a given period.
2. The actual cost (AC), formerly known as the *actual cost of work performed or (ACWP*) – the total of costs incurred in accomplishing work on the activity in a given period. The actual cost must correspond to whatever was budgeted for in the planned value and earned value (e.g. all labour, materials, construction equipment and indirect costs).
3. The earned value (EV), formerly known as the *budget cost of work performed or (BCWP*) – the value of the work actually completed.

These three values are combined to determine at that point in time whether or not work is being accomplished as planned. The most commonly used measures are the cost variance and the schedule variance:

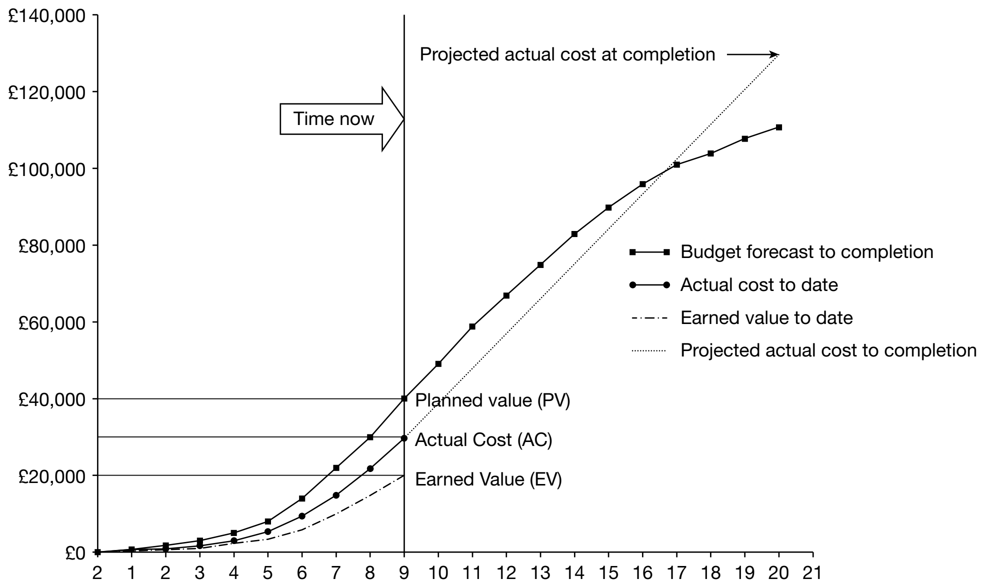


Figure 13.3 Earned value analysis example

Cost variance (CV) = EV – AC
(Figure 13.3 shows CV = (EV) £20,000 – (AC) £30,000; Cost Variance = –£10,000

Similarly, the cost of schedule slippage, the schedule variance in terms of cost, may be determined.

Schedule variance (SV) = EV – PV
(Figure 13.3 shows SV = (EV) £20,000 – (PV) £40,000; Schedule Variance = –£20,000)

The same data can be expressed as ratios that give an indication of value for money. If work is proceeding to, or better than, plan, these ratios will be equal to or greater than 1.0. Conversely, unfavourable variances will be less than 1.0.

1 How are we doing on money?
Cost performance index (CPI) = EV/AC
(Figure 13.3 shows CPI = (EV) £20,000/(AC) £30,000 = 0.66)
2 How well are we doing on time?
Schedule performance index (SPI) = EV/ PV
(Figure 13.3 shows SPI = (EV) £20,000/(PV) £40,000 = 0.50)

The earned value management approach provides a most powerful control tool. The data generated should enable senior management to identify the performance of the project as a whole, or of any part of the project, at any point in time. Furthermore, monthly trends can be easily identified by comparing the monthly CPI and SPI figures. Additionally the EVM approach enables the forecast of the out-turn situation.

Kidston (2005) identifies why Taylor Woodrow mandated the use of EVA on all its construction projects and gives examples of its use on Smithfield Market, the Albert Hall and Paddington Station. Kidston (2005) gives further useful practical guidance on setting up an EVA system.

Panel 13.2 Case study: Skanska Civil Engineering – use of EVM on Channel Tunnel Rail Link Section 2 contract

The Channel Tunnel Rail Link is a major element of the UK Government's Private Public Partnership, which enables important infrastructure to be provided for the benefit of the public sector, while taking advantage of private sector management and efficiency.

In 1996 London and Continental Railways (LCR) was selected by the Government to build and operate the Channel Tunnel Rail Link and to own and run Eurostar (UK) Ltd, the UK arm of the Eurostar train service. LCR's shareholders are Bechtel Ltd, SG Warburg & Co Ltd, National Express Group plc, French Railways Ltd, Systra-Sofretu-Sofrerail, EDF Energy Ltd, Arup Group Ltd and Sir William Halcrow & Partners.

Skanska Civil Engineering executed four contracts with a value of more than £500 million on the £7 billion Channel Tunnel Rail Link. The project under consideration comprised two tunnels of open box type structure at Stratford and East Pancras. The procurement method was two-stage design and build utilizing an NEC ECC target cost contract with the client's activity schedule.

The client (LCR) instructed all contractors to use an earned value management approach and required a standardized reporting system to be implemented.

The general approach to implementing EVM required:

- the production of a programme with milestone work packages;
- the production of a project/cost payment schedule that correlated with the project programme;
- a physical measure, each month, of all the work undertaken within each of the works packages;
- a calculated cost of the work completed;
- inputting the information obtained into Primavera P3 to achieve the earned value output.

Compared to the traditional approach, no additional work was required to operate the system; however, there was an increase in understanding and communication between the commercial and project teams. It was possible within the system to embrace the substantial variations and delays; the cost projection of the final account was also accurate. Future developments include encouraging subcontractors to use the EVM approach, thus benefiting the whole of the supply chain, particularly when bidding for future projects.

Source: Wiggin (2005)

Postscript: See case study 'Channel Tunnel Rail Link: risk transfer and innovation in Project Deliver' (Georgoulias, 2006) Version 1.

13.8 Relevant observations on use of cost control systems

In the *RICS Construction Journal* commercial management consultant Nick Curran identifies the difficulties of developing effective contractors' control systems in a traditional UK scenario where estimated costs, time control and actual costs are all produced in different formats using different functional software with little common integration between the packages (Curran, 2008a, 2008b, 2008c). He suggests that, under such an approach, monthly cost-value reconciliations, cash flows and profitability forecasts must be viewed with a degree of scepticism.

He describes the use of an effective contractor's project control system on a mega project – the Al Raha Beach Development in Abu Dhabi, United Arab Emirates – undertaken by a joint venture between Laing O'Rourke and UAE developer, ALDAR Properties PJSC. The project was managed under an NEC3 contract with a largely cost reimbursement approach. The control system was based on an integrated approach using work breakdown structures with a 'common analysis' throughout. The project plan 'level 2 WBS' from the Primavera project plan was adopted as the common analysis with standard coding throughout the project plan, the BofQ estimates and the actual costs allocated to it. The control system was designed to capture data in the same format/WBS across many projects, allowing accurate performance reporting/benchmarking, KPIs and earned value analysis. Furthermore, the system critically allowed the management team to undertake proactive up-front commercial decisions rather than reactive after-the-event decisions. The solution was implemented largely using off-the-shelf software linking Causeway Estimating solution with their Project Accounting software and the Primavera project planning tool.

In further correspondence with the author (Potts), Nick Curran identifies that the approach taken is actually a natural extension from the typical contractors' CVR whereby at month end a comparison is carried out between how much of the job is complete relative to the costs to carry out those works. Apart from the integral use of IT, the approach, however, has three further significant differences:

1 it defines at what levels the comparison will be carried out and structures the BofQ estimates to suit;
2 it sets up cost-capture systems to automatically capture costs against defined levels; and
3 it further compares the subsequent CVR with the programmed and actual progress from the project plan.

Laing O'Rourke have now made a significant commitment to the Causeway approach and have made a significant commitment to roll it out into Dubai and other parts of the world.

13.9 Conclusions

Developing and operating effective contractors' cost control systems is a major challenge to the commercial managers due to the unique nature of construction projects. The information collected often relates to the past and reflects the costs of fixed items of major construction equipment and temporary works which may prove impossible to alter even if they are showing a loss.

There needs to be a balance between the cost of developing and operating a system and the potential benefits. The more sophisticated systems are expensive to develop and operate and may not produce the information required, e.g. to support quotations for variations or justify expenditure after the event.

The author (Potts) recollects being involved in operating a highly detailed computerized contractor's cost control system in which every BofQ item was analysed at tender into labour/materials/plant and then each invoice and cost incurred was allocated to these same cost centres as the work proceeded. The system became a monster which required feeding monthly with vast amounts of data, including gross quantities of completed work and analysis of items not described in the BofQ.

With hindsight this system was far too ambitious on a complex civil engineering project. Indeed, it deflected the commercial team from the main task of producing the final account, finalizing the subcontractors' accounts, valuing the changes and evaluating the claims. However, this highly detailed system would probably work well on a more straightforward project, e.g. a housing development.

The rapid development of computer hardware and software has greatly assisted in the computerization of the control process with integration between the accounting and estimating software whilst supporting the needs of a cost control system. Nick Curran critically identifies the problems of the traditional method of working with separate functional IT packages and describes an effective control system based on a 'common analysis' using the earned value analysis approach allowing accurate reporting, analysis and forensic examination by auditors.

> The key factors in the success of the implementation were the buy-in from all levels, management of the change, and the management of the people who would ultimately be relied on to drive the system and produce the results.
>
> (Curran, 2008c)

13.10 Questions

Question 1

Critically review the effectiveness of your own company's cost control system. How effective is it?

13.11 References/further reading

Ahuja, H.N. (1980) *Successful Construction Cost Control*, John Wiley & Sons.

Barnes, M. (ed.) (1990) *Financial Control*, Engineering Management series, Thomas Telford.

Barrett, F.R. (1992) *Cost Value Reconciliation,* 2nd edition, CIOB.

Bennett, F.L. (2003) The *Management of Construction: A project life cycle approach*, Butterworth Heinemann.

Broome, J. (1999) *The NEC Engineering and Construction Contract: A user's guide*, Thomas Telford.

Causeway (2009) *Performance Management in Construction: How to improve the commercial management of construction projects*, www.causeway.com – cited 27 April 2009.

Cooke, B. and Williams, P. (2009) *Construction Planning, Programming and Control*, 3rd edition, Wiley Blackwell.

Cornick, T. and Osbon, K. (1994) 'A study of contractors' quantity surveying practice during the construction process', *Journal of Construction Engineering and Management*, Vol. 12, pp. 107–111.

Curran N. (2008a) 'Do you have the requisite tools?', *The Journal RICS Construction*, February/March, p. 21.

Curran N. (2008b) 'Let's pull together', *The Journal RICS Construction*, April/May, pp. 22–23.

Curran N. (2008c) 'A common approach', *The Journal RICS Construction*, September/October, pp. 18–19, 21.

Fleming, Q.W. and Koppleman, J.M. (2000) *Earned Value Project Management*, 2nd edition, Project Management Institute.

Fleming, Q.W. and Koppleman, J. (2002) 'Using earned value management', *Cost Engineering*, Vol. 44, No. 9, pp. 32–36, EBSCO Publishing.

Georgoulias, Andreas (2006) 'Channel Tunnel Rail Link: risk transfer and innovation in Project Deliver', Version 1, case study prepared as a basis for class discussion at the Harvard Design School under the supervision of Professor Spiro N. Pollalis: www.gsd.harvard.edu/people/faculty/pollalis/cases/CTRL-V5.pdf – accessed 16 September 2009.

Harris, F. and McCaffer, R. (2006) *Modern Construction Management*, 6th edition, Blackwell Publishing.

Hayes, H. (2002) 'Using earned value analysis to better manage projects', *Pharmaceutical Technology*, pp. 80'84, Contract Services.

Hoong, L.C. (2007) *A Critical Examination of Contractors' Cost Control Systems in the UK*, unpublished BSc (Hons) Commercial Management and Quantity Surveying dissertation, University of Wolverhampton.

Howes, R. (2000) 'Improving the performance of earned value analysis as a construction project management tool', *Engineering Construction and Architectural Management*, Vol. 7, No. 4, pp. 399–411, Blackwell Science Ltd.

Kidston, P. (2005) 'Controlling construction projects using earned value analysis': www.planningengineers.org/information-zone/publications/papers – accessed 18 May 2009.

Kim, E., Wells, W. and Duffey, M. (2003) 'A model for effective implementation of earned value management methodology', *International Journal of Project Management*, Vol. 21, pp. 375–382, Elsevier Science Ltd and IPMA.

Oberlender, G.D. (1993) *Project Management for Engineering and Construction*, McGraw Hill.

Pilcher, R. (1973) *Appraisal and Control of Project Costs*, McGraw Hill.

Pilcher, R. (1992) *Principles of Construction Management*, 3rd edition, McGraw-Hill.

Pilcher, R. (1994) *Project Cost Control in Construction*, 2nd edition, Blackwell Scientific Publications.

Raby, M. (2000) 'Project management via earned value', *Work Study*, Vol. 49, No. 1, pp. 6–9, MCB University Press.

Staffurth, C. (ed.) (1975) *Project Cost Control Using Networks*, 2nd edition, Heinemann.

Stephenson, P. and Hill, M.S. (2005) 'Cost value reconciliation (CVR) in the UK construction industry', *RICS COBRA Research Conference*, Brisbane, Australia, 4–8 July.

The Institute of Chartered Accountants in England and Wales (ICAEW) (1998) *Standard Statement of Accounting Practice 9 (Revised): 'Stocks and long-term contracts'*, London, ICAEW.

Walker, I. and Wilkie, R. (2002) *Commercial Management in Construction*, Blackwell Publishing.

Wiggin, C.P. (2005) *Critical Evaluation of the Use of Earned Value Management in the UK Construction Industry*, unpublished MSc Construction Project Management dissertation, University of Wolverhampton.

Wikipedia (2007) *Earned value management*: http://en.wikipedia.org/wiki/Earned_value_management – accessed 24 May 2007.

Websites

www.balfourbeatty.com – accessed 20 June 2012.

14 Change management: valuing variations

14.1 Introduction

Variations are inevitable on building and civil engineering projects and may range from small changes having little consequential effects to major revisions, which result in considerable delay and/or disruption to the project.

There are a number of reasons for the introduction of changes on building works, including: inadequate briefing from the client, inconsistent and late instructions from the client, incomplete design, lack of meticulous planning at the design stage, lack of coordination of specialist design work and late clarification of complex details (Gray *et al*., 1994). Additionally, on civil engineering works there are many cases where changes and new rates are necessary because of the nature of the ground. Furthermore, changes may occur due to the client's desire to include the latest technology.

Research by Salama and Habib (2009) reviewed the causes of variations on projects in the Middle East, particularly in Dubai. They noted that cost overruns and late completions were prevalent in Dubai. An example is the landmark Dubai Police Headquarters building, which was tendered for a value of AED111 million (£19 million) and 18 months' duration and was completed at a cost of AED147 million (£24 million) after 26 months, i.e. 28 per cent over budget and 44 per cent over scheduled duration, with 180 variation claims, out of which 165 were approved. They further identified that factors causing variations on projects in Dubai could be classified into three categories:

1. factors that occur during the initiation and planning stages – mainly as a result of lack of clear project definition;
2. factors relating to clients – clients insisting on playing a leading role in the approval of design or the selection of subcontractors and materials, causing delays in approvals;
3. external factors – a rapidly growing construction industry leading to short-term shortages in key skills, machinery and specialist subcontractors.

Establishing a realistic valuation for variations on construction works is often not an easy task. Both parties need considerable experience and sound judgment to settle variations. The parties are required to have a sound appreciation of the methods of construction, estimating practice and scheduling of construction works often utilizing computer planning software. But most importantly the parties should keep comprehensive, meticulous records of the factors relevant to the variation.

Panel 14.1 Case study: London Underground Jubilee Line extension

It was always the intention to have a full *engineer's design* for the civil works with full working drawings produced to form part of the tender package – albeit contractors were also encouraged to submit alternative design and construction proposals. The very tight timescales for the original design phase and the changing requirements meant this objective was ambitious and, in practice, could not be realized.

Consequently the working drawings issued at contract award, despite the moratorium, remained incomplete in terms of both number and substance. This was highlighted on one contract where the contractor stated that they had been issued with 48,000 instruments of change by the time the work was complete.

Source: Mitchell (2003)

The traditional method of valuing variations, both on building and civil engineering works, was to base the valuation of the variations on the rates or prices contained within the bills of quantities or schedules or pro-rata thereto and only in extreme conditions to apply a *fair valuation*. In this regard, it was general practice to value the variation based on 'the rate which the contractor would have inserted against that item had it been included at the time of tender' (Haswell, 1963).

This approach of valuing variations often led to disagreement between the parties, with the client's quantity surveyor wishing to rigidly adhere to the rates in the bill and the contractor wanting the rates to reflect the true cost as incurred or likely to be incurred. An analysis of the *Building Law Reports* shows that the valuation of variations has been a popular topic of litigation within the UK construction industry.

If the varied works are complex, the parties need to be skilled negotiators and be prepared to adopt a give-and-take attitude in order to bring about a satisfactory settlement. Under the traditional approach, compromise was often required for there was seldom one correct solution. Indeed, the parties might consider several different approaches before selecting the appropriate strategy.

However, in recent years there has been a shift of approach, with many standard conditions of contracts introducing the requirement for the contractor to submit a lump sum quotation for the variation prior to receipt of the official variation order and before carrying out the work. The advantage to the employer in this approach is that the final commitment, including disruption and extended time, is known prior to the instruction and the majority of the risk is transferred to the contractor. The advantage to the contractor is the certainty of obtaining adequate recompense for the variation – provided the quotation covers the full amount of the uncertainty.

14.2 Managing the change control process

The baseline of the project is defined within the client's project execution plan (sometimes called the project management plan). Any changes to this baseline need to be rigorously assessed and controlled by the client's project management team before any variation instructions can be issued to the contractor. All the project team members, including designers, should question whether the change is really required – does it add value? Furthermore, all should be familiar with the change control process and procedures.

Typically the change control cycle embraces the following stages:

Stage 1: Identify the change: all design drawings should be carefully checked by the client's quantity surveyor and any changes from the baseline tender drawings identified before these are sent to the contractor.

Stage 2: Evaluate the change: the anticipated impact on the project cost baseline and programme, together with any change to the quality or whole-ife cost, should be evaluated by the client's quantity surveyor with support from the construction programmer; if possible the contractor should be involved with this evaluation. Lazarus and Clifton (2001) critically identify that an adversarial culture is a major barrier to effective change management.

Stage 3: Internal review: the client's site-based project management team should check and approve the formal evaluation of the proposed change control order. Potts (1995) describes such a change order mechanism on the HKMTRC project, on which the client's project executive met twice a week to review the proposed changes to the baseline. On this mega project, change request submissions 'Form X ' were raised to cover all changes to the project baseline for design, construction (covering changes to the sequence or temporary works following an Engineer's Instruction) and claims/commercial settlements.

Stage 4: Client approval: the client's project executive should consider the proposed change order and approve, reject or defer. The aim should be to achieve a prompt turnaround from identification and evaluation through to authorization from the client's project executive.

Stage 5: Implement changes: upon approval the formal change instruction or variation order should now be issued to the contractor together with the necessary updated drawings.

Stage 6: Adjust the client's monthly financial statement: the client's quantity surveyor should include this additional expenditure/reduction in the monthly final statement and adjust the project contingency. The monthly statement should always reflect the anticipated out-turn cost, i.e. the anticipated final account – the aim is ensure that there are no surprises (see example of client's monthly financial statement within Potts, 1995).

However, it is acknowledged that any change management system has to be flexible enough to accommodate urgent changes, particularly where site health and safety issues are involved.

The CIRIA report C556, *Managing Project Change: A best practice guide* (Lazarus and Clifton, 2001) presents best practice recommendations for the effective management of change on construction projects. The guide sets out the various types of change and key management principles and identifies the importance of maintaining an appropriate project culture. The CIRIA Report C556 also contains a useful toolkit containing pro-formas, flowcharts and schedules. It also contains examples of change management processes, including Gardner and Theobald's 'Traffic Light System' – red sheets for advanced warning, amber sheets for unapproved estimates and green sheets for approved estimates.

Hao *et al*. (2008) reinforce these concepts with the development of a general change process model based on five stages: identify, evaluate, approve, implement and review changes; they also reflect on the difficulties in identifying a mature software model for managing construction changes.

14.3 Contractual requirements – ICE Conditions of Contract, 7th edition, January 2003

Although this particular form has now been withdrawn by the ICE, its change management approach is still relevant for its replacement contract, the Infrastructure Conditions of Contract (ICC) Measurement Version; hence this review. This form is designed for use on civil engineering projects based on a bill of quantities measured in accordance with the Civil Engineering Standard Method of Measurement. The quantities set out in the bill of quantities are the estimated quantities of the work. The standard form creates what is known as an *admeasurement* contract, by which the employer undertakes to pay for the actual quantities of work executed reflecting the engineer's design of the permanent works calculated based on the latest drawings and schedules.

The valuation of variations under clause 52 in the ICE 7th edition is as follows:

Option 1 – Clause 52(1) If requested by the Engineer the Contractor should submit their quotation for any proposed variation and their estimate of any consequential delay which should be agreed *before* the order is issued or *before* work starts.

Option 2 – Clause 52(3) Where a request is not made or agreement is not reached under Option 1 as soon as possible *after* receipt of the variation the Contractor should submit to the Engineer their quotation for any extra or substituted works *having due regard to any rates or prices included in the Contract* together with their estimate of the cost of any such delay.

The Engineer then has 14 days from receiving the submissions to either accept, or negotiate. Upon reaching agreement with the Contractor the Contract Price should be amended accordingly.

Option 3 – Clause 52(4) Failing agreement between the Engineer and Contractor under either sub-clause (1) or (3) the value of variations ordered by the Engineer in accordance with Clause 51 should be ascertained by the Engineer after consultation with the Contractor in accordance with the following principles and should be notified to the Contractor.

- Where work is of a similar character and executed under similar conditions to work priced in the Bill of Quantities it shall be valued at such rates and prices contained therein as may be applicable.
- Where work is not of a similar character or is not executed under similar conditions or is ordered in the Defects Correction period the rates and prices in the Bill of Quantities shall be used as the basis for valuation so far as may be reasonable failing which a fair valuation shall be made.

Under sub-clause 52(6) the engineer could instruct that any additional or substituted work should be carried out on a daywork basis – this should be minor or incidental work which cannot easily be measured. For further discussion on dayworks see Section 17.10 of Chapter 17, *FIDIC Contract*.

The 2003 edition of the ICE 7th edition introduced the new sub-clause 52(2) which refers to sub-clause 51(3) variations proposed by the contractor, in other words savings initiated through value engineering.

Furst and Ramsey (2001) note in Keating that the procedure under sub-clause 52(3) falls short of the 'Change Order Procedure found under many contracts based on the U.S. practice, where the change order may not be issued until agreement is reached on price and delay'.

14.4 Contractual requirements – JCT Standard Building Contract with Quantities (SBC/Q 2011)

At the instigation of the architect/contract administrator under clause 5.3.1. a quotation may be offered by the contractor for the work in accordance with Schedule 2 quotation. The schedule identifies that the quotation should include the following items with sufficient supporting information:

- amount of adjustment to the contract sum – which should be made by reference to the contract bills, where appropriate and with appropriate adjustment to the preliminary items;
- any adjustment in time required for completion;
- amount to be paid for direct loss and/or expense not included elsewhere;
- a fair amount for the cost of preparing the Schedule 2 quotation;
- where required by the instruction, information on additional resources required to carry out the variation and the method of carrying out the variation.

If the Employer wishes to accept the Schedule 2 quotation, then the architect/contract administrator should confirm the quotation and issue a variation to the contractor, making any necessary adjustment to the contract sum and the completion date.

If the employer does not accept the Schedule 2 quotation then the variation is valued based on the traditional valuation rules contained within clauses 5.6 to 5.10.

Clause 5.6 also requires that, if the work can be properly valued by measurement, then such work shall be valued in accordance with the following rules:

1 Where the additional or substituted work is of similar character to, is executed under similar conditions as, and does not significantly change the quantity of, work set out in the Contract Bills, the rates and prices for the work so set out shall determine the valuation.
2 Where the additional or substituted work is of similar character to work set out in the Contract Bills but is not executed under similar conditions thereto and/or significantly changes its quantity, the rates and prices for the work so set out shall be the basis for determining the valuation and the Variation shall include a fair allowance for such difference in conditions and/or quantity.
3 Where the additional or substituted work is not of a similar character to work set out in the Contract Bills, the work shall be valued at fair rates and prices.

Sub-clauses 5.6.1.4 and 5.6.1.5 also set out rules for where approximate quantities are included in the BofQ. If the valuation relates to the execution of additional or substituted work which cannot be properly measured, then the work should be valued on a daywork basis in accordance with the '*Definition of Prime Cost of Daywork Executed under a Building Contract*' issued by the RICS and the Construction Confederation as current at the base date, together with percentage additions on the prime cost at the rates set out by the contractor in the contract bills (Clause 5.7).

Apart from the requirement under clause 52(1) in the ICE 7th edition, where the contractor is to submit a quotation *without* reference to the contract rates or prices, the provisions for valuing variations under both the ICE 7th edition and the JCT 2011 are very similar.

The most comprehensive review of the legal principles involved in valuing variations under the JCT 98 contract was undertaken by Mike Rycroft, Director of James R. Knowles, and Dr Issaka Ndekugri, Director of the MSc Construction Law at the University of Wolverhampton (Rycroft and Ndekugri, 2002). The article, which examined the contract provisions with an aim of providing guidance on practical implications and how to avoid or deal with essential pitfalls, has since been referred to by learned judges when dealing with legal disputes involving variations.

14.5 Contractual requirements – The NEC Engineering and Construction Contract, 3rd edition

The 3rd edition of the NEC Engineering and Construction Contract (NEC3) was published in June 2005.

One of the more radical changes introduced by the NEC3 was the concept of 'compensation events', a term to denote any incidence of risk for which the client accepts liability under the contract. Clause 60.1 sets out 19 compensation events of which clause 60.1 (1) Changing the works information, is equivalent to the variations clauses under other standard forms of contract.

After discussing with the contractor different ways of dealing with the compensation event, which are practicable, the project manager may instruct the contractor to submit alternative quotations (clause 62.1).

Clause 62.2 requires the contractor to submit a quotation for the variation reflecting both the time and cost implication.

Clause 63 identifies that the changes to the prices are assessed as the effect of the compensation event upon:

- the actual defined cost of the work already done;
- the forecast defined cost of the work not yet done; and
- the resulting fee.

Clause 63.6 identifies that 'Assessment of the effect of a compensation event includes risk allowances for cost and time for matters which have a significant chance of occurring and are at the Contractor's risk under this contract'.

Quotations should be based on the assessment of *actual cost*, the definition of which is given in the contract. For example, Option B: Priced contract with bill of quantities, 'Actual cost is the cost of components in the Schedule of Cost Components'. This in effect links actual cost and assessment of the compensation event back to the schedules which relate to Part Two – data provided by the contractor – again making the parties' *bargain* form the basis for valuation. The idea with the Schedule of Cost Components is that conceptually the contractor is in the same position for a compensation event as when he tenders for the work (Mitchell and Trebes, 2005). If there are time and disruption implications, then a revised programme must be submitted. Mitchell and Trebes (2005) further contains within Appendix 2 a detailed calculation of a quotation for a new footbridge forming the basis of a compensation event under an NEC3 contract – this is an excellent example which should be standard reading for all those involved with NEC3 contracts.

Two viewpoints from practitioners on the practical issues involved in using the NEC Schedule of Cost Components for valuing variations are contained within the NEC Users' Group Newsletters, Issues 20 and 22 (see NEC website).

14.6 Fixing the rate (traditional contracts)

Max Abrahamson, in his book *Engineering Law and the ICE Contracts, 4th edition* (1979) (based on the ICE 5th edition) states that rate fixing 'is normally a give-and-take operation between the engineer and contractor'. Later he clarifies this with, 'The basic consideration is that the contractor has agreed to do all work within the contract – original and varied – on the basis of his bill rates'.

Max Abrahamson recommends that when fixing the rates the parties should attempt to follow the following rules:

- General principle: try to follow the same principles that the contractor used in calculating his rates for the tender.
- Fair valuation: fair to both parties, i.e. cost plus a reasonable percentage for profit, with a deduction for any proven inefficiencies by the contractor.

- Market rate: may be taken into consideration or used completely.
- However, only in exceptional cases should the basis of valuation from the BofQ rates be abandoned.

The logic in using bill rates and prices for valuations is that the contract itself is founded on these rates and, since the contract contemplates variations, it is fair to both parties that bill rates should be used in valuations.

The Contract gives very little practical guidance on the method of rate fixing. It will normally be necessary to break down the quoted rates into the various elements of plant, materials, labour and overheads, in order to make appropriate adjustments.

Table 14.1 shows how the original BofQ rate can be used to establish a new rate after the issue of a variation order changing the description of the formwork from exceeding 1.22 m. to formwork 0.4 –1.22 m. wide. The new rate has been built up using the same rate for *materials*, with 10 per cent addition on the *labour* and *plant* elements to reflect formwork to smaller areas. The same percentages for *site overheads* and *head office overheads and profit* as included in the original BofQ rate, 15 per cent and 10 per cent, respectively, has been incorporated into the build-up of the new *star rate*.

In order to adopt this approach it is recommended that the employer's contract administrator/quantity surveyor obtain a breakdown from the contractor of the six most significant rates prior to the signing of the contract. This information is rarely requested in the UK at the pre-tender stage. However, under the Singapore post-1980 SIA Contract it is a contractual requirement that contractors provide a make-up of prices (reported in Hudson's, 1995: 946).

The author (Potts) recollects visiting a contractor's office whilst working for the HKMTRC in Hong Kong in order to establish the basis of the tender build-up – there was one small problem: the contractor was French and, not surprisingly the estimate was in French. Thoughts of visiting the Japanese contractors for a similar tender breakdown were soon abandoned!

It can be said that the position for valuing variations under sub-clauses 52(3) and (4) under the ICE 7th edition is in line with most other standard forms, i.e. the basis of the valuation is on the concept of price rather than cost. The rationale is that the rates identified in the contract bills, or schedules of rates, will form the basis, either directly or indirectly, for the value of the additional works.

Table 14.1 Example of using BofQ rate to establish new rate ('star rate')

	BofQ item *Formwork rough finish plain vertical exceeding 1.22m* *(CESMM4 item G145)*	*New star rate item* *Formwork rough finish plain vertical 0.4–1.22m* *(CESMM4 Item G144)*
Labour	30.00	33.00
Materials	9.00	9.00
Plant	4.00	4.40
	———-	———-
	43.00	46.40
Site overheads @15%	6.45	6.96
	———-	———-
	49.45	53.36
Head office overheads @ 10%	4.95	5.34
	———-	———-
	£54.40	£58.70
	======	======

The intention of the contractual provisions will normally be to maintain the competitive element in the valuation of variations as represented by the contract bills or schedules of rates – if used – so that the parties' *bargain* forms the basis of valuation. This means adopting the existing rates as the starting point for valuing variations, irrespective of whether they appear too high, too low, or unreasonable for some other reason. This philosophy is confirmed in *Dudley Corporation v Parsons & Morrin (1959*) and *Henry Boot v Alstom* (2000) (see summaries in section 14.8).

Furst and Ramsey (2001) in Keating point out that *similar conditions* are those conditions which are to be derived from the express provision of the contract documents. Extrinsic evidence of, for instance, the parties' subjective expectations is not admissible. Davison and Mullen (2009) concur with these comments and cite the case of *Wates Construction (South) Ltd v Bredero Fleet Ltd* (1993) 63 BLR 128 in which the judge was asked to consider an appeal from the award of an arbitrator who had determined how the 'similar conditions' and 'character' of clause 13.5 in the 1980 JCT form could be ascertained. The judge concluded that the arbitrator was wrong to consider 'extrinsic' matters such as the knowledge gained as a result of negotiations when determining the contract conditions which should be derived from the contract bills, drawings and other documents.

However, in practice, contractors often argue that the work is not similar to the tendered work and fair rates should apply, often claiming that the work should be valued on a daywork basis, based on the actual records of resources used. Judge Bowsher, QC in his judgment in the case of *Laserbore Ltd v Morrison Biggs Wall Ltd* (1993) CILL 896 had to decide the meaning of *fair and reasonable payments for all works executed*. He considered that the costs-plus basis was wrong in principle even though in some instances it may produce the right result. The appropriate approach was to adopt general market rates. The judge saw no objection in the use of FCEC (Federation of Civil Engineering Contractors) Schedules of Dayworks provided there was no duplication in payment for insurances and head office charges.

In the *Tinghamgrange* case (see summary in section 14.8) the Court of Appeal held that, on a contract based on the ICE 5th edition, a fair valuation under clause 52(1) included compensation to the main contractor for a loss of profit on payment to a subcontractor in respect of the cancellation of an order resulting from an engineer's variation.

In the *Weldon Plant* case (see summary in section 14.8) it was held that a fair valuation under clause 52 of the ICE 6th edition should be based upon the reasonable cost of carrying out the work if reasonably and properly incurred. His Honour Judge Humphrey Lloyd, QC considered that a fair valuation must include something on account of each of the elements which are ordinarily to be found in a contract rate or price: elements for the cost of labour, the cost of plant, the cost of materials and the cost of overheads and profit, whilst time-related overheads (preliminaries) might require to be proved.

Example

A contractor has inserted a rate of £28/m^2 for formwork to a retaining wall. The quantity was 576 m^2 based on 24 bays 8 metres long by 3 metres high.

The engineer issued a variation order reducing the retaining wall to 16 bays, i.e. 384 m^2 after the shutter had been ordered but before the work commenced on construction of the wall.

Calculate a revised rate for this varied work making necessary assumptions (8 per cent site overheads/10 per cent head office overheads, profit and risk). The contractor has informed the engineer that in pricing the item he allowed for a purpose-built steel shutter 8 metres x 3 metres at a capital cost of £6,000.

Solution

First, it is necessary to analyse the original rate of £28.00/m^2. Unlike a traditional build-up of a rate we will need to start at the end and work backwards.

BofQ rate (based on 576 m^2)	£28.00
Less 10 per cent head office overheads and profit	
(Divide by 110 then multiply by 100)	£2.55
	£25.45
Less 8 per cent site overheads	
(Divide by 108 then multiply by 100)	£1.89
Net rate	£23.56
Material: purpose-built shutter	
£6,000 divided by 576 m^2	£10.42
Labour and plant:	
Erect and strike, including all necessary cranage	£13.14*

Now we have analysed the original rate we can build up the rate for the varied work using the same approach as above.

Labour and plant:	
Erect and strike including all necessary cranage	£13.14* (as original)
Material: purpose-built shutter	
Contractor is entitled to recover full cost	
£6,000 divided by 384 m^2	£15.63
	£28.77
Add 8 per cent site overheads	£2.30
	£31.07
Add 10 per cent head office overheads and profit	£3.11
New rate for formwork (based on 384 m^2)	£34.18/m^2
	=======

The rate should be confirmed on a *star rate* form and endorsed by authorized representatives from both the employer and contractor. This logical approach complies with the contract terms and should satisfy the auditor if the project is subject to audit.

Practical considerations

Variations have the potential to generate significant additional costs, delay and disruption to even the best-planned construction project. Some of the factors which should be considered for inclusion in a quotation submitted before the work is executed or in assessing a fair valuation after the event include:

- general items, including revised method statement, effect on the critical path, revised production rates, out of sequence working, restricted access, summer-to-winter working,

changed nature of ground, temporary works, additional cleaning, late payment and financing, etc.;
- labour, including uneconomic working, difficulty of access, attraction money, additional bonus, overtime payments, shift work, accommodation and welfare, etc.;
- construction equipment, including additional mobilization/demobilization, transport costs, additional scaffolding/hoisting/cranage, standing charges, additional payments to operators, working out of sequence, etc.;
- materials, including additional costs of late orders, additional procurement costs, airfreight, premium costs, small quantities, excessive waste, potential breakages and additional testing, etc.;
- subcontractor costs, including additional costs in expediting, possible additional visits to the subcontractors' factory/yard/works in the UK or overseas;
- inflation effect if work executed at a later date;
- additional costs in design work and reprogramming;
- cost of preparing the quotation;
- additional time-based preliminaries/site overheads;
- contingencies for contractor's risk;
- head office overheads and profit.

This above list is significant as it indicates the extent of the potential differences in the positions of the two main parties. A typical scenario is when the contractor wants to include many of the above items in the quotation, whilst the client's quantity surveyor is unable to agree and the variation ends up being valued using the traditional approach. The parties need to keep talking and negotiating in an open manner within a true spirit of trust and cooperation.

The author (Potts, 2003) demonstrated the difficulty of assessing risks on a quotation for a variation on a marine project based on the FIDIC 4th contract. The investigation showed that, under the engineer-designed traditional procurement route, the practice of submitting quotations before undertaking the work is carried out could lead to the contractor incurring substantial financial losses which are not recoverable.

Feedback from research

Research by Love and Li (2000) on the causes and costs of rework in construction on two Australian projects identified the costs of rework as 3.15 per cent and 2.40 per cent of the project value. They also identified that the primary causes of rework were changes initiated by the client and end user together with errors and omissions in the contract documentation.

Research by Sun *et al*. (2004) identified the direct effects of changes as follows: addition of work; deletion of work; demolition of work already done; rework; specification change; time lost in stopping and restarting current tasks in order to make the variation; revision to project reports and documents; and reorganization of schedule and work methods to make up the time. The indirect effects of changes were also identified as follows: need for communicating change to all project members; dispute and blaming amongst project partners; loss of productivity due to reprogramming; loss of rhythm; unbalanced gangs and acceleration; change in cash flow; financial costs; loss of earnings; increased risk of coordination failures and errors; lower morale of workforce; and loss of float. These therefore increased sensitivity to further delays.

Dr Monty Sutrisna investigated the quotation mechanism for pre-pricing variations on civil engineering works (Sutrisna *et al*., 2004). Feedback was obtained from 95 participants with a wide range of experience on the administration of civil engineering projects. However, exposure to ICE 7th edition was acknowledged by many as limited, with the emphasis in the sector shifting to use of customized versions of the NEC ECC 2nd edition. The respondents identified that the quotation mechanism has been perceived effective only in certain conditions. The perceived problems were twofold: limited time available to produce the quotation and calculation of appropriate risk allocation.

The following best practice in connection with quotations for variations which had the greatest chance of being accepted was also identified:

- basis of calculation of overheads in quotation – use original BofQ overheads;
- basis of pricing level to be applied – pricing level at time of preparing BofQ;
- basis of profit level – original BofQ profit level;
- contingency for risk – based on risk analysis assessment.

Dr Denise Bower's research (Bower, 2000) was developed based on a technique known as *Impact* used by Fluor Daniel Ltd in the process plant sector and was tested on low-risk, low-technology civil engineering projects. The technique enables the parties to calculate the *influence curve* for a project enabling the calculation and prior agreement of the indirect charges of variations based on the type of work involved. This technique would seem to have considerable merit, particularly on partnering projects where there is a long-term relationship between the parties.

S.G. Revay's research (Revay, 1992) based on an analysis of 175 projects in Canada found that:

> All in all the real cost of variations resulting from the incorrect or incomplete bid documents represented an average of 33.5 per cent of the original contract price. Simply stated, the real cost of the variations injected during the currency of the project was triple that of the direct.

Sun *et al*. (2009) describe the development of a capability maturity model which aims to provide a measurement framework for assessing the improvement of a project team's capability in dealing with contract changes. The model defines five levels of maturity – *ad hoc*, informal, systematic, integrated and continuous improvement. Measurement is carried out in six key process areas – management processes, risk management, communication, management information, collaboration and leadership/objectives. The assessment of the project team's change management capability can then be compared in key performance indicator format with the typical industry benchmark on a spider diagram.

14.7 Quantum meruit claims

Quantum meruit, Latin for *as much as he has deserved* can arise in two forms, contractual and quasi-contractual. Quasi-contractual actions embrace a range of claims based upon unjust enrichment and, therefore, they reside within the law of restitution.

Contractual *quantum meruit* claims may arise in the following situations:

- where the contract provides for the payment of a reasonable sum;
- where the contract does not stipulate the price to be paid or the contractual pricing mechanism fails;
- where part performance has been accepted; and
- where an innocent party elects to treat the contract as discharged following a repudiatory breach by the other party.

The circumstances in which restitutionary *quantum meruit* are likely to arise are as follows:

- work is carried out under the erroneous assumption that a contract exists;
- work is carried out in anticipation of a contract being concluded; and
- work is performed outside the scope of the contract.

Work is carried out under the erroneous assumption that a contract exists

An example is the case of *Peter Lind & Co Ltd v Mersey Docks and Harbour Board* (1972) 2 Lloyd's Rep. 234. The civil engineering contractor Lind had submitted two tenders to the Harbour Board. One of the tenders was for a fixed price and the other incorporated a fluctuation clause to account for changes in the price of labour and materials. The Board accepted Lind's tender without specifying which one. Nonetheless, Lind carried out the works and claimed payment on a *quantum meruit* basis.

The court held that there was no concluded contract since it was not clear which tender had been accepted and, therefore, Lind was entitled to be paid on a *quantum meruit* basis.

Work is carried out in anticipation of a contract being concluded

It is fairly common for work to begin whilst negotiations are continuing over critical issues such as price, scope of works and date of completion. If these matters remain unresolved, a contract is unlikely to arise even though work is underway.

The best illustration is *British Steel Corporation v Cleveland Bridge and Engineering Co* Ltd (1984) 1 All ER 504. Cleveland Bridge was involved in the construction of a bank in Saudi Arabia. For this purpose it required the manufacture and supply of steel nodes. Accordingly it issued a letter of intent to British Steel for the supply and delivery of the nodes. The letter requested British Steel to 'proceed immediately with the works pending the preparation and issuing to you of the official form of sub-contract.'

In the event there was no agreement on price or delivery dates and neither did British Steel receive the *official form of subcontract*. It sued Cleveland Bridge for £229,838 being the price of the nodes. Cleveland Bridge, whilst admitting liability in the sum of £200,853, issued a counterclaim for £867,736 on the basis that, in breach of contract, British Steel had delivered the nodes late and out of sequence. The alleged contract comprised the letter of intent; a subsequent telex from Cleveland Bridge dealing with delivery sequence; and, finally, British Steel's conduct in delivering the nodes. British Steel claimed that no contract had come into existence and therefore the counterclaim was misplaced.

Judge Robert Goff held that British Steel was entitled to its claim on a *quantum meruit* basis. The contract between the parties was still in a state of negotiation; there was no agreement on critical issues, especially the terms of the proposed subcontract.

Work is performed outside the scope of the contract

When work is carried out outside the scope of the contract, remuneration for such work can only be obtained on a *quantum meruit* basis. The case of *Costain Civil Engineering and Tarmac Construction Ltd v Zanen Dredging and Contracting Co Ltd* (1997) CILL 1220 is instructive.

The Welsh Office appointed Costain/Tarmac Joint Venture (JV) as main contractors under an ICE 5th edition contract for the construction of the A55 Conwy bypass and river crossing in North Wales. Part of the works involved dredging a trench in the bed of the estuary of the River Conwy, into which six prefabricated tunnel elements, made of reinforced concrete, were to be immersed and jointed together to form the carriageway of the bypass. These tunnel elements were constructed on-site in what was known as a casting basin, and when completed the casting basin was flooded and the tunnel elements floated out to their positions in the estuary where they were sunk into place. Zanen were engaged as dredging subcontractors under the Blue Form subcontract.

The contract provided options for dealing with the casting basin once works were complete. One proposal was that the basin should be backfilled, and this had been priced by the Costain/Tarmac JV as a saving in excess of £1 million, on the basis that it would be cheaper for them to backfill the casting basin rather than to remove the spoil and dispose of it off-site.

As an alternative, Crown Estates, who were not a party to the main contract, wanted to build a marina using the flooded casting basin. Accordingly they entered into agreements with the Welsh Office and with Costain/Tarmac to the effect that the contractor would credit the Welsh Office with the £1 million previously mentioned, but would be paid by Crown Estates approximately £2.5 million for additional works around the perimeter of the marina.

The Joint Venture instructed Zanen to carry out additional works, which Zanen considered outside their subcontract, but the JV stated that they were not and continued giving instructions relating to the marina works. The court agreed with Zanen that the works to the marina were outside the terms of the original subcontract and therefore fell to be evaluated using a *quantum meruit* approach.

The JV suggested that the correct approach was to reimburse the cost to the subcontractor of executing the marina works (£380,000) and allow a reasonable uplift in respect of its overheads and profits of 10 per cent. His Honour Judge Wilcox did not accept this position and considered that, as Zanen had executed the work, which had been wrongly instructed, under protest, therefore the assessment should be based on the principles of restitution and unjust enrichment. He awarded Zanen reimbursement based on *quantum meruit* calculated by reference to the cost (£380,000) together with a portion of the substantial profit made by the Joint Venture for the marina works (a further £380,000) which he considered reflected the benefit to the Joint Venture of having those works executed by a subcontractor whose resources were already mobilized on site.

14.8 Some other relevant legal cases (reported in date order)

Dudley Corporation v Parsons and Morrin Ltd (1959) Court of Appeal, *Building Industry News*, 17 February 1967

In this case an extra over item for excavating 750 cubic yards in rock was priced at £75 total, i.e. 2s (10p) per cubic yard. A fair and reasonable price would have been £2 per cubic yard.

It was not known beforehand whether rock would be met, but in fact 2,230 cubic yards of rock was excavated.

The architect (under a 1939 RIBA with Quantities form) valued the excavation at 750 cubic yards at 2s (i.e. the original extension of £75) and the balance at £2 per cubic yard. It was held that this approach was incorrect and that the contractor was entitled to 2s per cubic yard only for the whole of the quantity excavated.

Simplex Concrete Piles v St. Pancras Borough Council (1958) 14 BLR 80

Under a RIBA contract the contractor undertook to carry out design and construction of piling for the foundations on a block of flats and guaranteed to satisfy certain tests. In the event conditions made it impossible to satisfy the tests and the contractor suggested two alternative methods of piling – one method to be carried out by themselves and another involving a subcontractor.

The contractor submitted the two prices to the architect and received the following response: 'we are prepared to accept your proposals that the piles . . . should be of the bored type in accordance with quotations submitted by [the subcontractor]'.

It was held that the architect's letter was an architect's instruction involving a variation in design and the contractor was entitled to be reimbursed based on the subcontractor's quotation and not as the original tender price.

A.E. Farr v Ministry of Transport (1965) 3 E.R. 88; 5 BLR 94 (1977)
This case concerns a roadworks project executed under the *ICE Conditions of Contract*, 4th edition with a bill of quantities prepared in accordance with a standard method of measurement.

Clause 12 in the Conditions stated that the rates and prices in the bill were to cover all the contractor's obligations under the contract.

The bill of quantities specified that measurement of excavation be based on the net volume, with any additional excavation required for working space paid for as a separate item based on the sum areas of the excavation.

In the event, no separate item for working space was measured, though two specific items for working space were included in a part of the bills relating to subsidiary parts of the works. The contractor claimed that he should be paid for working space whenever it was reasonable to excavate outside the net plan area.

It was held by a majority in the House of Lords (overruling the decision of the Court of Appeal) that the quoted words amounted to a promise to pay the contractor extra for all working space required, whether or not described in a special item in the bills.

Note that this is in contrast with the modern provision of the Civil Engineering Standard Method of Measurement 4th edition, where working space is not measured separately as it is 'deemed included' in the contractor's excavation rates (CESMM4 Class E Coverage Rule C1).

Mitsui Construction Co v Att. Gen of Hong Kong (1986) 33 BLR 1
The conditions of contract were specifically produced by the Hong Kong Government and were based on the ICE 4th edition and JCT63. The 2-year project involved the construction of a tunnel 3,227 m long and 3.6 m in diameter. The ground conditions were extremely variable and the engineer specified five different types of tunnel lining suitable for the different ground conditions.

In the event the ground conditions were far worse than expected and the contractor was required to construct far more of the heavily designed tunnel section (2,448 m compared to 275 m billed) and much less of the unlined section. An extension of time of 2 years was granted.

The engineer argued that the changes in quantity were not the result of an official variation order and the contractor was paid at the rates in the BofQ. The contractor claimed that the increased quantities amounted to variations and that revised rates should apply. The HK Government took the view that the engineer had no power to revise the rates.

The Privy Council took 'a sensible and business like approach' and found in favour of the contractor, stating that the engineer did indeed have the power to fix a revised rate.

English Industrial Estates v Kier Construction Ltd (1991) 56 BLR 93
Two contracts were let to Kier in June and November 1987 for the reclamation at the former Dunlop factory at Speke in Liverpool. The excavation for both subcontracts was sublet to J&B Excavation Ltd.

In the specification the contractor was given a choice for structural fill using material arising from either demolition or importation.

The contract required the contractor to submit his programme and method statement with his tender. The contractor's method statement showed that the excavation subcontractor intended to crush only *suitable material arising from the demolition* with the remainder removed from site.

In January 1988 the engineer wrote to the contractor instructing him to crush *all* hard material arising from site. The subcontractor claimed compensation for the losses due to the additional costs involved.

The arbitrator held that the contractor's method statement was a contract document and the engineer's instruction was thus a variation under clause 51 of the ICE 5th edition.

On appeal, the High Court agreed with the arbitrator's decision.

Tinghamgrange Limited v Dew Group Ltd (1995) 47 Con LR 105
This case involved North West Water who commissioned works at its Oswestry Water Treatment Works. Part of the works required the removal and replacement with new, precast concrete under-drainage blocks.

The precast concrete blocks had to be specifically manufactured early in 1989 for inspection by North West Water, prior to the contractor, Dew, placing an order.

The order was placed in April 1989 for 282,354 precast concrete drainage blocks at 90p each. Dew's order contained a condition allowing cancellation and restricting the supplier Tinghamgrange's right in respect of any claim.

Ultimately, North West Water instructed Dew to cancel the order, as a change of specification was required. Tinghamgrange claimed loss of profit on the blocks ordered, but not delivered, as a result of the cancellation. The claim was passed onto North West Water as part of the costs associated with the variation.

North West Water accepted the cost of the special mould manufactured for the purpose of fulfilling Dew's order but rejected the claim in respect of loss of profits.

There was no dispute that the change was a variation and it was accepted that the substitution of tiles for concrete blocks involved work, which was not of a similar character. This required the engineer to value the new works using bill rates as the basis so far as reasonable and, if they could not provide a proper basis for valuation, then a fair valuation was required.

By a majority of 2:1, the Court of Appeal allowed Dew to recover the loss of profit; the majority view was that Tinghamgrange's loss was an integral part of Dew's costs and to exclude that element from a valuation of the work would be unfair.

Henry Boot Construction Ltd v Alstom Combined Cycles Ltd (2000) TLR April 11
In this case Alstom employed Henry Boot to carry out some civil engineering works at a new power station at Connah's Quay in Wales. The power station comprised four combined cycle turbines; each turbine comprised a turbine hall, a heat recovery steam generator and a cooling tower. The *ICE Conditions of Contract*, 6th edition applied.

During pre-contract negotiations Boot submitted a price of £250,880 for temporary sheet piling to trench excavation in the turbine hall area, and this price was incorporated into the contract.

During the course of the works the engineer issued variation orders instructing temporary sheet piling to trench excavation in the heat recovery system generator area and the cooling tower area.

In the event it was identified that Boot's price of £250,880 had been calculated in error, including sheet piling to both the turbine hall and the heat recovery steam generators, although the contract was clearly entered into on the basis that it was for the turbine hall alone.

The decision primarily concerns the application of clause 52(1)(b) in the *ICE Conditions*, dealing with the valuation of variations; the crucial part of the clause is set out below:

> Where work is not of similar character or is not executed under similar conditions or is ordered during the Defects Correction period the rates and prices in the Bill of Quantities shall be used as the basis for valuation so far as may be reasonable failing which a fair valuation shall be made.

Boot argued that the additional work should be valued using contract rates. Alstom considered that this approach was not reasonable and would result in an unjustified windfall for Boot; Alstom argued that a fair valuation should be made.

Initially the matter went to arbitration with the arbitrator agreeing with Alstom. However, on appeal the case was heard in the Technology and Construction Court before His Honour Judge Humphrey Lloyd, QC, a most experienced construction lawyer.

The judge stressed the importance of the contract rates and the fact that they cannot be avoided simply because one party is dissatisfied with them. 'The contract rates were sacrosanct, immutable and not subject to correction. The fact that a rate or price, which would otherwise be applicable, may be considered too high or too low is completely immaterial.'

The judge quoted with approval Max Abrahamson in his *Engineering Law and the ICE Conditions of Contract* (1979: 185):

> It is not unreasonable to apply rates as a basis for applying varied work merely because the rates are mistaken. . . . What is reasonable is to be decided by reference to the nature of the original and varied work, not extraneous conditions.

The Judge held that it was not a windfall for Boot – it was 'all part of the risks of contracting which produced thrills as well as spills'.

The Court of Appeal dismissed Alstom's appeal and confirmed the decision of Judge Humphrey Lloyd, QC. The Court of Appeal also confirmed that clause 52(2) (which permits the engineer to vary a rate if the nature or amount of the variation is such as to make the rate inappropriate) did not justify displacing the rates themselves because they were inserted by mistake or were too high or too low or otherwise unreasonable.

The decision confirms the well-established view that a contractor will be held to his rates and prices in the contract for both original and varied work. It also illustrates the serious consequences of failure to pick up errors at tender stage.

Postscript: In a later case of *Aldi Stores Ltd v Galliford (UK) Ltd* (2000) the principle of using bill rates in valuing variations was confirmed. However, in this case it had the opposite effect and the use of bill rates resulted in a significant loss to the contractor.

Weldon Plant Ltd v The Commission for New Towns (2000) TCC BLR 496

Weldon Plant Ltd entered into a contract, based on the *ICE Conditions* 6th edition, for the construction of Duston Mill Reservoir. Material to be excavated consisted of clay and gravel. Under the terms of the contract Weldon could excavate below the designed level of the reservoir bed to obtain additional gravel, which it was entitled to sell – the contractor priced this work at a negative rate.

However, the engineer issued an instruction, which required Weldon to excavate all the gravel below the bed and to backfill with clay to the design level. The engineer valued the instruction as a variation and wished to apply the negative rate, also awarding an extension of time of over 7 weeks.

Weldon Plant disputed the engineer's findings and referred the matter to arbitration and later to the technology and Construction Court.

The arbitrator found that the bill rates could not be applied in this instance and that a fair rate should be used. However, having decided upon this, the arbitrator refused to include in the fair rate any provision for profit or contribution which the varied work might have made to the fixed and running overheads of the business. His logic was that the contractor could not recover these unless he could prove that he had lost an opportunity to earn extra profit or overheads elsewhere by reason of the variation. As no such proof had been provided, fair rates and prices should exclude these elements.

The Technology and Construction Court disagreed with the arbitrator. In the court the judge took the view that in evaluating a fair valuation the calculation should be based upon the reasonable costs of carrying out the work if reasonably and properly incurred.

Attention was drawn to what *Keating on Building Contracts* has to say on the constituent elements of a fair valuation. It states that useful evidence may include a calculation based on the net cost of labour and materials used, plus a sum for overheads and profit. The judge considered that a fair valuation should include these elements and referred the case back to the arbitrator for him to include in his valuation an amount for overheads and profit.

The judge also expressed approval, in passing, of the principle that fair rates and prices should, if need be, be tempered so as not to fall too far out of line with the bill rates.

Sam Woo Bore Pile Foundation Limited v China Overseas Foundation Engineering Limited (2006) (originally heard as HCCT 76/1996)

This case concerned a HK$7.9 million (£650,000) dispute on the measurement of large-diameter piling on a Hong Kong project. The bill of quantities included an item for 'Extra over 1500 mm diameter vertical pile shaft for toeing-in to bedrock 1.50m in depth (min)'.

Notes on the subcontract drawings identified that 'founding levels will be finalised by the Engineer after drilling proof boreholes and that piles will be socketed into rock (of grade II or III or better) in accordance with the "Details of Pile Base" shown on the drawings'. The ultimate founding levels under the subcontract were to be finally determined by the engineer on the basis of actual ground conditions, with a minimum of 1.50 m depth.

In the event the toeing in lengths for the 64 piles were considerable, with many being over 5 m long and on some occasions up to 11 m. The plaintiff, Sam Woo, claimed that the toeing item should be remeasured in linear metres as per the terms of the subcontract and the CESMM requirements, which state that 'separate items are to be provided in BofQs for each 0.5 m in depth of extra-over in the toeing-in of cast-in-situ concrete piles'.

Mr Justice Reyes, in the Hong Kong Court of Appeal upheld the Court of First Instance's earlier judgment of 1996. He considered that the CESMM measurement rule in linear metres was not relevant as the contract included a provision that SMM applies 'save expressly stated otherwise'. The judge considered that, as the BofQs were prepared on the basis of a unit rate per pile (not length of pile), this was in effect an express statement that SMM §9.14 (which concerns an amount payable per unit length) was not intended to apply.

Mr Justice Reyes also commented:

> How a subcontractor allocates his risks, costs and profit among the various items of a BofQ is a matter for him. It is perfectly plausible for a contractor to decide to charge a fixed amount per pile to cater for the possibility of excess toeing in lengths. The risk of a considerable excess might then be factored into the fixed amount quoted in the BofQ. Where the subcontractor has inadequate information about ground conditions on site, he may decide to charge a greater fixed amount per pile. But he might also opt not do so. He may, for example, think that it would be more appropriate to charge only a modest amount per pile and instead to

cater for the risk that such costing might entail by charging more for other items in a BofQ. It would not be for the Court to look behind the agreed consideration and examine the adequacy or reasonableness of the fixed amount charged by the contractor per pile.

Sam Woo's claim for additional lengths of toeing in piling to bedrock was thus rejected.

14.9 Conclusions

Valuing variations based on *cost* as opposed to *price* at first sight seems a radical shift in philosophy. However, in practice the only real effect of the changes in the valuation of variations provision from the pre-2000 standard forms of contract to the ICE 7th edition, JCT 2011 and the NEC3 is that there is an intention to agree the valuation of variations in advance where possible.

In principle, the contractor could forward a quotation irrespective of *actual* likely cost and disruption. In reality such a quotation is likely to be rejected for being unreasonable and not '*in the spirit*' of the contract conditions; indeed Dr Monty Sutrisna's research confirms that quotations are only effective in certain circumstances. In this instance, the effect of the rejection of the quotation is to bring into play provisions for valuation, which have existed for some time, thus returning to the traditional variation rules.

Despite the foregoing it is appropriate to highlight the fundamental change in philosophy adopted by the new contracts. The NEC3 has clearly adopted a partnering type approach and this has been followed to some extent initially by the ICE 7th edition and latterly by the JCT 2005 and 2011 forms. This should have a bearing when the contractor submits the quotation and the project manager/engineer/architect/contract administrator assesses it; indeed experience to date would suggest this is the case.

14.10 Questions

Question 1

Identify the different opinions offered by experts on the definitions of *similar character/conditions* and *fair rates, prices and allowances* as reported in Rycroft and Ndekugri (2002).

Compare and contrast how these opinions might be applied in the case of changes to a deep basement for a pumping station on a greenfield site executed under either the JCT11 SBC/Q or the NEC3 contract.

Question 2

Identify the possible difficulties and solutions in valuing variations using the Schedule of Cost Components under the NEC3 Contract.

(See NEC website for Paul Pavia, Franklin and Andrews, *NEC Users' Group Newsletter* Issue No. 20; Bryan Tyrell, Currie and Brown, *NEC Users' Group Newsletter*, Issue No. 22.)

Question 3

Identify those factors, which should be considered by the client's project manager in developing an effective strategy to reduce/minimize the impact of variations on a construction project.

You may make any assumptions concerning the type and nature of the project.

Question 4

Where work is omitted from the contract by way of a variation can a contractor/subcontractor claim for loss of profit?

Question 5

The case of *Costain and Tarmac JV v Zanen Dredging* (85 BLR 77) concerned the construction of the Conwy Bypass and the river crossing in Wales. Zanen argued that work to a marina was outside their contract and should be valued on a *quantum meruit* basis.

What is meant by *quantum meruit* and what are the guidelines for valuing work on this basis?

Question 6

Critically review and summarize in 250 words the article by Denise Bower 'A systematic approach to the evaluation of indirect costs of contract variations' in *Construction Management & Economics* (2000) Vol. 18, pp. 263–268.

Question 7

On a new £1 million retail store, where the JCT Intermediate Contract 1984 applied, the bill of quantities contained the following items which were priced by the contractor as stated.

A.	Disposal of excavated material off-site	1,547 m^3 @ £8.63/$m^{3:}$: £13,350.61
B.	Disposal of excavated contaminated material off-site in a licensed tip	1463 m^3 @ £44.60/m^3: £65,249.80

The client considered the contractor's tender too high, and the architect negotiated a reduction to the bid based on:

- raising the level of the site to take all the clean material, and
- burying contaminated material on site in borrow holes.

Based on this, the contractor agreed that the revised bill of quantities rates for both items 'A' and 'B' was £0.00/m^3.

In the event, all the material to be excavated was contaminated and disposed off-site. How much would you pay the contractor for this work? For the solution: see *Aldi Stores v Galliford (UK) Ltd* (8 March 2000).

Question 8

Working in groups of four critically review the case of *Sam Woo v China Overseas* (2006). Consider the risks for Sam Woo when tendering. As his estimator how would you identify these? Was the fact that there was no specific Particular Preamble stating that the item was not measured as per CESMM relevant? What about the case of *A.E. Farr v Ministry of Transport* 5 BLR 94 (1977)?; were any of the comments contained in the *Building Law Reports* for the *A.E. Farr v Ministry of Transport* case relevant to this case? You should also consider John Molloy's relevant comments on measurement of civil engineering works in Hong Kong (Molloy 2002, 2007).

How would you have settled this dispute? Would the settlement have been any different if the project had been procured using a project-partnering agreement or a long-term alliance?

For technology details, see 'Particular Specification for large-diameter bore piles socketed into bedrock' (Government of Hong Kong Architectural Services Department website).

14.11 References/further reading

Abrahamson, M.W. (1979) *Engineering Law and the ICE Conditions of Contract*, 4th edition, Elsevier Applied Science Publishers.

Bower, D. (2000) 'A systematic approach to the evaluation of indirect costs of contract variations', *Construction Management and Economics*, Vol. 18, pp. 263–268.

Broome, J.C. (1997) 'Best practice with the new engineering contract', *Proceedings Institution of Civil Engineers*, Civil Engineering, 120, May, pp. 74–81.

Eggleston, B. (2001) The *ICE Conditions of Contract*, 7th edition, Blackwell Scientific Publications.

Furst, S. and Ramsey, V. (2001) *Keating on Building Contracts*, 7th Edition, Sweet & Maxwell.

Gray, C., Hughes, W. and Bennett, J. (1994) *The Successful Management of Design*, *A handbook of building design management*, The University of Reading.

Hao, Q., Shen, W., Neelamkavil, J. and Thomas, R. (2008) 'Change management in construction projects', *CIBW78 25th International Conference on Information Technology: Improving the Management of Construction Projects through IT Adoption*, Santiago, Chile, July 15–17, pp. 387–396.

Haswell, C.K. (1963) 'Rate fixing in civil engineering contracts', *Proceedings Institution of Civil Engineers*, Vol. 24, February, pp. 223–234.

Lazarus, D. and Clifton, R. (2001) *Managing Project Change: A best practice guide*, CIRIA C556, Construction Industry Research and Information Association, London.

Love, P.E.D. and Li, H. (2000) 'Quantifying the causes and costs of rework in construction', *Construction Management and Economics*, Vol. 18, pp. 479–490.

Mitchell, B. (2003) *Jubilee Line Extension: From concept to completion*, Thomas Telford.

Mitchell, B. and Trebes, B. (2005) *NEC Managing Reality: Book 4 managing chang*e, Thomas Telford.

Molloy, J. (2002) *Civil Engineering Measurement Disputes*, http://202.65.206.164/hkis/html_qsd/upload/PubConlaw/conlaw15_0.pdf – accessed 11 November 2012.

Molloy, J. (2007) 'Civil engineering measurement claims in Hong Kong', *TS 3F Management of Partnership and Conflict*, FIG Working Week, Hong Kong SAR, China, 13–17 May.

Potts, K. (1995) *Major Construction Works: Contractual and financial management*, Longman Scientific and Technical.

Potts, K. (2003) 'Risk management on variations – two civil engineering case studies', *RICS COBRA Research Conference*, RICS.

Revay, S.G. (1992) 'Can construction claims be avoided?', in Fenn, P. and Gameson, R. (eds) *Construction Conflict and Resolution, International Construction Management Conference*, Manchester, E & FN Spon.

Rycroft, M. and Ndekugri, I. (2002) 'Variations under the JCT standard form of building contract', *Construction Law Journal*, Vol. 18, No. 4, pp. 310–333.

Salama, M. and Habib, A.P. (2009) 'Investigating the causes of variation within the construction projects in UAE', in Dainty, A. (ed.) *Proceedings of the 25th Annual ARCOM Conference, 7–9 September 2009*, Nottingham, UK, Association of Researchers in Construction Management, pp. 949–957.

Sun, M., Sexton, M. and Anumba, C. (2004) *Managing Changes in Construction Projects*, EPRSC.

Sun, M., Vidalakis, C. and Oza, T. (2009) 'A change management maturity model for construction projects', in Dainty, A. (ed.) *Proceedings of the 25th Annual ARCOM Conference*, 7–9 September 2009, Nottingham, UK, pp. 803–812.

Sutrisna, M., Potts, K. and Proverbs, D. (2004) 'Quotation mechanism for pre-pricing variations in civil engineering projects: a quest for best practice', *Journal of Financial Management of Property and Construction*, Vol. 9, No. 1, pp. 13–25.

Wallace, I.N.D. and Hudson, A.A. (1995) *Hudson's Building and Engineering Contracts: Including the Duties and Liabilities of Architects, Engineers and Surveyors*, Sweet & Maxwell.

Websites

www.archsd.gov.hk/english/publications/publication_pdf/c142.pdf – accessed 20 October 2009.
www.atkinson-law.com.
www.newengineeringcontract.com.

15 Claims management

15.1 Introduction

Settling delay claims is a challenge both to clients and their advisors and to contractors as claims management requires knowledge of construction technology, construction law (including relevant case law), the conditions of contract, contract administration, project planning systems and the psychology of negotiation.

The architect/contract administrator or project manager/engineer does not have an easy task when settling extension of time (eot) claims. His Honour Judge Richard Seymour, QC in the legal case of *The Royal Brompton Hospital NHS v Watkins Gray International (UK)* (2000) identified that the architect needs three basic skills.

The first skill is *construction knowledge*. Judge Seymour observed that the construction of a modern building involves the carrying out of a series of operations, some of which can be undertaken at the same time as others, but many can only be carried out in sequence. It is not therefore immediately obvious which operations have an impact upon others and which delays affect the ultimate completion date. The architect must therefore have an in-depth knowledge of construction and the inter-relation between trades and construction operations.

The second skill is *an understanding of programming techniques*. Judge Seymour observed that, in order to make an assessment of whether a particular event has affected the ultimate completion of the work, rather than just a particular operation, it is necessary to consider what operations, at the time when the event happens, are critical to the forward progress of the work as a whole. The architect will usually have to adopt an appropriate programming technique to analyse the effect of various events. There are a number of established methods of analysis, but each is likely to produce different results to others, sometimes dramatically different results.

Most importantly the accuracy of any of the methods in common use depends upon the quality of the information used. It is much more difficult to establish the critical path if one does not know how the contractor planned the job. Not only that, but the critical path may well change during the course of the works, and almost certainly will do if the progress of the works is affected by some unforeseen event.

The third skill is *contractual awareness* – the architect must understand the relevant contractual provisions and be up to date on decided cases.

To add to the architect's difficulties, as observed by Judge Seymour, often the contractor gives a written notification of delay regardless of whether it really thought that the event would cause delay to the completion of the works. Notices are given every time anything alters or anything happens which could conceivably delay any individual activity. While, from a contractor's point of view, adopting such a practice has the advantage that he is covered, no matter how things should turn out, it does make life difficult for the architect. In addition, the contractor often makes exceptionally optimistic predictions of the extent of the likely delay caused by the matters that it notified.

Settling claims also requires an understanding of the psychology of negotiation. There are two main styles that can be adopted – problem-solving (i.e. cooperative) or bargaining (i.e. competitive). Problem-solving negotiations normally involve both parties working together with a level of mutual trust. In contrast, a bargaining approach is often confrontational, and a gain for one party is a loss for the other. Cooper and Potts (1995) identify the stages and review best practice involved in a typical scenario of a successful negotiation.

Claims are inevitable on most large construction projects and are usually motivated by a single cause – the contractor, or subcontractor, anticipates spending, or actually spends, more money than they expected and they believe someone else is responsible.

It is important to identify some of the main reasons leading to the submission of claims by contractors, these might include:

- inadequate time and planning before the project commenced on site;
- inviting tenders on incomplete drawings;
- introducing extensive revisions throughout the project;
- inadequate site investigation – particularly on civil engineering works involving deep basements, piling, earthworks, tunnelling, etc. In the author's experience, a claim for unforeseen ground conditions is encountered on most large projects;
- extensive changes to standard forms shifting the risk to the contractor often lead to claims – standard forms of contract are tightly integrated documents;
- client's interference with the timing and sequence of construction.

To avoid or minimize claims, parties must ensure clear drafting of the contract, equitable and appropriate distribution of risks, combined with an innovative procurement strategy that promotes a change in the claims culture (McNeill, 2011).

15.2 Terms in contract conditions

The terms in the relevant contract are obviously critical; these will identify the grounds for extensions of time and cost recovery and state the procedures and relevant timescales for notifications and submissions. There is likely to be a close link between making a claim for delay and recovering the additional costs incurred by the contractor. Delay claims are therefore of considerable commercial importance to contractors.

The effect of extending time is to maintain the contractor's obligation to complete within a defined limit, and failure by the contractor to do so leaves him liable for damages, either liquidated or general, according to the terms of the contract. 'The benefit of an extension of time for the Employer is that it establishes a new contract completion date, and prevents time for completion of the works becoming at large' (SCL, 2002: 5). It should be noted that an extension of time award on its own does not carry any cost refund; it is necessary to examine separate clauses in the contract.

Standard JCT Form of Building Contract, 2011 edition (JCT 11)

An architect/contract administrator, who is appointed by the employer and acts as his agent, administers JCT 11; however it is noted that the architect is required to act fairly and reasonably towards the contractor. Extensions of time are dealt with under clause 2.27, with clause 2.29 listing 13 categories of delay, called *relevant events* that give rise to an extension of time in the event that they occur. The key issues are identified as follows:

- When it becomes apparent that the progress of the works is being or is likely to be delayed then the contractor should forthwith notify the architect/contract administrator of the cause of delay and identify whether it is a relevant event.
- The contractor is required to provide with the notice, or as soon as possible after the notice, particulars of the event and an estimate of the length of any of the expected delays to the completion of the works or any section beyond the relevant completion date.
- Upon receipt of the notice and any further particulars the architect/contract administrator is required to decide whether in his opinion any of the events notified are relevant events and whether as a result of such events the works are likely to be delayed beyond the completion date. If they so decide, they are then required to give a fair and reasonable extension of time to the contractor.

In practice, it is quite often the case that the architect will wait for full particulars of the actual effect of the event before making a decision, by which time the event and its consequences may be long past and the actual effect may be measured with greater certainty. It is quite common for architects to wait until after completion before making such grants of extension of time, but this is clearly not what the clause intended (Burr and Palles-Clark, 2005).

The claim for loss and expense is dealt with separately under clause 4.23 which lists only five *relevant matters*.

ICE Conditions of Contract, Measurement Version, 7th edition, 1999 (ICE 7th edition)

In 2009 the ICE Council elected to solely endorse the NEC3 suite of contracts and 2 years later officially withdrew from its involvement in the *ICE Conditions of Contract*. It is noted, however, that one of the standard Network Rail contracts (NR8) and indeed the Infrastructure Conditions of Contract (ICC) Measurement Version being promoted by the Association for Consultancy and Engineering (ACE) and the Civil Engineering Contractors Association (CECA) are still based on an amended version of the *ICE Measurement Version*, 7th edition. It is therefore necessary to consider its approach to claims management.

The ICE 7th edition is administered by the engineer who is appointed by the employer and acts as their agent, but is also required to act fairly towards the contractor and act as an independent quasi-arbitrator in the event of disputes: 'Should the Engineer consider that the delay suffered fairly entitles the Contractor to an extension of time for the substantial completion of the Works . . .'.

Items giving grounds for an extension of time under the ICE 7th edition include:

- any variation ordered under clause 51(1);
- increased quantities referred to in clause 51(4);
- any cause of delay referred to in the conditions, e.g. clause 7(4) late drawings;
- exceptionally adverse weather conditions;
- any delay impediment prevention or default of the employer;
- other special circumstances of any kind whatsoever.

An extension of time under the ICE 7th edition gives no entitlement to payment to the contractor, and the question of whether a particular delay is reimbursable or non-reimbursable is properly determined from the cause of delay and proof of cost arising.

The following issues give potential grounds for extension of time and extra cost under the ICE 7th edition:

Clause	Subject
5	documents mutually explanatory;
7(4)	further drawings – delay in issue;
12(6)	unforeseen conditions (including profit);
13(3)	engineer's instructions;
14(8)	revised method or programme;
31(2)	facilities for other contractors;
32	fossils;
40(1)	suspension of the works;
42(3)	late possession of the site;
59(4)	nominated subcontractor's default.

15.3 Legal requirements of claims submission

Delay analysis is necessary for two main reasons:

1 to demonstrate entitlement to extension of time and hence relief from liquidated damages; and
2 to demonstrate entitlement to the costs of prolongation.

It is relevant to consider the observations made by judges when dealing with the settlement of construction disputes.

In the case of *John Barker v London Portman Hotel* (1996) the judge observed: '[the Architect] did not carry out a logical analysis in a methodical way of the impact which the relevant matters had or were likely to have on the Plaintiff's planned programme. . . . He made an impressionistic, rather than a calculated assessment.'

In the more recent case of *Balfour Beatty v Borough of Lambeth* (2000) His Honour Judge Humphrey Lloyd, QC observed:

> By now one would have thought that it was well understood that, on a contract of this kind, in order to attack (a non-completion certificate or an eot) the foundation must be the original programme (if capable of justification and substantiation to show its validity and reliability as a contractual starting point) and its success will similarly depend on the soundness of its revisions on the occurrence of every event, so as to be able to provide a satisfactory and convincing demonstration of cause and effect. A valid critical path (or paths) has to be established both initially and at every later material point since it (or they) will almost certainly change.

Some means has also to be established for demonstrating the effect of concurrent or parallel delays or other matters for which the employer will not be responsible under the contract.

The contractor's claim must fulfil certain legal criteria:

- The claim must prove that a loss has been suffered.
- The claim must show that the loss arose as a result of the relevant acts or omissions.

- The contractor is under the legal burden of proving the link between the event, or the cause, and the delay to completion, or the effect; they must therefore be able to demonstrate the cause and effect.
- The legal quantum of the claim must be established. The measure of damages in common law remain as stated in *Robinson v Harman* (1848):

The rule of common law is that where a party sustains a loss by reason of a breach of contract, he is as far as money can do it, to be placed in the same situation, with respect to damages, as if the contract had been performed.

This comment indicates that the contractor is not entitled to earn additional profit on the claim.

- It must be shown that the loss could not have been mitigated by reasonable conduct; e.g. the contractor should remove mobile construction equipment if no work is being carried out.
- The losses must not be seen to be too remote. The principles concerning a common law damages claim were set down in *Hadley v Baxendale* (1854). In this case the court laid down two situations where the defendant should be liable for loss caused by a breach of contract:
  1. loss which would arise naturally, *according to the usual course of things*, from their breach; and
  2. loss *as may reasonably be supposed to have been in the contemplation of the parties at the time when they made the contract, as the probable result of the breach of it*.

15.4 Contractor's programme

The contractor will normally be required to produce a construction programme at the commencement of the project and both parties will rely on this programme in order to justify any extensions of time. 'The programme should be updated to record actual progress and any extensions of time granted. If this is done, then the programme can be used as a tool for managing change, determining extensions of time and periods of time for which compensation may be due' (SCL, 2002: 5). However, unless the programme is submitted with the bid it is unlikely to become a contract document, and the client's representative will be under no obligation to accept it as a basis for payment. Employers sometimes request contractors to include the programme and method statement with their tender in order to check on the 'quality' of the contractor's bid. There are potential risks to the employer in this approach as highlighted in the legal case of *Yorkshire Water Authority v Sir Alfred McAlpine Ltd* 32 BLR 119 (1985).

The programme should preferably be in network format in order that the logic can be checked and the critical path established. Normally extensions of time would be awarded only for any items that are delayed and are on the critical path. The programme should be linked with the method statement and record key dates for information required from the client. In order to avoid confusion some enlightened clients specify the software to be used by contractors/ subcontractors in order to ensure compatibility with their own systems.

The contractor may have included *float* within the programme to allow for any time for which they are responsible, e.g. inclement weather. Traditionally this float has been considered the contractor's own and should not be utilized by the engineer without compensation to the contractor. However, in the case of *Anson Contracting Limited v Alfred McAlpine Construction Isle of Man* (1999) Judge Hicks considered that any float should be considered on a first-come-first-served basis and that McAlpine, not having suffered any loss, were not allowed to recover from their subcontractors a hypothetical loss that they would have suffered had the float not existed.

The Society of Construction Law's *Delay and Disruption Protocol* (SCL, 2002) recommends that the contract should identify who owns the float and if this is not specified then the 'project' should own the float. This latter recommendation has also been confirmed by the US Courts.

In 2008 the Chartered Institute of Building (CIOB) published the results of a survey of its members on project control and time management. The results from 73 companies with over 2,000 projects do not make good reading. It showed that the quality of time management is generally poor, with 54 per cent of the respondents using a simple bar chart and only 14 per cent using a fully linked critical path. The survey concluded that the more complex the project the less likely it is to be completed on time, with a high proportion of complex projects likely to be completed more than 6 months late (CIOB, 2008). In contrast, it is noted that most contracts for major public works in the USA contain CPM scheduling specifications (Lowe *et al*., 2007).

15.5 Concurrent delays

The courts generally favour the *common sense* approach when dealing with matters of causation. However, in practice, there may be competing causes of delay. For example, delays caused by the client and entitling the contractor to additional time and cost (e.g. late instructions) may occur at the same time as a delay due to exceptionally bad weather (normally time only) or a breakdown of the contractor's plant (contractor's risk).

Keating on Building Contracts, 7th edition (Furst *et al*., 2001) offers a number of alternatives for settling these complex issues, as described below.

The Devlin approach

If a breach of contract is one of two causes of loss, both causes cooperating and both of approximately equal efficacy, the breach is sufficient to carry judgment for the loss.

The Devlin approach, if applied to delays, would always come down in the contractor's favour if one of the competing causes of delay was a breach of contract on the part of the employer or the engineer or architect acting on his behalf.

The dominant cause approach

If there are two causes, one the contractual responsibility of the defendant and the other the contractual responsibility of the plaintiff, the plaintiff succeeds if they establish that the cause for which the defendant is responsible is the effective, dominant cause.

Which cause is dominant is a question of fact, which is not solved by the mere point of order in time, but is to be decided by applying common sense standards.

Keating on Building Contracts supports this approach:

> The dominant cause approach is supported as indicated above by great authority of weight in insurance cases. It is thought that the principles, so far as they apply, apply to contracts generally. It is accordingly submitted that the dominant cause approach is or should be the correct approach, as the law now stands, for Case C and for Case B also, unless exceptionally the contract on its true construction provides explicit answer without sophisticated analysis.

Case B as described in *Keating on Building Contracts*, concerns claims for payments under the contract for delay resulting from variation instructions where there is a competing cause of delay which could be no one's fault or the contractor's own delay in breach of contract. Case C provides for the same situation but where the contractor is instead claiming damages for breach of contract.

In the case of *City Inn Ltd v Shepherd Construction Ltd* (2010) the Scottish Court of Appeal upheld the decision of the lower court and considered that the dominant cause may be given effect where concurrency can be shown.

The burden of proof approach

If part of the damages is shown to be due to a breach of contract by the plaintiff, the claimant must show how much of the damage is caused otherwise than by his breach of contract, failing which he can recover nominal damages only.

Relevant legal cases

Two cases offer some guidance on establishing extensions of time when there are concurrent events: *Balfour Beatty Building v Chestermount Properties* (1993) and *Henry Boot Construction v Malmaison Hotel (Manchester)* (1999). In the latter case the judge said,

> It is agreed that if there are two concurrent causes of delay, one of which is a relevant event and the other is not, then the contractor is entitled to an extension of time for the period of delay caused by the relevant event, notwithstanding the concurrent effect of the other event. Thus to take a simple example, if no work is possible on site for a week, not only because of exceptionally inclement weather (a relevant event), but also because the contractor has a shortage of labour (not a relevant) event), and if failure to work during that week is likely to delay the works beyond the completion date by one week, then if he considers it fair and reasonable to do so, the architect is required to grant an extension of time of one week.

The *Malmaison* case was considered and His Honour Judge Seymour, QC gave further support to this approach in the case of *The Royal Brompton Hospital NHS Trust v Frederick Alexander Hammond* (No. 7) (2001). In a more recent case of *Motherwell Bridge Construction v Micafil Vakuumtechnik* (2002), when considering concurrent events, His Honour Judge Toulmin, QC agreed that his approach should follow the Henry Boot judgment. He commented,

> Crucial questions are (a) is the delay on the critical path? And if so, (b) is it caused by Motherwell Bridge? If the answer to the first question is yes and the second is no, then I must assess how many additional working days should be included.

Judge Toulmin departed slightly from the guidance in the Henry Boot case and went on to say,

> Other delays caused by Motherwell Bridge (if proved) are not relevant, since the overall time allowed for under the contract may well include the need to carry out remedial works or other contingencies. These are not relevant events, since the court is concerned with considering extensions of time within which the contract must be completed.

Judge Toulmin commented that the approach must always be tested against an overall requirement that the result accords with common sense and fairness.

It is quite common for delays to occur where both the contractor and the employer, or engineer or architect acting on his behalf, cause delays at the same time. The courts in the USA have had occasion to deliberate on this question. A situation may arise where the contractor is in delay, let us say due to essential materials not arriving on programme, whilst at the same time they are waiting for details from the engineer necessary to fix the materials when they arrive on site.

A widely employed legal maxim, which would be applicable to these circumstances, is one which states that *a party to a contract is not entitled to benefit from its own errors*. This being the case, the employer would be prevented from deducting liquidated damages and the contractor from claiming additional payment.

The SCL (2002:7) recommends that:

> If a Contractor incurs additional costs that are caused both by Employer delay and concurrent Contractor delay, then the Contractor should only recover compensation to the extent it is able to separately identify the additional costs caused by the Employer delay from those caused by the Contractor delay. If it would have incurred the additional costs in any event as a result of Contractor delays, the Contractor will not be entitled to recover those additional costs.

Roger Knowles offers the following advice on concurrent delays: 'Bearing in mind the various theories previously explained the best advice one can offer is to suggest that the contractor selects the theory which best suits his case and to argue it as forcefully as possible' (Knowles, 1992). This would seem sound advice on many of the issues concerning claims.

15.6 Proving the delay

There are basically four commonly used techniques in order to prove the entitlement to a delay (Lane, 2005, 2006):

1. as planned versus as built
   This is the most simplistic technique, which involves comparing the planned sequence and timing of the project with the actual sequence and timing. It does not require a critical path programme or separate the events or make any allowance for the contractor's inefficiency.
2. as planned impacted
   This technique takes the contractor's initial planned programme then adds the delays for which the employer is responsible. In theory the contractor should be entitled to an extension of time for their effect and will themselves be responsible for the difference between the impacted finish date and the actual finish date. This approach is highly theoretical and may bear no relationship to what the contractor did on site.
3. time impact analysis
   This technique takes a snapshot looking at the effect of the delay on the planned programme at the time the event occurs. The planned programme obviously needs to take account of the progress at the time the delay occurs, with the effects of the events then plotted on an updated planned programme. The disadvantage of this approach is that the snapshot approach may not embrace significant factors occurring between the snapshots.
4. as built but for analysis
   This approach involves identifying the *actual* sequence of the works. Events that are the employer's risk under the contract are identified and extracted from the as built programme to show how long the work would have taken but for the events at the employer's risk.

The main problems with using any of these approaches are that there is no consensus on the most suitable approach. The Society of Construction attempted to introduce some conformity by recommending the use of approach c) time impact analysis. Davison and Mullen (2009: 39) concur, stating,

> The proper basis for analysis of the impact of a change in terms of effect upon the sequence and timing of the works must be the programme in position immediately preceding the change to be analyzed, incorporating all known relevant information and revisions at that time.

In practice, however, it seems that the experts cannot reach a consensus on which approach is the most appropriate (Lane, 2006).

A simple time impact analysis will require the following approach:

- as planned network validated;
- known or notional employer delays added in to network to model effect on programme;
- network time analysed to calculate revised completion period;
- amount by which revised completion period extends beyond due date is eot entitlement.

This approach has the following advantages: (i) it is relatively cheap and easy to prepare; and (ii) it is easy to agree between parties or between experts. However, it has the following disadvantages: (i) it is theoretical and takes no account of actual methods and sequences of construction, nor of actual progress; and (ii) it is unlikely to be accepted as proof by a tribunal and it does not assist with concurrency of delays.

In contrast, a sophisticated time impact analysis will use the programme current at the time of delay. It has the following advantages: (i) it takes into account the contractor's progress up to the time of delay; (ii) it takes into account the contractor's intended planning at the time of the delay; and (iii) it is less a theoretical assessment of eot entitlement as at the time of the delay.

However, the sophisticated approach will have the following disadvantages: (i) it is very difficult for a tribunal to verify and hence trust the results; and (ii) if the information being used is not correct, then the results will prove nothing: 'garbage in–garbage out' (Marshall, 2005).

15.7 Disruption

The concept of delay, i.e. lateness, is readily understood; disruption, on the other hand, is more complex. Disruption causes loss of production, disturbance and hindrance and could be one of three kinds:

1. The work in question takes longer to complete, using the original resources.
2. The work takes the same time because of increased resources.
3. The contract takes the same time to complete, but certain resources are kept on site longer than originally necessary.

Thus, it can be seen that the contractor may be entitled to additional costs for disruption even though he has completed the contract on time or within the extended period.

The SCL Protocol (2002) identifies that the most appropriate way to establish disruption is to apply a technique known as *the Measured Mile*. This compares the productivity achieved on an un-impacted part of the contract with that achieved on the impacted part.

15.8 Progress records

The contractor and architect/engineer commonly keep these records. If possible the records should be taken jointly or be agreed/disagreed at the time of compilation. Well-maintained and accurate records form the backbone of most successful claims. It is preferable that settlement should be made at the time of occurrence of the circumstances giving rise to the claim.

The following should be included as a realistic minimum:

- a master programme based on a critical path network, together with subsequent updates. It is important that programmes showing progress at a certain time should be saved rather than overwritten with the progress of the following period;
- records of progress achieved and labour and plant resources applied;
- labour allocation sheets showing where the operative is working and when;
- plant records showing when plant is working and when it is standing;
- progress photographs/video records;
- site diaries in standard format – a daily record of the job in progress;
- a drawing register kept up to date as new drawings are issued;
- payroll records showing overtime worked and production records during these periods;
- handwritten notes taken at meetings;
- e-mails;
- details of target cost or bonus system operating;
- a weekly log of activities commenced, completed and problematic;
- budgeted and actual costs and man-hours;
- compilation of standard delay and disruption schedules (similar to *Scott Schedule* used in litigation/arbitration – see Table 15.1).

15.9 Claims presentation

The contractor should send to the architect/contract adminstrator/engineer as soon as possible their *notice of claim* which should:

- explain the circumstances giving rise to the claim;
- explain why the contractor considers the employer to be liable; and

Table 15.1 Delay/disruption schedule

Ref No	*Cause and effect of delay or disruption*	*Period of delay to sections or part of works*	*Period of delay to completion date*	*Contract clause relevant to delay*	*Contract clause relevant to loss/expense or contract clause breached*	*Date of delay notices and particulars*	*Date of loss and expense notice and particulars*
1	Introduction of additional piling to S.E. corner of Block 'A' Letter 29.07.08 refers	3 days	3 days	2.29.1	4.24.1	Contractor's letters 29.07.08 03.09.08	Contractor's letters 29.07.08 03.09.08

- state the clause(s) under which the claim is made.
- The contractor should, as soon as possible, follow up this *notice of claim* with a detailed *submission of claim* which should contain the following:
- a statement of the contractor's reasons for believing that the employer is liable for extra cost, with reference to the clauses under which the claim is made;
- a statement of the event giving rise to the claim, including the circumstances they could not reasonably have foreseen;
- copies of all relevant documentation, such as:
  1. contemporary records substantiating the additional costs as detailed;
  2. details of original plans in relation to use of plant, mass haul diagrams involved;
  3. relevant extracts from the tender programme and make of major BofQ items;
  4. information demonstrating the individual or cumulative effect of site instructions, variation orders and costs relating to the claim.
- a detailed calculation of entitlement claimed, with records and proofs.

A contractor's claim should be submitted in a similar format to that required for a *statement of case* in the courts. It should be self-explanatory, comprehensive and readily understood by someone not connected with the contract. It should contain the following sections:

- title page
- index
- recitals of the contract particulars
- relevant clauses and reasons for the claim
- evaluation
- appendices.

15.10 Quantifying the claim

The objective of all claims is to put the contractor back into the position he would have been in but for the delay; the original profit (or loss) should remain as included in the bid. It is therefore necessary to consider the *actual* additional costs incurred by the contractor at the time of the loss – provided of course that such costs have been reasonably incurred. It can be appreciated therefore that basing the evaluation on the contractor's tendered preliminaries is incorrect – even though this is the method sometimes used in practice for expediency. It is important to realize that any claims for prolongation and disruption will involve two tiers of evaluation. First, the direct consequences of the event or change will be required, usually in the form of an analysis of the effect on the contractor's resources and working methods – this is often the major part of the claim. Second, any indirect consequences, such as increased overheads or increased costs, will need to be considered.

The items described under the headings below are frequently encountered as *heads of claim* for the indirect consequences.

On-site establishment costs

These are often called site overheads or simply *preliminaries* because the prices are found in the preliminary section of the bill of quantities. However, all these costs should be ascertained from the contractor's cost records – these are the equivalent of damages at common law. It is also noted that the site establishment should be recorded when delay occurred and not at the end of the project when the resources will be running down.

This should be established based on the contractor's contemporary records, including:

- supervisory and administrative staff;
- site accommodation, including welfare and toilets;
- construction equipment and tools, e.g. tower cranes, scaffolding, etc;
- site services, telephones, electricity.

Head office overheads

In principle, head office overheads are recoverable, although difficult to ascertain in practice. The contractor should make all reasonable efforts to demonstrate through records the head office overheads that it has failed to recover. If this is not feasible, then the following formulae may be used with caution:

Hudson formula

The formula appears on page 1076 of *Hudson's Building and Engineering Contracts*:

h/100 x c/cp x pd

where *h* is the head office overheads and profit percentage included in the contract, *c* is the contract sum, *cp* the contract period in weeks and *pd* the period of delay in weeks.

Emden formula

An alternative is produced in *Emden's Building Contracts and Practice*, Vol. 2, p. N/46:

h/100 x c/cp x pd

where *h* is the head office percentage arrived at by dividing the *total* overhead cost and profit of the contractor's organization as a whole by the *total* turnover, *c* the contract sum, *cp* the contract period in weeks and *pd* the delay period in weeks.

Eichleay formula

This formula is best known and most widely used in the USA. The formula computes the daily amount of overhead that the contractor would have charged to the contract had there been no delay. The formula is developed in three stages:

Stage 1:

$$\frac{\text{Contract billings}}{\text{Total billings for actual contract period}} \times \text{Total HO overhead incurred during contract period} = \text{Overhead allocatable to the contract}$$

Stage 2:

$$\frac{\text{Allocatable overhead}}{\text{Actual days of contract performance}} = \text{HO overhead allocatable to contract per day}$$

Stage 3:

Overhead allocatable to contract per day	×	Number of days of compensable delay	=	Unabsorbed overhead

The use of formulae, such as Emden or Hudson, has been considered a legitimate and helpful way of ascertaining the loss of contribution to head office overheads in the recent case of *Walter Lilly & Company Limited v (1) Giles Patrick Cyril Mackay (2) DMW Developments Limited* (2012). In the cases of *Alfred McAlpine Homes North v Property and Land Contractor* (1995) and *Amec Building Limited v Cadmus Investments* (1996) the court simply calculated the contractor's average weekly costs (by reference to the company's accounts) multiplied by the number of weeks of delay and then allocated them to the particular contract by means of a pro-rata calculation based upon the value of the work carried out on the site during the overrun period and the value of all works being carried out by the contractor during the overrun period.

In his decision of *JR Finnegan Ltd v Sheffield City Council* (1988) the judge, William Stabb, said:

> It is generally accepted that, on principle, a contractor who is delayed in completing due to the default of his employer, may properly have a claim for head office off-site overheads during the period of delay on the basis that the work-force, but for the delay, might have had the opportunity of being employed on another contract which would have had the effect of funding the overheads during the overrun period.

Chappell (1998) identifies that there is a use for formulae in appropriate situations, usually as a last resort, where it is clear there has been a loss, but where there is a complete lack of proper evidence. However, their uncritical use without regard to available facts and without supporting evidence is not recommended.

> Pettet (1998) describes the 'forensic method of calculation' identifying a three-stage process for recovering head office overheads requiring calculation of specific overheads, non-specific overheads and overhead credits. Pettet (1998) includes a typical case study on a £1 million 50-week project with 20 weeks' delay and calculates the typical loss of head office overheads and profit under the various formulae as follows: Hudson formula: £40,000; Emden formula £30,000; Eichleay formula £17,600; and the forensic method £10,250.

Interest and financing charges

In order for reimbursement to be made under this heading, loss must be actually suffered. Further to the cases of *F.G. Minter Ltd v Welsh Health Technical Services Organisation* (1980) and *Rees & Kirby Ltd v Swansea City Council* (1985) it is now evident that contractors can recover as *cost* or *direct loss and expense* either:

- the interest payable on the capital borrowed; or
- the interest on capital that would otherwise have been invested.

This approach was confirmed as valid in the case of *Amec Process & Energy v Stork Engineers & Contractors* (2002). Amec put forward a claim for interest on alternative footings. First, compound interest was claimed on the basis that the contract terms allowed for the reimbursement of financing charges. Second, interest was claimed as damages for breach of contract. Finally, as a fallback position, Amec claimed statutory simple interest pursuant to the court's discretionary powers to award interest on judgment sums. Amec had financed the work from its own resources and from the use of inter-company loans and financing facilities provided by its parent company.

Judge Thornton concluded that, having regard to the valuation provisions of the contract, nothing could be fairer or more reasonable than that the extra cost to Amec of funding the additional work should be recoverable from Stork. Following *Rees v Swansea*, Amec was also entitled to the calculation of interest on a compounded basis to reflect the manner in which its works were financed.

It followed that the claim for financing could also be made as one for damages for breach of contract pursuant to the second limb of the *Hadley v Baxendale* (1854) case, being a foreseeable loss in specific knowledge of the parties at the time of making the contract.

The appropriate rate of interest is normally based on the actual rate paid by the contractor provided it is not excessive. Financing charges should be calculated using the same rates and methods as the contractor's bank, e.g. compounding interest at regular intervals.

Judge Anthony Thornton, QC (2008) identifies the relevance of The Late Payment of Commercial Debts (Interest) Act 1998 (LPCDIA). He concludes his paper on the significance of the *Sempra Metals v Commissioners of Inland Revenue* (2007) 4 All ER 657 case on the recovery of compound interest and financing claims:

> I predict that the effect of the Sempra Metals case will be two-fold. Firstly it will allow many significant claims that are based on a compounding of an interest-type claim to be brought and succeed. Secondly, it will raise litigants' consciousness as to the ready availability of recovery of compound interest as damages in circumstances that have not hitherto founded claims. The Sempra Metals case will also lead to greater reliance on the LPCDIA and to more frequent recovery of interest at 8 per cent over the official dealing rate.

Increased costs

If the contract is fixed price then the additional cost of carrying out the work later than anticipated due to delay and disruption is generally recoverable. Normally reimbursement would be on the basis of a known formula e.g. NEDO or *Baxter*. These are formulae used in conjunction with published indices for adjusting building, specialist engineering and civil engineering contracts to allow for changes in the costs of labour, plant and materials.

Profit

Loss of profit that the contractor would have earned but for the delay and disruption is an allowable head of claim following the rule established in the *Hadley v Baxendale* (1854) case. However, in order to succeed in such a claim the contractor must be able to prove that he has been prevented from earning profit elsewhere. This position is affirmed in *Aldgate Construction Company Ltd and Unibar Plumbing & Heating Limited* (2010).

Loss of productivity/winter working

Inefficient use of labour and plant is an acceptable head of claim. It can be established by comparing the production rates during the disrupted period with those rates achieved prior to the disruption.

Costs of claim preparation

Again, the contractor must be able to prove that they have incurred additional costs. Leading commentators seem to concur that the contractor's additional cost in preparing the claim and/or the cost of outside consultants is recoverable provided that the item has not been claimed elsewhere, e.g. as site overheads.

In the case of *Richards and Wallington (Plant Hire) Limited v Devon County Council* (1984) the costs of the claimant's staff, who were not acting as experts, was disallowed as a recoverable cost. However this approach was overturned in the recent case of *Amec Process & Energy v Stork Engineers & Constructors* (2002). Amec had engaged its own personnel in collating, analysing and presenting the primary and supporting evidence to be used by its expert witness. His Honour Judge Thornton, QC noted that the Civil Procedures Rules defined recoverable costs as including *fees, charges, disbursements, expenses and renumeration*. Judge Thornton was satisfied that the time charges incurred by Amec in employing its own personnel fell within each of these categories of cost.

15.11 Global claims

The SCL Protocol (2002) identifies that the practice of contractors making composite or global claims without substantiating cause and effect is discouraged and rarely accepted by the courts.

In general, it is necessary for the contractor to establish each and every head of claim, by means of supporting documentation and other evidence. The global approach was recognized in *J. Crosby & Sons Ltd v Portland UDC* (1967), which was decided under the *ICE Conditions of Contract*, 4th edition. However, this approach should be the exception, not the rule, only applicable where there are numerous/complex/inter-related issues. Doubt was cast on the global approach following The Privy Council's decision in the Hong Kong case of *Wharf Properties Ltd v Eric Cumine Associates* (1991), where the client's action against their architect for negligent design and contract administration were struck out as incomplete and therefore disclosing no reasonable course of action.

Following the case of *How Engineering Services Ltd v Lindner Ceiling Partitions PLC* (1995) Chappell (1998) considered that the courts have clearly set out what is required of a contractor when making a claim:

- The claimant must set out an intelligible claim, which must identify the loss, why it has occurred, and why the other party has an enforceable obligation recognized at law to compensate for the loss.

The claim should tie the breaches relied on to the terms of the contract and identify the relevant contract terms.

- Explanatory cause and effect should be linked.
- There is no requirement that the total amount for the loss must be broken down so that the sum claimed for each specific breach can be identified. But an 'all or nothing' claim will fail in its entirety if a few causative events are not established.
- Therefore a global claim must identify two matters:

    1 The means by which the loss is to be calculated if some of the causative events alleged have been eliminated. In other words, what formula or device is put forward to enable an appropriate scaling down of the claims to be made?
    2 The means of scaling down the claim to take account of other irrevocable factors such as defects, inefficiencies or events at the contractor's risk.

The case of *John Doyle Construction v Laing Management (Scotland) Limited* (2004) provided an important reassessment of global claims. This case has resulted in three main changes in the emphasis of the law:

1 Whereas previously it was understood that *any* cause of loss shown not to be the responsibility of the defendant would be fatal to the global claim, it now appears that this only applies if the cause of loss is *significant or dominant*.
2 The court seemed comfortable with the idea of apportionment of loss by the tribunal between causes for which the employer is not liable, even if this may be a rough-and-ready process.
3 The issue of whether causation can be proved should normally wait until the trial when all the evidence is in and so, presumably, would not be decided at the interlocutory stage on an application to strike out.

15.12 Conclusions

Claims submissions are inevitable on construction projects. Delays will be caused to the project which are outside the control of the contractor. These may entitle the contractor to additional costs as well as extensions of time. This chapter has identified some of the key issues and demonstrated the legal and administrative complexity of the subject. The parties will need to be skilled negotiators in order to avoid a lengthy arbitration or a court case.

From the employer's viewpoint, claims settled early are usually settled cheaply, for contractors will seldom be able to anticipate the full impact of delay and disruption until receipt of subcontractors' and suppliers' final invoices.

15.13 Some legal cases

Below are listed some of the more important cases involving construction claims:

Interest and financing charges

Farrans (Construction) Ltd v Dunfermline District Council (1988) [Court of Session – Inner House] 4 Con LJ 314.

Holbeach Plant Hire Ltd and Another v Anglian Water Authority (1988) [OR] (1988) CILL 448, 14 Con LR 101.

Morgan Grenfell (Local Authority Finance) Ltd v Seven Seas Dredging Ltd (No 2) (1990) [OR] 51 BLR 85, (1990) CILL 618, 21 Con LR 122, (1991) 7 Const LJ 110.

Kingston-upon-Thames (Royal Borough) v AMEC Civil Engineering Ltd (1993) 35 Con LR 39.

Secretary of State for Transport v Birse-Farr Joint Venture [QBD] 62 BLR 36, (1993) CILL 903, (1993) 35 Con LR 8, (1993) 9 Const LJ 213.

Blaenau Gwent Borough Council v Lock (Contractors Equipment) Ltd (1994) [OR] 71 BLR 94 (1993) CILL 904, 37 Con LR 121.

Costain Building & Civil Engineering Ltd v Scottish Rugby Union plc (1994) [Court of Session, Inner House] 69 BLR 80, 43 Con LR 16.

Ogilvie Builders Ltd v Glasgow City District Council (1994) [Court of Session] 68 BLR 122, (1994) CILL 930, 41 Con LR 1.

Amec Process & Energy v Stork Engineers & Contractors BV (No 4) (2002) (QBD (TCC)) CILL 1883.

Fitzroy Robinson Limited v Mentmore Towers Limited (2009) EWHC 3365 (TCC).

Extensions of time and liquidated and ascertained damages

Peak Construction (Liverpool) Ltd v McKinney Foundations Ltd (1970) [CA] 1 BLR 11, (1970) 69 LGR.
Temloc Ltd v Errill Properties Ltd (1987) [CA] 39 BLR 30, (1986/87) CILL 376, 12 Con LR 109, (1988) 4 Constr LJ 63.
Fairweather (H) and Co. Ltd v London Borough of Wandsworth (1987) [OR] 39 BLR 106.
Balfour Beatty Building Ltd v Chestermount Properties Ltd (1993) [Commercial Court] 62 BLR 1, 32 Con LR 39, (1993) 9 Const LJ 117.
John Barker v Portman Hotel (1996) 83 BLR 31.
Ascon Contracting Limited v Alfred McAlpine Construction Isle of Man (1999) 66Con LR 119.
The Royal Brompton Hospital NHS v Watkins Gray International (UK) (2000) TCC.
Balfour Beatty Construction Ltd v Lambeth LBC (2002) EWHC 597 (TCC).
Steria Ltd v Sigma Wireless Communications Ltd (2007) EWHC 3454 (TCC).
Liberty Mercian Ltd v Dean & Dyball Construction Ltd (2008) EWHC 2617 (TCC).
Azimut-Benetti SpA (Benetti Division) v Darrell Marcus Healey (2010) EWHC 2234 (Comm).

Concurrent Events

H Fairweather & Co. v London Borough of Wandsworth (1987) 39 BLR 106.
Balfour Beatty Building v Chestermount Properties (1993) 62 BLR 1.
Henry Boot Construction v Malmaison Hotel (Manchester) (1999) 70 Con LR 32.
The Royal Brompton Hospital NHS Trust v Frederick Alexander Hammond (No. 7) (2001) 76 Con LR 148.
Motherwell Bridge Construction v Micafil Vakuumtechnik (2002) TCC 81 CON LR 44.
City Inn Ltd v Shepherd Construction Ltd (2010) ScotCSC IH 68.
De Beers UK Limited v Atos Origin IT Services UK Limited (2010) EWHC 3276 (TCC).

Acceleration

Glenlion Construction Ltd v The Guiness Trust (1987) [OR] 39 BLR 89, (1986/7) CILL 360, (1998) 4 Const LJ 39.
John Barker Construction Ltd v London Portman Hotel Ltd (1996) 83 BLR 35.
Amec & Alfred McAlpine (Joint Venture) v Cheshire County Council (1999) BLR 303.
Anson Contracting Limited v Alfred McAlpine Construction Isle of Man Limited (1999) 66 Con LR 119.

Global claims

Crosby (J) and Sons v Portland Urban District Council (1967) [OR] 5 BLR 121.
Mid-Glamorgan County Council v J Devonald Williams and Partner (1991) [OR] (1992) CILL 722, 29 Con LR 129, (1991) 8 Const LJ 61.
Wharf Properties Ltd v Eric Cumine Associates (No. 2) (1991) [PC] 52 BLR 1, (1991) CILL 661, 29 Con LR 113, (1991) 7 Const LJ 251.
British Airways Pension Trustees Ltd v Sir Robert McAlpine & Sons Ltd and Others (1994) 72 BLR 26.
Laing Management (Scotland) Limited v John Doyle Construction Limited (2004) BLR 295 (2007) EWHC 752 (TCC).
Petromec Inc v Petreleo Brasileiro S.A Petrobras (2007) EWCA Civ 1371.

Costain Ltd v Charles Haswell & Partners Ltd (2009) EWHC 825 (TCC).
Walter Lilly & Company Limited v (1) Giles Patrick Cyril Mackay (2) DMW Developments Limited (2012) EWHC 1773 (TCC).

Engineer's duty to contractor/tenderer and when preparing bills

Pacific Associates Incorporated and RB Construction Ltd v Baxter and Others (1988) [CA].
Christiani & Neilsen Ltd v Birmingham City Council (1994) [OR] (1995) CILL 1014.
Blackpool and Fylde Aero Club Ltd v Blackpool Borough Council (1990) 1 WLR 1195, (1990) 3 All ER 25, 88 LGR 865.

Unforseeable conditions under clause 12 of the ICE Conditions/Quality of Materials

Young & Marten Ltd v McManus Childs Ltd (1969) [HL] 2 All ER 1169, (1968)] 3 WLR 630.
Humber Oils Terminal Trustees Ltd v Hersent Offshore Ltd (1981) 20 BLR 22.
Humber Oils Terminal Trustee v Harbour & General Works (1991) [CA] 59 BLR 1.
Rotherham Metropolitan Borough Council v Frank Haslam Milan and Company Ltd and MJ Gleeson (Northern) Ltd (1996) [CA] 78 BLR 1, (1996) 12 Const LJ 333.

15.14 Questions

Question 1

A building contractor intends to submit to the client a claim for loss and expense because of late delivery of drawings (JCT SBC/Q 2011 applies). Outline the factors you would need to consider in compiling such a claim and discuss what information you would expect to provide in order to support your claim.

Question 2

A contractor (C) is awarded a £10 million contract to construct a 25-kilometre pipeline over hilly country. The commencement date is anticipated to be the first week in May 2011 with a time for completion of 18 months.

The contractor submitted his clause 14 programme, which was approved by the engineer, showing a close-down during January, February and March because of anticipated bad weather.

The contractor was delayed by:

- failure by the engineer to provide the drawings necessary for the contractor to construct the work, on the part of the site most inaccessible to plant, in time to meet the programme (8 weeks' delay – June/July 2012);
- failure by a nominated supplier (S) to deliver the pipes required in accordance with the programme agreed between C, S and the engineer (4 weeks' delay – April/May 2012);
- the ground conditions proving more difficult than expected (8 weeks' total delay – September/October 2011);
- it proving harder than expected to engage suitable skilled operatives to undertake the work (4 weeks' delay throughout project);
- adverse weather in December 2011 (from 15th–31st);

- restricted access to the site due to an outbreak of foot and mouth disease in the local cattle (12 weeks' delay – April to June 2012);
- breakdown of pipe-laying equipment (2 weeks' delay in October 2011);
- national strike by readymix concrete suppliers (1 week's delay in November 2011).

You have been appointed by the contractor to assist them with their claim – they have claimed 41 weeks' extension of time all with associated costs. Write to advise the contractor how they should proceed to obtain additional payment from the employer for their additional costs in each case and indicate the likelihood of success; clearly identify the relevant clauses in the conditions of contract.

You should base your solution on the FIDIC 1999 *Red Book*.

Question 3

Prepare a brief written summary (no more than 250 words) of TWO cases involving construction claims, clearly identifying the issues involved. Make an oral presentation to your peers on your findings.

Question 4

Critically review the key issues involved in the case of *City Inn Ltd v Shepherd Construction Ltd* (2007) CSOH CA101/00 and recommend an appropriate extension of time, prolongation of costs and liquidated damages (all in weeks).

15.15 References/further reading

Burr, A. and Palles-Clark, R. (2005) 'The consideration of critical path analysis in English law', *Construction Law Journal*, Vol. 21, No. 3.

Chappell, D. (1998) *Powell-Smith and Sims' Building Contract Claims*, 3rd edition, Blackwell Science.

Chartered Institute of Building (CIOB) (2008) 'Managing the risk of delayed completion in the 21st century', CIOB, www.ciob.org.uk/resources/research – accessed 24 March 2009.

Cooper, S. and Potts, K. (1995) 'Successful negotiation', *Project*, Association for Project Management, March, pp. 12–13.

Davison, R.P. and Mullen, J. (2009) *Evaluating Contract Claims*, 2nd edition, Wiley-Blackwell.

Furst, S., Ramsey, V., Keating, D. and May, A. (2001) *Keating on Building Contracts*, 7th edition, Sweet and Maxwell.

Knowles, R. (1992) *Claims: Their mysteries unravelled: an introduction to claimsmanship for contractors and subcontractors*, JR Knowles.

Knowles, R. (2001) 'Hudson's Formula revisited – a recent case', *Civil Engineering Surveyor*, June, pp. 14–15.

Lane, N. (2005) 'Listen, this is important', *Building*, 2 December.

Lane, N. (2006) 'How to be good', *Building*, 17 February.

Linnett, C. and Lowsley, S. (2006) 'A simple approach', *The Journal RICS Construction*, November/December.

Lowe, R.H., Barba, E.M. and Lare, G.B. (2007) *A View from Across the Pond: An American perspective on the SCL delay and disruption protocol*, Paper D78, Society of Construction Law.

Marshall, J. (2005) 'Delay analysis', Lecture to MSc Construction Law/MSc Construction Project Management students, University of Wolverhampton.

McNeill, G.D. (2011) *Claims in Construction Contracts and How To Avoid Them*, FTI Consulting, Inc., available at: www.fticonsulting.com/global2/case-law/claims-in-construction-contracts-and-how-to-avoid-them.aspx – accessed 12 November 2012.

Pettet, J.W. (1998) *Claims for Head Office Overheads and Profit in the Construction Industry*, Construction Papers, No. 93, CIOB.
Pickavance, K. (2006) 'A case for the defence', *The Journal RICS Construction*, September.
Thomas, R. (1993) *Construction Contract Claims*, Macmillan.
Thornton, A. (2008) *Compound Interest and Financing Claims: The Sempra Metals revolution*, Paper 150, Society of Construction Law.
Trickey, G. and Hackett, M. (2001) *The Presentation and Settlement of Contractors' Claims*, E & FN Spon.

Websites

www.atkinson-law.com.
www.bailii.org.
www.fticonsulting.co.uk/our-firm/case-law/index.aspx.
www.scl.org.uk The Society of Construction Law (SCL) *Delay and Disruption Protocol* (2002).
The Protocol is not intended to be a contract document, but it does provide recommendations and guidance to those involved with drafting contracts. It is intended to act as an aid in the interpretation of delay and disruption disputes on standard form build and civil engineering contracts.

16 The NEC Engineering and Construction Contract

16.1 Introduction

Currently used on over 6,000 contracts world-wide from small projects to large internationally known projects such as the Channel Tunnel Rail Link, BAA Heathrow Terminal 5 and the 2012 London Olympics, the NEC Engineering and Construction Contract (hereafter called NEC or NEC ECC) has established itself as the number one form of contract that helps avoid disputes, delays and ultimately extra costs.

Widely adopted in the civil engineering sector, the NEC ECC is now making major inroads into the building sector. Among the many notable users are the Highways Agency, the Environment Agency, BAA, Sainsbury's, London Underground, NHS Estates – through its £4.3 billion ProCure21 and *potentially* £4.2 billion ProCure 21+ framework programme for hospital buildings – BT and the Welsh Assembly. The majority of UK local authorities use the NEC ECC for highway and drainage projects and increasingly for schools, offices and social housing schemes. The NEC3 suite of contracts has also been chosen by Crossrail on Europe's largest construction project below London due for completion in 2017 and comprising 21 kilometre of twin-bored rail tunnels and eight new stations, with an estimated out-turn cost of £15.9 billion.

The NEC ECC is radically different from other standard forms of contract currently in use. Introduced by the Institution of Civil Engineers (ICE) in 1993, the form has great flexibility and can be used on all types of construction and engineering works. It aims to be easier to understand and use than conventional contract forms and stimulate effective project management by encouraging a foresighted cooperative approach. The philosophy and objective of the NEC ECC is to create an open, cooperative, no-blame, non-adversarial team approach to managing contracts.

The launch of the NEC 3rd edition in July 2005 coincided with a unique endorsement from the UK Office of Government Commerce (OGC). The endorsement reads:

> OGC advises public sector procurers that the form of contract used has to be selected according to the objectives of the project, aiming to satisfy the Achieving Excellence in Construction (AEC) principles. This edition of the NEC (NEC3) complies fully with the AEC principles. OGC recommends the use of NEC3 by public sector construction procurers on their construction projects.

A further significant endorsement of the use of NEC contracts overseas was made by one of the leading construction lawyers, His Honour Humphrey Lloyd, QC:

> In a nutshell there are no real difficulties in using the NEC3 contract either inside or outside the UK. With a couple of exceptions, the core clauses of NEC3 do not contain any significant features that would make it unwise to use abroad.
>
> (Lloyd, 2009)

16.2 The NEC family of contracts

The NEC3 comprises a family of standard integrated contracts incorporating the following standard forms:

- the NEC3 Engineering and Construction Contract (ECC) – between the employer and contractor for construction and engineering works;
- the NEC3 Engineering and Construction Short Contract (ECSC) – between the employer and contractor, for low-risk, straightforward work;
- the NEC3 Term Services Contract (TSC) – for engaging suppliers of services for a period of time;
- the NEC3 Framework Contract (FC) – for engaging suppliers to provide services operating under a framework;
- the NEC3 Engineering and Construction Subcontract (ECS) – between a contractor and subcontractor, back to back with ECC;
- the NEC3 Engineering and Construction Short Subcontract (ECSS) – between: a contractor and subcontractor, under either ECC or ECSC;
- the NEC3 Professional Services Contract (PSC) – for engaging a supplier of professional services;
- the NEC3 Adjudicator's Contract (AC) – for engaging an adjudicator to settle disputes between parties under an NEC contract.

The contracts are supported by guidance notes, flowcharts and the advisory *NEC3 Procurement and Contract Strategies*.

The principal parties to the contract are the employer and the contractor. The employer has little direct involvement in the project management and administration of the project as they appoint a project manager and supervisor to represent their interests. The employer, however,

Panel 16.1 Case study: London 2012 Olympic and Paralympic Games

The UK Olympic Delivery Authority (ODA) confirmed that the full suite of NEC3 contracts was used to deliver facilities for the £9.3 billion London Olympics. The NEC3 contract was chosen both for its flexibility and for its emphasis on trust and collaboration.

The NEC3 Option C (Target Contract with Activity Schedule) was the most widely used NEC3 variant with the ECC Subcontract used by all tier 1 suppliers for their major subcontractors.

The ODA also used the NEC3 Professional Services Contract (PSC) to retain its delivery partner CLM – a consortium made up from CH2M Hill, Laing O'Rourke and Mace – as well as for supervisor appointments and venue design teams.

Source: Fullalove S. (2008) 'Full NEC3 suite delivering London 2012', *NEC Users' Group Newsletter*, Issue 43, July is required to allow access to the site and to pay the amount certified by the project manager at the required time. The employer also has further obligations in the matters of insurance, termination and dispute resolution. Furthermore, following the decision in *London Borough of Merton v Stanley Hugh Leach Limited* (1985) 32 BLR 51, the employer also has a duty not to prevent or hinder the contractor in his performance.

The chart shown in Figure 16.1 demonstrates how a design and build (bi-party partnering) contract is administered using the NEC family of contracts.

16.3 Objectives of the NEC

The NEC is a simple and flexible form of contract designed around a concept of common purpose. The primary objective is to shift the emphasis of control from procedures for the calculation of extra payment to the contractor if things go wrong, to arranging matters so that things are less likely to go wrong.

Clarity

The form is written in plain English, and long sentences have been avoided where possible. There is a simple structure and clause numbering. A flowchart has been developed as a check on drafting and as an aid for users.

The actions by parties are defined precisely in the contract and the time periods for all-important actions are deliberately set tightly to motivate timely responses. Subjective phrases such as *fair* and *reasonable* have been avoided. Moreover, there is a single procedure for assessing all compensation events, which includes an assessment of both cost and time for all events; it is not retrospective and, once carried out, is fixed.

Flexibility

The NEC is intended to be used on all types of engineering, construction and mechanical and electrical work. It allows the degree of contractor design responsibility to be varied from 100

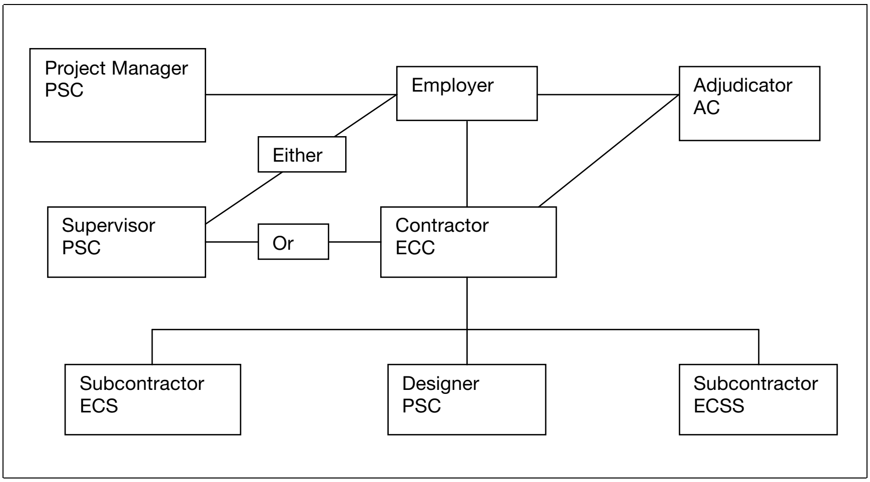


Figure 16.1 The NEC family of contracts under design and build (bi-party partnering)

per cent to 0 per cent – the extent is defined in the works information. The contract is also adaptable for use on international contracts.

The NEC provides a choice of tender and procurement arrangements to suit most project circumstances. This allows the allocation of risks to suit the particular contract through the use of priced contracts, target contracts, cost reimbursable contracts and management contracts.

The NEC provides core clauses, which are common to all options with six main payment options and secondary options allowing the user to fine-tune the risk allocation.

Stimulus to good project management

The NEC is founded on three key principles:

Principle 1 – Foresighted, cooperative management shrinks risks and mitigates problems

The NEC3 achieves this by including: an *early warning* procedure for identifying future problems and minimizing their impact; a regularly updated and agreed programme with method statements and resources showing timing and sequencing of employer and contractor actions; assessment of time and cost as contract progresses, ideally before work is done; and stated maximum time-scales for the actions of parties.

Principle 2 – Both parties are motivated to work together if it is in their professional and commercial interests to do so

The NEC3 achieves this by including: a clear statement of events for which the employer is liable (compensation events); a structured method of calculating changes in contractor's costs; profit that is tendered on compensation events; and an independent role of an adjudicator.

Furthermore, there are sanctions to encourage the contractor to: early warn; submit a first programme containing information required; maintain an up-to-date Accepted Programme; and provide realistic and timely quotations.

Principle 3 – Clear division of function and responsibility helps accountability and motivates people to play their part

NEC3 achieves this by clearly identifying the roles of the key players. The traditional role of the engineer or architect has been split into four:

Role 1 – the designer (not mentioned in the contract): designers' for the employer's design are appointed by the employer. If several designers are appointed, possibly covering different disciplines, a lead designer should be appointed.

The designers' role is to develop the design to meet the employer's objectives to the point where tenders for construction are to be invited. If a *design and construct* contract is envisaged, the employer's designers' role is restricted largely to providing a performance specification together with standards for design and materials which they may wish to specify for inclusion in the works information.

Role 2 – the project manager: responsible for time and cost management on the employer's behalf. The employer should also ensure that the project manager's brief includes management of the designers' activities.

The project manager is appointed by the employer, either from their own staff or from outside. The project manager is the spokesperson for the employer. Their role within the NEC ECC is to manage the contract for the employer with the intention of achieving the employer's objectives for the completed project.

The employer will normally appoint a project manager in the feasibility study stages of a project. Their duties may then also include acting on behalf of the employer and advising on the procurement of design, on estimates of cost and time, on the merits of alternative schemes and on choosing the most appropriate contract strategy.

The Channel Tunnel Rail Link case of *Costain Ltd v Bechtel Ltd* (2005) EWHC 1018 (TCC) addressed the role of the client's project manager (Bechtel) under the NEC ECC 2nd edition. A significant gap had arisen between the target cost and the projected out-turn cost. It was claimed that Bechtel had instructed their staff to aggressively disallow costs where they could, indicating that they were not acting impartially. Costain sought an injunction restraining Bechtel from exercising its functions otherwise than impartially and in good faith. The Judge (Mr Justice Jackson) thought that there were good arguments that, in the circumstances of that contract, the project manager was also a 'certifier', that is 'that when assessing sums payable to the Contractor the Project Manager's duty is to act impartially as between Employer and Contractor'.

Role 3 – the supervisor: responsible for ensuring that the quality of construction meets that in the works information/specification.

The supervisor is appointed by the employer for a particular contract. They can be an in-house person or someone from outside. Essentially, their role is to check that the works are constructed in accordance with the contract. It is similar to that of a resident engineer or architect who may be assisted by an inspector or clerk of works.

Role 4 – the adjudicator: an independent third party brought in to rapidly resolve any disputes. The adjudicator becomes involved only when a dispute is referred to him. As a person independent of both employer and contractor, they are required to give a decision on the dispute, within stated time limits. If either party does not accept their decision, they may proceed to the tribunal (either arbitration or the courts). Under the adjudicator's contract, payment of the adjudicator's fee is shared equally by the parties.

16.4 Design principles

In order to create a contract under the NEC3 the employer is required to specify and include the following:

- one of the six main payment options;
- the nine core clauses;
- one of the dispute resolution options;
- which of the 17 secondary options apply – if any;
- any additional clauses under secondary Option Z.

Main payment options

The main options are the following contract types, one of which must be chosen:

Option A: Priced contract with activity schedule: this is a lump sum contract based upon a priced activity schedule submitted at tender stage. This option is appropriate where the employer is able to define accurately what they require. It is suitable for use when the employer designs the work in the form of drawings and specification or where a performance specification is provided by the employer and the contractor designs the work or where the design responsibility is divided.

The prices entered for each activity are lump sums. The tenderer decides how to break up the work into activities, enters them on the schedule and prices each one. If the employer wants to specify particular activities, which the contractor is to identify in the activity schedule, they should state their requirements in the instructions to tenderers.

An activity is essentially one bar on a bar chart, which the contractor has priced. Activities can include fixed overheads, time-related charges, temporary works and materials on site, as well as the permanent works. The activity schedule is extracted from the programme, but is a separate document. Rowlinson (2011:127) notes that the activity schedule is not normally asked for with the tender but is submitted later by the successful tenderer, thereby reducing the tendering costs of unsuccessful contractors.

Under Option A, payments are only made against activities when 100 per cent complete; the contractor should therefore plan his activities for payment on a monthly basis in order to secure a realistic cash flow. There are no separate payments for materials on site, provisional and prime cost sums under the NEC3. Under the activity schedule payment Options A and C, the contractor could include separate activities for 'materials on site' and these would be paid upon delivery of the defined item. Under the bill of quantities payment Options B and D, the contractor should enhance his rates to reflect the cash flow shortfall for materials on site.

Option B: Priced contract with bill of quantities: this is a lump sum contract based upon a priced bill of quantities submitted at tender stage. This option is used where the project is well defined at tender and designed by the employer's design consultants, but some changes are anticipated.

The bill of quantities is prepared by the employer's cost consultants based upon a standard method of measurement e.g. SMM7, NRM or CESMM4. Traditionally in the civil engineering sector, where a bill of quantities is prepared based on the CESMM4, the whole of the works are subject to remeasurement upon completion. In contrast, in the building sector the bills of quantities are considered lump sums and are not normally subject to remeasurement. The parties should therefore ensure that the form of tender and the form of agreement make clear that the final value of the works will be determined by remeasurement (Eggleston, 2006).

Option C: Target contract with activity schedule: this is a cost reimbursable contract, which is awarded to the contractor on the basis of a priced activity schedule, prepared by the contractor and submitted with their tender. Payment for carrying out the works is on a cost reimbursable basis with an additional amount paid if the final cost is less than an agreed target cost, which is adjusted for compensation events. The activity schedule is only used to calculate the 'target' – it is used at the end of the project to calculate the share.

Option D: Target contract with bill of quantities: this is a cost reimbursable contract, which is awarded to the contractor on the basis of a priced bill of quantities, normally prepared by the employer, submitted at tender stage. Payment for carrying out the works is on a cost reimbursable basis with an additional amount paid if the final cost is less than the agreed target cost, which is adjusted for compensation events and remeasurement. Under this option, the bill of quantities is only used to calculate the target – it is also used at the end of the project to calculate the share.

Options C and D are used where the work is not fully defined or where the anticipated risks are greater or where the employer sees a significant benefit in encouraging collaboration through the target mechanism.

Option E: Cost reimbursable contract: this is a cost reimbursable contract that is awarded to the contractor on the basis of a fee percentage submitted at tender stage. Payment for carrying out the works is on a cost reimbursable basis based on the contractor's defined cost plus a fee to cover off-site overheads and profit. This option should be used where the definition of the work is inadequate even as a basis for a target price and yet an early start is required. This approach is suitable for refurbishment work, for enabling work or for emergency repair work.

Option F: Management contract: this is a cost reimbursable contract that is awarded to the contractor on the basis of a fee percentage submitted at tender stage. Payment for carrying out the works is on a cost reimbursable basis with an additional fee percentage. The contractor sublets all the works in conjunction with the client. Management contracts are normally used where there is a need to coordinate a number of works contractors, when the employer does not have the capability to manage the project or where the timescale is tight, requiring an early start in construction.

The ECC main options offer different basic allocations of risk between the employer and contractor.

Options A and B are priced contracts in which the risks of being able to carry out the works at the agreed prices are largely borne by the contractor:

- Option A – all financial risks other than the employer's risks (listed in Clause 80.1 and the Contract Data) and compensation events are the contractor's.
- Option B – as Option A, except the employer also takes the risk of accuracy of the bill of quantities.

Options C and D are target contracts in which the financial risks are shared by employer and contractor in agreed proportion:

- Option C – employer's risk is as Option A. Contractor also has the financial risk for disallowed cost and accuracy of fee percentages. All other risks are shared between the parties;
- Option D – employer's risks are as Option B. Contractor has financial risk for disallowed cost and accuracy of fee percentages. All other risks are shared between the parties.

Options E and F are two types of cost reimbursable contract in which the financial risk is largely borne by the employer:

- Option E – contractor has financial risk for disallowed cost and accuracy of fee percentages. All other financial risks are with the employer.
- Option F – As Option E, but contractor also has risk for lump sum prices that they quote for parts of the work.

All the main options can be used with the boundary between design by the employer and design by the contractor set to suit the chosen strategy. If the works information set down by the employer is only a performance specification, most of the design will be done by the contractor (effectively a *design and construct contract*). If the works information includes detailed drawings and specifications, little design remains for the contractor to complete.

The *ECC Guidance Notes* recommend that the following factors be taken into account when selecting the contract strategy:

- Who has the necessary design expertise?
- Is there particular pressure to complete quickly?
- How important is performance of the complete works?
- Is certainty of final cost more important than lowest final cost?
- Where can a risk be best managed?
- What total risk is tolerable for contractors?
- How important is cross-contract coordination to achievement of project objectives?
- Has the employer good reasons for himself selecting specialist contractors or suppliers for parts of the work?

The result of these considerations should be a statement of the chosen contract strategy comprising:

- a schedule of the parts of the project which will be let as separate contracts;
- for each contract – a statement of the stages of work which it will include, covering management, design, manufacture, erection, construction, installation, testing and commissioning as appropriate; and
- a statement of the ECC main option which will be used for the contract.

16.5 Core clauses

There are nine core clauses, all of which are common to all NEC ECC contract types:

1 General: This clause defines the duties and obligations of the parties, procedures that are to be followed, communication methods, interpretation of the contract and early warnings that must be given. Clause 10 notes the requirements for the parties to act in a spirit of mutual trust and cooperation.

The fee includes all the costs of the contractor that are not included in defined cost, together with profit and any allowance for risks (Clause 11.2(8)). The fee is calculated by applying the fee percentages stated in the contract data, part 2, to the relevant parts of the defined cost. The fee is used in assessing compensation events and, for Options C, D, E and F, in assessing amounts due to the contractor.

The purpose of early warning (Clause 16.1) is to make it compulsory for the project manager or the contractor to call an early warning meeting as soon as possible to discuss anything which may affect the cost, timing of completion and quality of the works. The sanction for failure by the contractor to give early warning is to reduce the payment due to him for a related compensation event (Clause 63.5).

The risk register (Clause 11.2(14))] is a new addition to NEC3. Initially it will contain those risks identified by the employer and the contractor in parts one and two respectively of the contract data. Risks are then added to the risk register as part of the early warning process described in Clause 16, or removed because of actions taken by the parties to avoid them or because they did not happen. The risk register does not allocate risks. It is a post-contract management tool which is collated by the project manager. In practice it is useful to identify the risks as *high*, *medium or low* and show them as *red*, *amber* and *green*.

Patterson (2007: 5) confirms that 'The "Risk Register" should not be allowed, even to hint at which party carries a particular risk post-contract. Thus, as stated in Clause 11.2(14), the NEC3 risk register should contain only two items: a description of the risk and a description of the actions to be taken to avoid or reduce the risk. In contrast, the *project risk register* will in addition identify the probability, time impact, cost impact, owner, etc. of each risk.

Clause 16.2 requires the project manager or the contractor to instruct the other to attend a risk reduction meeting. Fergusson (2009: 5) notes that 'The ability of either party to instruct the other to attend a risk-reduction meeting creates a forum recognized within the contract which stimulates cooperation between the parties to achieve the best project outcome.'

2 Contractor's main responsibilities: The contractor's main responsibilities are set out in this clause, including that of design.

The contractor's basic obligation is to *provide the works*, which is defined as including supplying all the necessary resources to achieve the end result including designing, fabricating, delivering to site, erecting, constructing, installing, testing and making good defects. The works information, defined in Clause 11.2 (19), provided by the employer, should state everything which is intended concerning the work, including design work, which should be done by the contractor.

Under Clause 21.1 the contractor's liability for his design can be limited to an amount stated in the works information. This liability can also be limited to *reasonable skill and care* by inclusion of Option X15. Without this option, the contractor's obligation is to design strictly in compliance with the works information.

Clause 26.2 provides that the contractor may subcontract parts of the works, provided the project manager accepts the proposed subcontractors. No provision is included in ECC for nomination of subcontractors. Alternatives to nominating subcontractors whilst achieving similar objectives are:

- making the contractor responsible for all the work. They can then subcontract parts and the project manager retains some control over the selection of the subcontractors;
- providing for separate contracts, with the project manager managing the time and physical interfaces between them;
- including lists of acceptable subcontractors for particular tasks in the works information.

It is noted that, under main Options C, D, E and F, Clause 20.4 requires the contractor to forecast the total defined cost for the works at intervals stated in the contract data. This should be calculated based initially on the resourced method statement submitted with the accepted programme and updated at regular intervals to include the compensation events.

3 Time: All matters concerned with time are dealt with by this clause, such as start and completion dates, programming, possession of the site and taking over of the works.

The period of time within which the contractor is required to provide the works is not stated. Instead, the starting date and the completion date are given in the contract data. This enables tenderers to know when the work may begin.

Provision has been made for a programme either to be identified in the contract data, part 2 at the contract date or to be submitted by the contractor within a period stated in the contract data, part 1. The programme is an important document for administering the contract. It enables the project manager and the contractor to monitor progress and to assess the time effects of compensation events, including changes to the completion date.

Employers may wish to have programmes submitted with tenders in order to judge whether a tenderer has fully understood his obligations and whether they are likely to be able to carry out the work within the stated time, using the methods and resources proposed. Hide (2010a) advises 'That it is fundamental that a detailed, thorough programme should be provided at tender stage' in order to demonstrate that the contractor has the ability to produce the programme and use the associated software and has fully understood the project. He further considers that 'the produced programme should be a significant factor in the assessment of the overall tender submission and be reflected as such in any scoring or weighting that the employer may use to evaluate the tender'.

Clause 31.2 lists the information, which the contractor is required to show on each programme submitted for acceptance. It consists of:

- dates which are shown in the contract data or changed in accordance with the contract (the starting date, access dates, key dates and completion date; planned completion);
- the contractor's updated planned completion (and sectional completion if Option X5 is used) as the work progresses;
- the order and timing of the contractor's own work, updated;
- the work of the employer and others;
- the dates when the contractor plans to complete work for which key dates apply, and work needed to allow the employer and others to do their work;
- float and, separately, time risk allowances;
- health and safety requirements;
- other information required in the works information;
- dates when the contractor will need access and other things to be provided to him by the employer and also information from others;
- general information about resources that the contractor plans to use for each operation.

Method statements for the contractor's operations consists of descriptions of the construction methods as well as details of the resources, including equipment, they intend to use. Thus, any reference in the contract to the programme includes these method statements. This means, for example, that a contractor's quotation submitted in relation to a compensation event which includes a revised programme must include any revised methods of construction and resources.

Separate references to *float* and to *time risk allowances* are included in Clause 31.2. It is important that they are clearly identifiable in the programme.

The project manager has 2 weeks to either accept the programme or set out reasons for rejecting it. There are four default reasons set out in Clause 31.3: first, if the contractor's plans are not practicable; second, if the programme does not show the information required by the contract; third, if it is not realistic; or, finally, if it does not comply with the works information.

For detailed advice on producing and managing a programme under the NEC form of contract see Hide (2010a and 2010b).

4 Testing and defects: This clause deals with searching for and notifying of defects, tests, correcting defects and uncorrected defects.

5 Payment: This clause deals with payment for work done, payment certificates and payment of actual cost. Payment mechanisms for the six main options are based on the use of the three key terms: the prices; the price for work done to date (PWDD); and the defined cost.

Each term is defined for each main option in Clause 11.2 as set out in Table 16.1. Abbreviations used in the table are: AS – activity schedule; BofQs – bill of quantities; DC – defined cost. These terms, which are defined in the main option clauses, when used in conjunction with the core clauses in Section 5, establish the payment mechanism for each main option.

In accordance with Clause 50.2 the core of the amount due to the contractor is the price for works done to date (PWDD). All other payments except advanced payments (e.g. for plant and

Table 16.1 Payment mechanism for six main options

Option	*Prices*	*Price for the work done to date (PWDD)*
A	Activity Schedule prices for activities 11.2(30)	Total of the prices for completed activities 11.2(27)
B	BofQs rates and lump sums 11.2(31)	Quantities of completed work at BofQs rates and proportions of lump sums 11.2(28)
C	Activity schedule prices for activities 11.2(30)	Defined cost forecast to be paid before next assessment + fee 11.2(29)
D	BofQs rates and lump sums 11.2(31)	As Option C
E	Defined cost + fee 11.2(29)	As Option C
F	Defined cost + fee 11.2(29)	As Option C

Source: *NEC3 Guidance Notes 2005*

materials outside the working areas, retention, repayments of advanced payment, damages, VAT and sales tax) are added or deducted from the PWDD to calculate the amount due. The content of PWDD varies according to which main option is used.

Under the target cost payment Options C and D, payment to the contractor is calculated based on the defined cost as defined in Clause 11.2(23) – amount due to subcontractors plus the cost of components as defined in the schedule of cost components – less the disallowed cost as defined in Clause 11.2(25).

This is then used to arrive at the price for work done to date, i.e. 'the total Defined Cost which the Project Manager forecasts will have been paid by the Contractor before the next assessment date plus the Fee' (Clause 11.2.29). The fee is composed of two separate elements: the subcontract fee percentage and the direct fee percentage – Clause 11.2(8) refers.

Thus, when calculating the PWDD under Options C and D up to the end of, say, October, the project manager is required to *forecast* the amount which will have been paid by the contractor up to the end of November (i.e. the next assessment date). Thus the PWDD should include the costs of all directly employed weekly and monthly paid people in November, together with those payments forecast to be made to plant hire companies, materials suppliers and subcontractors in November. Any payments due to be made after the end of November should not be included.

Clause 50.3 is designed to provide a powerful motivation for the contractor to submit a programme which contains the information required by the contract. The clause imposes a test to determine whether a quarter of the price for work done to date should be retained. The test for withholding this retention is one of submission of a programme by the contractor, not acceptance by the project manager.

Under Clause 53.1 (main Option C) and Clause 53.5 (main Option D) the project manager is required to assess the contractor's share of the difference between the target and the PWDD. This calculation is carried out only twice – following completion and in the last payment 4 weeks after the defects certificate. Under main Option C the target is the tender sum based on the activities on the activity schedule adjusted for compensation events. Under main Option D the target is the remeasured bill of quantities, which would include compensation events.

The enactment of the Local Democracy Economic Development and Construction Act (LDEDCA) 2009, amending the Construction Act 1996, has triggered some changes to the payment provisions in the NEC3 contracts. Where payment follows the issue of a payment certificate, the certificate and details of how the payment was calculated must be issued together, and these must be defined as *the payment notice*. In the ECC for instance, this amendment applies to Clause Y2.2. Where payment is made without the issue of a certificate, the contractor's application or consultant's invoice will constitute the payment notice (NEC, 2011).

The timing of issue of this payment notice must now also be fixed as not later than 5 days after the payment due date. In Clause Y2.3 there is now a superficial change in terminology requiring either payment of the notified sum or issuing of a notice of intention to pay less. These are revised in NEC3 contracts to comply with this new provision.

6 Compensation events: This clause deals with compensation events and their identification, and assessment and acceptance of quotations from the contractor.

Compensation events are events which, if they occur, and do not arise from the contractor's fault, entitle the contractor to be compensated for any effect the event has on the prices and completion date. The assessment of a compensation event is always of its effects on both prices and completion date. Any event may entitle the contractor to additional payment and also to additional time. This is a major difference when compared to traditional forms of contract, where a 'neutral event', for example exceptionally inclement weather, would allow a contractor to claim for an extension of time but no additional costs.

Compensation events are listed in the core clauses, the options and the contract data. The main list is in the core Clause 60.1, which includes compensation events 1 to 19. Events applicable to main Options B and D are stated in Clauses 60.4–60.7. Other compensation events are stated in secondary option Clauses X2.1, X14.2, X15.2 and Y (UK) 2.4. Following the introduction of the LDEDCA 2009, the short forms which previously did not include any right to suspend performance due to non-payment of amounts due, have also been amended to identify suspension as a compensation event, so that the assessment is carried out as for other events (NEC, 2011).

Part 1 of the contract data also permits the employer to insert additional compensation events. If they do so the effect is to take the risk of costs and delay arising from the event from the contractor.

Under Clause 60.1, variations to the works are made by the project manager's instruction to change the works information. The authority given to the project manager for this purpose is in Clause 14.3. A variation may comprise deletion or addition of work or alteration to work. It may include changes to the employer's design, to design criteria or to performance requirements for the contractor's design.

Issue of a revised drawing or specification is a compensation event. Clarifications of previously issued drawings or specification are only made by changing the works information. Consequently, all such clarifications are compensation events.

For many years, it has been the practice in construction contracts for the employer to take the risk of physical conditions which have been described in such terms as 'those which could not have been foreseen by an experienced contractor'. The interpretation of such clauses has been the source of many disputes. In the case of *Humber Oil Trustees Ltd v Harbour and General Public Works (Stevin) Ltd* (1991) 59BLR1 *physical conditions* was considered to have a much wider meaning than *ground conditions*. The ECC Clause 60.1(12) Physical Conditions, includes an overhauled but not radically different procedure. This compensation event is limited to those physical conditions which are encountered within the site. Since most claims for unforeseen conditions are in respect of ground conditions, the more information concerning ground conditions which is made available to tenderers by the employer, the greater the certainty with which appropriate allowances can be made in tendering.

Under Clause 60.1(13) Adverse Weather – rather than rely on the subjective generalizations about ‘exceptionally inclement weather’ sometimes included in standard forms of contract – the ECC includes a more objective and measurable approach. The purpose is to make available for each contract weather data, compiled by an independent authority and agreed by both parties beforehand, establishing the levels of selected relevant weather conditions for the site for each calendar month which have had a period of return of more than 10 years. If weather conditions more adverse than these levels occur it is a compensation event. Weather which the weather data shows is likely to occur within a 10-year period is the contractor’s risk in relation to both cost and time.

The provisions for weather in the ECC have been developed in consultation with the UK Metrological Office (the Met Office) which can provide advice and information about the availability of recorded weather data.

Gerrard (2010) confirmed that there is a defined process to agree (or impose) the effects of a compensation event within defined time limits: notification (Clause 61), quotation (Clause 62), assessment (Clauses 63 and 64) and implementation (Clause 65).

Clause 61.3 puts the onus on the contractor to notify certain compensation events within 8 weeks of becoming aware of the event. If the contractor does not do so, they may lose rights to additional time and money. This acts as what the law calls a time bar, which is a condition precedent to entitlement.

> However there is one important proviso. The time limit does not apply to those events that the project manager should have notified under clause 61.1, that is any event which arises as a result of the project manager or supervisor giving an instruction or changing an earlier decision. Therefore it would not apply to compensation events arising from clause 60.1(1), (4), (7), (8), (10), (15), or (17). In our experience this proviso generally covers more than 90% of compensation events!
>
> (Gerrard, 2009:7)

The project manager would normally require the contractor to submit a quotation for the compensation event. Clause 61.4 lists the four tests which the project manager applies to an event notified by the contractor in order to decide whether or not to instruct the contractor to submit quotations for its effect. Clause 61.4 introduces strict procedural timescales into the contract for notifications if the project manager fails to respond after being prompted by the contractor. If the project manager fails to comply with the strict time provisions of this clause, he could find that an item with which he disagrees is treated as a compensation event and an instruction to submit quotations and the timetable at Clause 62.3 will commence.

Clause 61.6 considers the case where the nature of the compensation event may be such that it is impossible to prepare a sufficiently accurate quotation. One example of this is where unexpected physical conditions are encountered (compensation event 12) but their extent is unknown. In these cases, quotations are submitted on the basis of assumptions stated by the project manager in his instruction to the contractor. If the assumptions later proved to be wrong, the project manager’s notification of their correction is a separate compensation event (Clause 60.1(17)).

Clause 62.6 again reinforces the importance of the project manager keeping on top of the contractual administration – if the project manager ignores the submission of the contractor’s quotation and subsequent notification, then the quotation could be considered accepted by the project manager.

Under Clause 63.1, assessment of compensation events as they affect prices is based on their effect on defined cost plus the fee. For Options C, D and E, pricing of the various components of defined cost is normally based on the schedule of cost components (SCC) with the associated percentages tendered in the contract data, part 2, although the shorter SCC may be used in some circumstances (see Clause 63.15). The shorter SCC is used with Options A and B. The fee is calculated in accordance with Clause 11.2(8).

This approach is different from most standard forms, where variations are valued using the rates and prices in the contract as a basis. The reason for this policy is that no compensation event for which a quotation is required is due to the fault of the contractor or relates to a matter which is at his risk under the contract. It is therefore appropriate to reimburse the contractor his forecasted additional cost or actual additional costs if work has already been done arising from the compensation event. Hence, disputes arising from the applicability of contract rates are avoided. 'The use of defined cost in the calculation of the price paid for compensation events has shown to be a very much fairer mechanism than the more traditional approach of rates provided at tender stage.' (Fergusson, 2009: 5). However, it is noted that under main Options B and D Clause 63.13 allows the assessment of compensation events to be valued using the traditional methods based on the rates and prices in the bill of quantities.

Mitchell and Trebes (2005) in Book 4, *Managing Change*, describe in a 90-page appendix the process of calculating quotations for a compensation event under an NEC contract.

Under Clause 63.6 a delay to the completion date is assessed as the length of time that, due to the compensation event, planned completion is later than planned completion shown on the accepted programme. Rowlinson (2011: 200) notes that under these provisions the contractor owns the project float – this is in contrast to the traditional approach, where the project owns the float and whoever delays the project first gets the benefit of any project float.

It is also noted that under clause 63.6 the compensation event should include cost and time risk allowances for matters which have a significant chance of occurring and are at the Contractor's risk. Such issues have already been reviewed in Chapter 14 under 'Practical considerations' to be included in a quotation for a variation.

Rowlinson (2011: 207) also notes that many users of the NEC contract ignore the time effect of smaller compensation events when assessing the value of such individual compensation events and consider the compound time effect of all smaller compensation events at pre-agreed intervals, often at the regular revision of the programme.

7 Title: The employer's title to equipment, plant and materials both off-site and brought into the working area are dealt with by this clause.

8 Risks and insurance: This clause allocates the various defined risks between the parties and identifies the insurance policies and cover they are required to provide. Clause 80.1 identifies those risks which are carried by the employer, and Clause 81.1 identifies that those risks not carried by the employer are carried by the contractor. Clause 84 requires the contractor to provide the insurances listed in 'Insurance Table'.

9 Termination: This clause sets out the reasons for termination. In summary, either party may terminate in the event of insolvency, as defined in Clause 91.1. The contractor may terminate if not paid within 13 weeks of the date of the certificate, while the employer may terminate if the contractor fails to comply with his obligations, does not provide a bond or guarantee, appoints a subcontractor for a substantial piece of work before the project manager has accepted that subcontractor or hindered the employer or others or substantially broken a health and safety regulation.

Dispute resolution option

There are also two options for dispute resolution:

1 Option W1 (used unless the Housing Grants, Construction and Regeneration Act 1996 applies)
2 Option W2 (used when the Housing Grants, Construction and Regeneration Act 1996 applies).

16.6 Secondary options

Note that all the secondary options are *optional*, allowing the employer to build up the contract to suit his specific requirements:

Option X1: Price adjustment for inflation – calculated based on a formula method enabling the employer to carry most of the risk of inflation.
Option X2: Changes in the law – employer carries risk of changes in law after the contract date.
Option X3: Multiple currencies – used in priced contracts only.
Option X4: Parent company guarantee – required from the contractor often as an alternative to the performance bond.
Option X5: Sectional completion – sections should be identified in contract data, part1 prepared by the employer.
Option X6: Bonus for early completion – additional motivation for contractor if early completion would benefit the employer.
Option X7: Delay damages – these are the equivalent of liquidated damages which should be based on a genuine pre-estimate of the employer's likely losses.
Option X12: Partnering – enables multi-party partnering agreement to be implemented
(for a detailed case study describing Worcestershire Highways' use of NEC X12, see Rankin et al., 2007).
Option X13: Performance bond – form and amount should be stated in the contract data, part 1.
Option X14: Advanced payment to the contractor – relevant if contractor will incur substantial 'up front' costs, e.g. in pre-ordering specialist materials, plant or equipment; the amount must be stated in contract data, part 1.
Option X15: *Limitation of the contractor's liability for his design to reasonable skill and care* – without this clause the standard liability for contractor's design is generally 'fitness for purpose'; this option reduces the liability to the standard of a consultant designing for the employer.
Option X16: *Retention* – enables employer to retain a proportion of the price for works done to date until the contractor has completed the works. Then, following a partial release at *take over* (completion of the whole of the works), the balance is released upon the issue of the defects certificate.
Option X17: *Low performance damages* – where performance in use fails to reach the specified level, the employer can take an action against the contractor to recover damages or as an alternative can recover liquidated damages under Option X17.
Option X18: *Limitation of liability* – places limits on various liabilities of the contractor.
Option X20: *Key Performance Indicators* – this option enables the contractor's performance to be monitored; this could be linked to the payment of bonuses if works are completed early or there is an exceptional accident record.

MIGHTYBUILD CONSTRUCTION CONTRACT: METROPOLIS SPORTS COMPLEX								
To: Project Manager			C.E. No 12	Sheet 1		21 May 2009		
QUOTATION FOR COMPENSATION EVENT **Bush hammer existing sloping concrete paving and provide galvanized railings to east side of sports hall** Shorter Schedule of Cost Components								
Activity no./nos A100 + A200		Delay to planned completion: 0 days			Section of works 5B			
1. PEOPLE								
Activity A100 – bush hammering paving								
	No.	*Days*	*Total days*	*Hrs*	*Total hrs*	*Rate*		
Foreman	1	5	5	10	50	16.00	800.00	
Labourer	2	5	10	10	100	11.00	1,100.00	1,900.00
Add Percentage for people: 30%								570.00
2. EQUIPMENT								
Activity A100 – bush hammering paving								
	No.	*Days*	*Total days*	*Hrs*	*Total hrs*	*Rate*		
Compressor	1	5	5	10	50	22.00	1,100.00	
Hammer	2	5	10	10	100	2.00	200.00	1,300.00
(Rates taken from CECA Dayworks Schedule)								
Deduct: Equipment adjustment(quoted by contractor in Contract Data, part two) minus 25%								(325.00)
3. PLANT AND MATERIALS								0.00

Figure 16.2 Example quotation for compensation event using shorter schedule of cost components

Option Y (UK) 2: The Housing Grants, Construction and Regeneration Act (1996) – as amended by the Local Democracy, Economic Development and Construction Act 2009.

Option Y (UK) 3: The Contracts (Rights of Third Parties) Act 1999 – this option confers rights under the contract on third parties identified in the contract data.

Option Z: *Additional conditions of contract* – this option enables further conditions to be added to the contract depending on the specific circumstances. Gould (2007) identifies that Z clauses might include: the provision of collateral warranties, copyright, prohibited materials and assignment.

4. CHARGES		0.00
5. MANUFACTURE AND FABRICATION OUTSIDE THE WORKING AREAS		0.00
6. DESIGN OUTSIDE THE WORKING AREAS		0.00
7. INSURANCES		0.00
8. CONTRACTOR'S TIME/RISK ALLOWANCES		0.00
TOTAL DIRECT WORK		3,445.00
9. FEE Direct fee percentage (quoted by contractor in Contract Data, part two): 17%		585.65
TOTAL DEFINED COST FOR OTHER WORK		4,030.65
TOTAL SUBCONTRACTED WORK **10.** Fabricate handrails, galvanize, deliver to site and fix (The contractor should break down the subcontractor's lump sum similar to Sections 1 and 2 above) **11.** Fee percentage (quoted by contractor in Contract Data, part two): 5%		5,000.00 250.00
TOTAL DEFINED COST OF SUBCONTRACTED WORK		5,250.00
TOTAL DEFINED COST, OTHER WORK AND SUBCONTRACT WORK		£9,280.65

Figure 16.2 continued

16.7 ECC tender documents

The documents to be issued with the invitations to tender include:

- instructions to tenderers (including any instructions for preparing activity schedules under Options A and C);
- a form of tender;
- contract data, part 1;
- contract data, part 2 (pro-forma for completion by tenderers);
- bills of quantities (Options B and D);
- works information;
- site information;
- a pre-tender health and safety plan is normally required for UK contracts. Under the Construction Design and Management (CDM) Regulations 2007 the employer is also required to appoint a CDM coordinator;
- others, e.g. programme, performance bonds, etc.

Contract data

The contract data is divided into two parts: part 1 – data provided by the employer and included in the tendering documents; and part 2 – data provided by the contractor and returned with their tender, including pricing information and the rates and percentages for use in calculating payments and/or assessing compensation events (depending on the selected main option).

Works information

The works information and site information (Clauses 11.2(5) and (6)), together effectively form the specification and drawings in the traditional sense of the word.

The documents containing the works information provided by the *employer* are identified in part 1 of the contract data. Any works information for the *contractor*'s design submitted by tenderers with their tenders is to be identified in part 2 of the contract data.

The works information in part 1 of the contract data should include the following items: description of the works, including drawings and specification, plant and materials specifications, health and safety requirements, statement of contractor's design, definition of work to be done by the completion date, working with employer and others, subcontracting, additional information required to be included by the contractor on the programme, descriptions of tests and clarification on contractor's title over materials from excavations and demolition.

The ECC guidance notes recommend that, for contracts with little contractor's design, a list of what is to be designed should be provided. For more comprehensive design and build projects, a list of what has been designed by the employer should be given, with the contractor made responsible for designing the balance of the works.

Site information

The documents in which the site information is contained are identified in part 1 of the contract data. Site information may include the following:

- subsoil investigation borehole records and test results;
- reports obtained by the employer concerning the physical conditions within the site or its surroundings. This may include mapping, hydrographic data and hydrological information;
- references to publicly available information about the site and its surroundings such as published papers and interpretations of the *Geological Survey*. The purpose of listing these references is to help the tenderer to prepare his tender and decide his method of working and programme. Normally only factual information about physical conditions on the site and its surroundings is included in the site information. Interpretation is a matter for the contractor;
- information about plant and services below the surface of the site;
- information about piped and other services;
- information about buildings, structures, plant (including machinery) adjacent to and on the site.

The schedules of cost components

An important part of NEC3 is the schedule of cost components (SCC) and the shorter schedule of cost components (SSCC). Their role is to define the basis for the assessment of 'costs'. Under payment Options C, D and E, the SCC is used in both the calculation of the PWDD and the effect of compensation events.

The shorter schedule of cost components is designed for use with payment Options A and B in the assessment of compensation events, but can be used for the same assessment in payment Options C, D and E with the agreement of the parties.

Both schedules include strict definitions of which issues can be included within the following Sections: 1) People, 2) Equipment, 3) Plant and materials, 4) Charges, 5) Manufacture and fabrication, 6) Design and 7) Insurance.

Calculating the costs of 1) People can be an extremely time-consuming exercise. Rowlinson (2011: 148) notes that, in order to reduce administration costs, many employers and project managers have introduced a schedule of job titles/basic salary ranges against which the tendering contractors have inserted hourly rates. These rates are then used when assessing the PWDD and the compensation events.

Calculating the cost of 2) Equipment is treated differently under the two schedules. Under the SCC, equipment is listed in five classes, each of which has its rules for evaluation. Outside hire equipment is charged at the hire rate, whilst equipment owned by the contractor is charged at the market rate. Any items purchased specially for the project are paid at the rates quoted by the contractor in contract data, part 2.

In contrast, under the SSCC, the cost of 2) Equipment is calculated based on the latest edition of industry's standard construction equipment schedule of charges with the percentage

Panel 16.2 Case study: The Eden Project, Cornwall, UK

The creation of the Eden Project is an incredible story, the vision of one man – Tim Smit – and his challenge to create the eighth wonder of the world located in a disused clay pit in Cornwall. The Eden Project's iconic biomes, the world's largest conservatories, are the symbol of a living theatre of plants and people, of regeneration and hope for the future.

The Eden Project was one of the largest projects funded by the National Lottery to celebrate the Millennium and involved a massive earthworks operation, construction of the two large dome structures, exhibition and catering facilities and horticultural planting.

The fundamental contractual requirement was to place a design and construct lump sum contract with a guaranteed maximum price (GMP) with the successful contractor investing equity into the project. After 12 months of negotiations the £60 million project was awarded to a joint venture of Sir Robert McAlpine and Alfred McAlpine, the first partnership between the two since they split in 1940. The design team, including the signature architect Nicholas Grimshaw & Partners, was then novated to the contractor. The contract was executed based on the NEC Option C target cost – with GMP and savings/bonus provisions.

> One agreed a profit in advance with the contractor, obviating the need for them to find fault with others in order to prosper, and then the contract would be run on an open-book basis, meaning that all costs would be open to scrutiny from both sides. The scary thing was that for it to succeed everybody needed to work with the utmost good will; however, this would turn out to be one of the best decisions we ever made.
>
> (Tim Smit, 2002)

Sources: Smit (2002); Anon (2000); Carter, *NEC Users' Group Newsletter*, No. 16

adjustment included by the contractor in contract data, part 2. In the UK the two main schedules are the RICS's 'BCIS Basic Schedule of Plant Charges' and the Civil Engineering Contractors Association's 'Schedules of Dayworks carried out Incidental to Contract Work'.

It is noted that payment for subcontractors' work is treated differently depending which payment option is chosen. Under options A and B the subcontractors' resources are treated as

Panel 16.3 Case study: Crossrail contract strategy

As indicated in Chapters 9 and 12, Crossrail is the biggest engineering project in Europe. It is inherently complex both organizationally and technologically, involving many delivery and supply chain partners, five tunnelling drives comprising 21 kilometre of twin-bore tunnels under central London, eight new underground stations, which have to be connected to the existing Underground and rail networks, and four overground spurs including a connection to Heathrow Airport. All these had to be realized with minimal disruption to the existing network and London as a whole. A contract strategy that could effectively respond to these complex challenges was thus required.

To this end a target cost contract strategy using NEC3 ECC Option C, where risk is shared between the parties was selected by Crossrail Ltd (CRL) for procuring most of the projects within the programme of works. NEC3 ECC Option C has been selected to reflect emphasis on timely completion, certainty of out-turn cost, fair risk allocation and the desire for the teams to work in a collaborative manner to ensure safe delivery with minimum disruption. It has, however, been amended to take the second edition approach of not including as a compensation event the provision relating to prevention which is deemed insufficiently clear.

Key features of this strategy are that contractors can recover costs for carrying out and rectifying defective work, provided such defects are notified by the contractor to the project manager, the work carried out was compliant with works information or accepted quality plan and remedial works take place prior to completion. This approach is to encourage contractors to proactively check the quality of their own work.

The contractual incentive mechanism to support the delivery of the key project objectives is an equitable share of savings which provides a real incentive to control costs to deliver within the target price. CRL has also deleted entitlement to the payment of fee on costs incurred above the target (similar to the Channel Tunnel Rail Link).

Instead of cash retention, CRL requires a 2.5 per cent retention bond which will remain in place until the defects certificate is issued (following the Olympic Delivery Authority's approach). This is a significant boost to contractors' cash flow.

CRL has also retained risk of unexpected physical conditions and exceptional weather condition, but has sought to transfer risk of changes in law to the contractor.

An Owner Controlled Insurance Programme (OCIP) was also to be established by CRL to cover (1) damage to the works and completed works; (2) damage to existing structures; (3) damage to the tunnel boring machines; and (4) third party liability.

Significantly, CRL has set out a general obligation on both parties to use reasonable endeavours to resolve any disputes which may arise by means of prompt discussions in good faith at a managerial level appropriate to the dispute to avoid the need for a reference to adjudication.

Source: 'Crossrail procurement policy' (Crossrail website) if they are the contractor's and included under the calculation of cost under the SSCC, all as stated in Clause 11.2(22). In contrast, payments to subcontractors under Options C, D, E and F are based on the subcontractors' approved interim applications as stated within the definition of defined cost – Clause 11.2(23) refers.

16.8 Conclusions

In this chapter the authors have attempted to give a brief overview of some of the key provisions of the NEC3 contract which should be relevant to the construction cost manager. For a more in-depth understanding of the NEC3 contract readers are advised to refer to the NEC3 *Guidance Notes* and Mitchell and Trebes' *Managing Reality* and, if possible, attend one of the excellent NEC conferences.

Using the NEC system requires a considerable commitment, both at the front-end in defining the scope and throughout the project. However, this high level of commitment and administrative support should ensure that there are no surprises at the end and secure early final settlement. Several commentators have made the point that full compliance with the NEC3 contract administration requirements will require a higher level of resource than most other standard forms of contract. Chris Barker compared the effectiveness of the NEC contract with the traditional ICE contract on two similar road schemes with the same contractor and employer, and found that the employer saved on staffing costs, whilst the contractor's administrative set up was similar; despite this, the final account was settled much quicker under the NEC approach. The NEC project also showed improvement on the wider issues of customer care, environment and sustainability. Additionally, the NEC approach enabled clearer identification and control of risks, giving more certainty of out-turn costs and profits (Barker and Potts, 2009). At the same time Wright and Fergusson (2010) compared the effectiveness of the NEC contract and the FIDIC 1999 *Red Book* on two separate energy projects with the same client and two different contractors in New Zealand. Their research concluded that the NEC contract not only delivered business benefits but the collaborative relationship also provided a positive safe working environment.

The NEC system is based on the concept of cooperation with a proactive team-based approach. Great emphasis is placed on communications, programming and disciplined contract management by both parties. The NEC contract documents should be referred to throughout the project; they should be considered manuals of project management as well as sets of conditions of contract.

The NEC contract poses fundamental challenges to the quantity surveying profession.

The most important change within the NEC contract when compared to traditional contracts is the compensation event procedure. The NEC contract requires the contractor to submit quotations for all changes prior to the receipt of the official instruction. Christopher Ennis, Director of Legal Support at Davis Langdon identifies the reality of the situation under the target cost payment Options C and D: 'In practice, however, this can also mean an incentive to maximise adjustments to Target Cost through recognition of Compensation Events at the highest possible value' and 'the onus is essentially transferred to the Employer to show inadmissibility according to the terms of the contract' (Ennis, 2010).

As Martin Barnes critically observed reflecting on 10 years of use of the NEC:

> No reform is ever bought at zero cost. Many users of NEC have complained that some of the NEC processes require more time to handle than the old ways. We expected that there would need to be more people planning the work so this is no surprise. The time taken to deal with compensation events is more than we expected and we need to do something about that.

> But people tend to forget the amount of time which non-NEC contracts require to be committed to processing variations, claims and disputes. In the brave new world of NEC, you should retrain your quantity surveyors to become planners/estimators – using their ingenuity to come up with clever ways of building the thing instead of clever arguments over who should pay how much for work finished long ago.
>
> (Barnes, 2003)

Postscript

Martin Barnes's comments are important and should be taken seriously by all quantity surveying/commercial management course providers. When acting as RICS external examiner, the author (Potts) found that project planning or scheduling was generally not well provided for in some quantity surveyor courses. Likewise, tendering and estimating tended to focus on the traditional pre-contract cost planning and builders' unit rate estimating. The authors have found the following text books useful in helping students understand the construction methods, the construction equipment, the temporary works, the method statement and the planning techniques which should underpin the contractor's quotation on anything but the simplest or most straightforward project:

- Holmes, R. (1995) *Introduction to Civil Engineering Construction*, 3rd edition, The College of Estate Management.
- Illingworth, J.R. (2000) *Construction Methods and Planning*, 2nd edition, E & FN Spon.
- Cooke, B. and Williams, P. (2009) *Construction Planning, Programming and Control*, 3rd edition, Wiley Blackwell.

All these textbooks are written by experienced practitioners and help to identify, with the aid of numerous illustrations, the real issues involved in the cost of executing construction projects.

16.9 Questions

Question 1

Critically review the use of the NEC2 or NEC3 Option C (target contract with activity schedule) under the NHS ProCure 21 and 21+ schemes.

Question 2

Prepare a 5-minute presentation to the rest of the class of the key issues raised in the following case studies identified in the *NEC Users' Group Newsletters*:

- The Millennium Stadium in Cardiff (Issue 12, January 2000)
- The Channel Tunnel Rail Link (Issues 25, April 2005 and 41, January 2008)
- Cambridge University Estates (Issue 26, July 2003)
- The Rochdale Canal Project (Issues 20, April 2004 and 29, April 2004)
- Housing maintenance projects (Issues 30, July 2004 and 32, January 2005)
- NHS Estates ProCure 21 (Issues 30, July 2004 and 32, January 2005)
- Worcester County Council's Highways Service (Issue 35, April 2006)
- Maintenance of Rampton Hospital (Issue 39, July 2007)
- Cambridge University Plant Growth Facility (Issue 42, April 2008).

Question 3

Briefly review when to use the target cost option and identify the key implementation points within this strategy (*NEC Users' Group Newsletter,* Issue 15, October 2000).

Question 4

Identify the benefits to local authorities in using the NEC (*NEC Users' Group Newsletter,* Issue 16, January 2001).

Question 5

Identify the characteristics of successful project alliances and state the advantages of open book cost management (*NEC Users' Group Newsletter,* Issue 17, April 2001).

Question 6

Identify the key issues raised in the independent view of the X12 partnering option (*NEC Users' Group Newsletter,* Issue 18, July 2001).

Question 7

Compare and contrast the provisions for seeking additional costs and/or extensions of time within the ECC, the ICE and the JCT contracts (*NEC Users' Group Newsletter,* Issue 19, October 2001).

Question 8

Identify the benefits which can occur when the NEC is used on small projects (*NEC Users' Group Newsletter,* Issue 20, January 2002).

Question 9

Identify the problems which were being encountered when using the schedule of cost components under the NEC ECC 2nd edition and consider if the problems have been eradicated under NEC3 (*NEC Users' Group Newsletter,* Issues 20, January 2002, 22, July 2002 and 36, August 2006).

Question 10

Identify the major differences between the partnering options, NEC Option X12 and PPC2000 (*NEC Users' Group Newsletter,* Issue 21, April 2002).

Question 11

Identify the mechanics of the early warning system and consider some of the questions raised concerning its use in practice (*NEC Users' Group Newsletter,* Issues 21, April 2002 and 39, July 2007).

Question 12

Review the key issues involved in the administration of 'actual costs' within target cost contracts (*NEC Users' Group Newsletter,* Issue 23, October 2002).

Question 13

Identify the key issues which should be considered when evaluating compensation events (*NEC Users' Group Newsletter,* Issues 23, October 2002, 26, July 2003, 37, December 2006 and 41, January 2008).

Question 14

Identify the mechanisms and practical issues involved when using the NEC in connection with managing project time (*NEC Users' Group Newsletter,* Issue 24, January 2003; also 28, 29, 30, 33, 38, 42, 43).

Question 15

Review how risks can be managed under an NEC contract (*NEC Users' Group Newsletter, Issue* 40, October 2007).

Question 16

Review how transparency can be achieved under NEC contracts (*NEC Users' Group Newsletter*, Issue 43, July 2008).

Question 17

What items should the project manager include in the certificate of payment under NEC3 Option C (target contract with activity schedule)? For solution, see Gerrard R., 'Project manager's certificate of payment', FAQs, *NEC Users' Group Newsletter*, Issue 45, January 2009, p. 7.

Question 18

Ennis (2010) identifies that 'some of the elements of Disallowed Cost can provide fertile scope for dispute'.

A project is procured based on the NEC3 engineering and construction contract Option C target contract with activity schedule. During the course of this contract the contractor is paid the defined cost (Clauses 52.1 and 11.2(23)) plus the fee (Clause 11.2(8)) – defined as the price for work done to date. The contractor requires payment for the following items. Identify which of these items are (a) allowable within the definition of defined cost or (b) considered part of the fee (tendered by contractor in contract data, part 2) or (c) a disallowed cost (Clause 11.2(25)):

1 transporting construction equipment to site
2 erecting the tower crane
3 purchase of new compressors, generators and pumps
4 subcontractors' discounts of 2.5 per cent
5 subsistence and lodging costs for workmen

6 minibus used to transport workmen
7 standing time (i.e. non-working time) for a fleet of backactors and dumptrucks due to wet weather
8 welders employed by the contractor fabricating temporary works off-site
9 design costs on temporary works
10 purchase of integrated accounting software package and staff training
11 company cars
12 excessive wastage on materials
13 theft of subcontractor's materials
14 accommodation for catering facilities, medical and first aid
15 costs incurred for which the contractor should have given an early warning notice
16 costs of correcting defects after completion.

Each year the Institution of Civil Engineers (ICE) offers an annual set of examinations in Law and Contract Management; Modules 2 and 3 contain questions on the NEC ECC contract. Questions with solutions can be found on the ICE website.

16.10 References/further reading

Anon (2000) 'Guaranteeing the Eden experiment', *Building*, 24 March.

Barker, C. and Potts, K. (2009) 'How effective is the NEC?', *The NEC Users' Group Newsletter*, No. 47, July.

Barnes, M. (2003) 'NEC – a decade of success', *The NEC Users' Group Newsletter*, No. 25, April.

Bennett, J. and Baird, A. (2002) *NEC and Partnering: The guide to building winning teams*, Thomas Telford.

Broome, J.C. (1997) 'Best practice with the New Engineering Contract', *Proceedings of the Institution of Civil Engineers*, Civil Engineering, 120, May, pp. 74–81.

Broome, J.C. (1999) *The NEC Engineering and Construction Contract: A user's guide*, Thomas Telford.

Carter, T., *NEC Users' Group Newsletter*, No. 16, 1, www.edenproject.com.

Civil Engineering Surveyor, October 1997, November 1997, December 1997/January 1998, February 1998, March 1998, April 1998, May 1998, June 1998, July/August 1998, September 1998.

Cox, A. and Thompson, I. (1996) 'Is the NEC going to succeed? – an examination of the Engineering and Construction Contract (alias the NEC 2nd edition)', *The International Construction law Review*, Part 3, pp. 327–337.

Eggleston, B. (2006) *The NEC 3 Engineering and Construction Contract: A commentary*, 2nd edition, Blackwell Science.

Ennis, C. (2010) 'Financial claims under NEC3 contracts: an overview', *Society of Construction Law*, December, Paper D117, www.scl.org.uk.

Fergusson, W. (2009) 'NEC powers on in New Zealand', *NEC Users' Group Newsletter*, No. 49, January, pp. 4–5.

Forward, F. (2002) *The NEC Compared and Contrasted*, Thomas Telford.

Gerrard, R. (2009) 'Eight-week time bar', *NEC Users' Group Newsletter – FAQs*, No. 47, July, pp. 6–7.

Gerrard, R. (2010) 'NEC in practice, some issues', *NEC for Academia conference*, Leeds Metropolitan University, 8 December.

Gould, N. (2007) 'NEC3: construction contract of the future?', *Society of Construction Law*, *September*, Paper D084, www.scl.org.uk.

Hide, G. (2010a) 'Producing a programme under the NEC form of contract', *Proceedings of the Institution of Civil Engineers, Management Procurement and Law*, 163, May, pp. 59–64.

Hide, G. (2010b) 'Managing a programme under the NEC form of contract', *Proceedings of the Institution of Civil Engineers, Management Procurement and Law* ,163, August, pp. 111–119.

Lloyd, H. (2009) 'Some thoughts on NEC,' *NEC Users' Group Special Issue*, January, www.neccontract.com.

McInnis, J.A. (2001) *The New Engineering Contract: A legal commentary*, Thomas Telford.

Mitchell, B. and Trebes, B. (2005) *Managing Reality* – set of 5 books – *Book 1: Introduction to the engineering and construction contract*; *Book 2: Procuring an engineering and construction contract*; *Book 3: Managing the contract*; *Book 4: Managing change*; *Book 5: Managing procedures*, Thomas Telford Publishing.

NEC Users' Group Newsletters, www.neccontract.com/news/index.asp?Type=Newsletters – accessed 12 November 2012).

NEC (2011) Amendments to NEC3 Contracts resulting from The Local Democracy, Economic Development and Construction Act 2009, ICE.

Patterson, R. (2007) 'NEC and risk management', *NEC Users' Group Newsletter*, No. 40, October, p. 5.

Perry, J.G. (1995) 'The new engineering contract: principles of design and risk allocation', *Engineering, Construction and Architectural Management*, Vol. 2, No. 3, pp. 197–208.

Rankin, J., Jameson, P. and Yarwood, N. (2007) NEC X12 at the heart of Worcestershire Highways, *Proceedings of the Institution of Civil Engineers, Municipal Engineer*, 160, March 2007, pp. 31–36.

Rowlinson, M. (2011) *A Practical Guide to the NEC3 Engineering and Construction Contract*, Wiley-Blackwell.

Smit, T. (2002) *Eden*, Corgi.

The Institution of Civil Engineers (2005) *NEC3 Guidance Notes for the Engineering and Construction Contract*, Thomas Telford Ltd.

Valentine, D.G. (1996) 'The new engineering contract: part 1 – a new language; part 2 – claims for extensions of time; part 3 – late completion and liquidated damages', *Construction Law Journal*, Vol. 12, No. 5, pp. 305–332.

Wright, J.N. and Fergusson, W. (2010) 'Benefits of the NEC ECC form of contract: a New Zealand case study', *International Journal of Project Management*, Vol. 27, pp. 243–249.

Websites

www.crossrail.co.uk.

www.ice.org.uk/topics/lawandcontracts/Legal-examinations – cited 20 November 2012.

www.icevirtuallibrary.com.

www.neccontract.com.

www.procure21plus.nhs.uk/introduction – cited 12 November 2012.

17 FIDIC standard forms of international construction contract

17.1 Introduction

The FIDIC (*the Fédération Internationale des Ingénieurs-Conseils*) forms of contract, which were first published in 1957, are the most widely used standard international construction contracts. The FIDIC forms reflect the common standard for a wide range of international contracts around the world and are used with or without amendments or form the basis of bespoke public works contracts.

FIDIC, whose headquarters is in Switzerland, has membership in more than 60 countries and represents most of the private consulting engineers in the world. FIDIC prepares and publishes a range of standard forms, which are updated on a regular basis after widespread consultation with its members, international contractors, major multilateral banks including the World Bank and the International Bar Institution.

At first the FIDIC standard forms were intended for international use, that is for projects where the client country was seeking participation of contractors from other countries. However, in recent years the FIDIC forms have been increasingly used for domestic contracts where both client and contractor are the same nationality. Following developments in the industry and after acknowledging anomalies in the old standard contracts, FIDIC produced in 1999 a new suite of forms to replace the existing forms. Corbett (2002) referred to the standard forms as 'FIDIC's 1999 Rainbow' due to the different colours for different options.

FIDIC contracts have been translated into about 15 languages, which indicates their widespread relevance and use (Hillig *et al*., 2010). Significantly, Lord *et al*. (2010) note that China, the largest construction market in the world, has adopted the FIDIC 1999 contract as the basic reference framework for its construction contracts.

17.2 The new forms

Late in 1999, FIDIC published four new standard forms; each of the new books for major works includes General Conditions together with guidance for the preparation of the Particular Conditions, a Letter of Tender, Contract Agreement and Adjudication Agreements.

1 Conditions of contract for construction (for building and engineering works designed by the employer) – the new Red Book

This is a traditional contract suitable where the employer (or engineer) does most of the design. The contractor constructs the works in accordance with the design provided by the employer –

typically based on the drawings and specification, but also including work specified in the engineer's instructions. However, the works may include some elements of contractor-designed civil, mechanical, electrical and/or construction works, e.g. construction details and reinforcement.

Under the new *Red Book* the engineer is required to administer the contract, monitor the construction works and certify payment; the employer is kept fully informed throughout the project and can make variations. Payment is based on a remeasurement using the rates quoted in the bill of quantities or lump sums for approved work done. The 'accepted contract amount' refers to the sum stated in the letter of acceptance, whereas the 'contract price' is the sum which the employer will eventually pay after remeasurement.

The new *Red Book* is based on the traditional pattern of engineer-designed, contractor-built works. The new *Red Book* is similar to the old *Red Book* (FIDIC's *Conditions of Contract for Works of Civil Engineering Construction*, 4th edition, 1987). Its principal features, including some new ones, are as follows:

- It is suitable for projects where main responsibility for design lies with employer (or his engineer).
- Some design may be carried out by the contractor.
- Administration of contract and supervision is performed by the engineer.
- Approval of work, payment, etc., is certified by the engineer.
- The engineer acts as the impartial certifier and valuer.
- The engineer's decision is the first stage of dispute resolution (now renamed as decisions on matters of dissatisfaction).
- Work done is measured, and payment is according to bill of quantities.
- There is an option for payment on a lump sum basis.
- There is a new requirement for a progress report (Clause 4.21).
- There is a new value engineering clause (Clause 13.2).
- There are new financing charges for late payments: at 3 per cent above bank rate (Clause 14.8).
- There is a new impartial dispute adjudication board (Clause 20).

The underlying legal concepts of the 1999 *Red Book* are based on English law as the first edition of the *Red Book* published in 1957 was based on the *ICE Conditions of Contract*, 4th edition, published in 1954.

In 2005, FIDIC licensed the Multilateral Development Banks (MDBs) to use the MDB Harmonized Edition of the Construction Contract for projects funded by the banks.

In using the FIDIC conditions it had been the regular practice of the MDBs to introduce additional clauses into the Conditions of Particular Application or *Particular Conditions* in order to amend provisions contained in the FIDIC General Conditions.

Furthermore, the provisions in bid documents, including the additional clauses contained in the Particular Conditions, varied between MDBs. Hence, the need for the development of the MDB Harmonized Form which was first published in 2005 with an amended second version in 2006. The 2005 MDB form also includes sample forms for contract data, securities, bonds, guarantees and Dispute Board agreements.

FIDIC states that it is not the intention to replace the standard 1999 contract – this is still available for use. However, in reality the MDB Harmonized Edition 2005 will surely become the standard contract throughout the developing world on projects funded by the international financing institutions.

2 Conditions of contract for plant and design–build (D–B) (for electrical and mechanical plant and for building and engineering works designed by the contractor (the new Yellow Book)

Under this contract the contractor (or supplier) is expected to do the majority of the design, not only of plant projects but also of various infrastructure and other types of work. The contractor's design is required to fulfil the 'Employer's Requirements', i.e. an outline or performance specification prepared by the employer. Under this contract the engineer administers the contract, monitors the manufacture and erection on site or construction work. The engineer also certifies payments, which are normally based on the achievement of milestones, generally on a lump sum basis.

3 Conditions of contract for EPC turnkey projects (engineer–procure–construct) (the Silver Book)

Where the employer requires an engineer–procure–construct (EPC) contract, with the construction contractor taking total responsibility for design and construction of the infrastructure or other facility, the *Silver Book* is most appropriate. This form is suitable on a PFI or PPP project where a concessionaire takes total responsibility not only for design and construction, but also for the financing and operation of the project.

Under this arrangement the employer does not expect to be involved in the day-to-day progress of the works. However, the employer expects a high degree of certainty that the agreed contract price and time will not be exceeded. Likewise, the contractor would expect to be paid a premium in return for bearing the extra risks involved.

This form can also be used on process plant or power plant projects where the employer provides the finance and wishes to implement the project on a fixed-price turnkey basis. However, in certain circumstances, the EPC (*Silver*) *Book* is not suitable and the plant and D–B (*Yellow*) *Book* is considered preferable.

4 Short form of contract (for contracts of relatively small value) (the Green Book)

This form is suitable for a relatively small contract, say under US$500,000, or where the construction time is short, say less than 6 months, or where the work involved is relatively simple or repetitive. The new form is suitable for construction, electrical, mechanical or other engineering work with design by the employer (or his engineer/architect) or by the contractor.

Since 1999 FIDIC has introduced the other standard contracts including: *Model Representative Agreement*, test edition, 2004; *White Book 2006: Client/Consultant Model Services Agreement*, 4th edition; *Blue-Green Book 2006: Form of Contract for Dredging and Reclamation Works*, 1st edition; *Gold Book 2008: Conditions of Contract for Design, Build and Operate Projects*, 1st edition; *Standard Prequalification Form*, 3rd edition, 2008.

17.3 Balance of risk

All contracts are a compromise between the conflicting interests of the parties. The new *Red Book* attempts to allocate risks fairly between the parties. The basic principle is that the risk is allocated to the party that is best able to bear and control that risk. It follows therefore that the contractor can only be expected to be bound by and to price for conditions which are known to him or which he is able to foresee and reasonably price in his tender.

Typical risks carried by the contractor include: accuracy of estimate, appropriateness of method statement, costs of production, achieving estimated productivity, adherence to the programme, design and installation of temporary works, failure to obtain labour and materials, breakdown of construction equipment, failure by subcontractors, design of permanent works where undertaken by the contractor, weather and inflation.

17.4 Structure of the new *Red Book*

The *Red Book* is divided into three sections, namely:

1 the General Conditions, including the General Conditions of Dispute Adjudication Agreement and Procedural Rules;
2 Guidance for the Preparation of Particular Conditions, including example Forms of Parent Guarantee, Tender Security, Performance Security Guarantee (both 'on demand' and 'upon default'), Advance Payment Guarantee, Retention Money Guarantee and Payment Guarantee by Employer (Annexes A to G);
3 Forms of Letter of Tender, Appendix to Tender, Contract Agreement and Dispute Adjudication Agreement (both for one-person and three-person Dispute Adjudication Board).

Contract documents

The 'Forward' to the contract states that the 'The General Conditions and the Particular Conditions will together comprise the Conditions of Contract governing the rights and obligations of the parties. It will be necessary to prepare the Particular Conditions for each individual contract.'

The contract documents are defined in Sub-Clause 1.1.1 (Definitions), as:

- The Contract Agreement;
- The Letter of Acceptance;
- The Letter of Tender;
- These Conditions [General Conditions and Particular Conditions];
- The Specification;
- The Drawings;
- The Schedules;*
- The further documents listed in the Contract Agreement or in the Letter of Acceptance.

* typically comprising a bill of quantities and a daywork schedule

Sub-clause 1.5 identifies that 'The documents forming the Contract are to be taken as mutually explanatory of one another'. For the purpose of interpretation, the priority of the documents should be in accordance with the sequence listed above.

Under Sub-clause 1.12 'The Contractor shall disclose all such confidential and other information as the Engineer may reasonably require in order to verify the Contractor's compliance with the Contract'. This sub-clause could place the contractor in a difficult position in situations where a dispute has arisen with regard to third parties (EIC, 2003).

The parties

The parties to the contract are the employer and the contractor. The employer plays very little part in the running of the contract. The contractor has to construct the works to the satisfaction of the engineer. The engineer is not a party to the contract, but is appointed by the employer and is given very wide powers to issue instructions to the contractor.

The engineer acts as an agent for the employer, e.g. when they issue instructions under Sub-clause 3.3 (Instructions of the engineer) or under Sub-clause 4.12 (Unforeseeable physical conditions).

> The Engineer is not authorised to amend the Contract, but he is deemed to act for the Employer as stated in sub-paragraph 3.1 (a) .The role of the Engineer is thus not stated to be that of a wholly impartial intermediary unless such a role is specified in the particular conditions.
>
> (FIDIC, 2000: 82)

However, the engineer is required to act fairly between the parties. For example under Sub-clause 3.5 the engineer has to make a 'fair determination in accordance with the Contract'. Likewise, Sub-clause 14.6 requires interim payment certificates to show the amount which the engineer 'fairly determines to be due'.

Research by Ndekugri *et al*. (2007) identified three major changes in the role of the engineer under the FIDIC 1999 contract compared to the traditional role of the engineer. First, a duty to act impartially had been replaced by a duty to make fair determination of certain matters. Second, the employer can assume greater control of the engineer by stating in the Particular Conditions the powers that the engineer is not able to exercise without the employer's approval. Third, there is provision for a Dispute Adjudication Board (DAB) to which disputes may be referred, including any dissatisfaction with the engineer's determinations. Although the duality has not been eliminated completely, the contract is structured flexibly enough to support those who wish to contract on the basis of the engineer acting solely as the agent of the employer.

Control of the project is undertaken at two levels:

1 At the top, the engineer corresponds with the contractor.
2 On site, the engineer is represented by the resident engineer (Sub-clause 3.2), and the contractor by the contractor's representative (Sub-clause 4.3).

17.5 The employer (Clause 2)

The employer's role is limited to matters such as nominating the engineer; giving the contractor right of access to and possession of the site within the times stated in the Appendix to Tender; providing assistance to the contractor to obtain permits, licences and approvals; ensuring own personnel comply with safety and protection of the environment procedures; making payment upon certification; giving notice to the contractor of employer's claims and giving notice to terminate the contract. The employer gives all authority for the administration of the contract to the engineer.

Under Sub-clause 2.4 'The Employer shall submit, within 28 days after receiving any request from the Contractor, reasonable evidence that financial arrangements have been made and are being maintained which will enable the Employer to pay the Contract Price'; failure to produce such evidence entitles the contractor to suspend or reduce the rate of work (Sub-clause 16.1) and ultimately (if no evidence is received within 12 weeks) to terminate the contract. This sub-clause will be particularly relevant where the immediate client is a special purpose vehicle (SPV) and is funded by loans.

Under another new Sub-clause 2.5 'If the Employer considers himself to be entitled to any payment under any Clause of these Conditions . . . and/or to any extension under the Defects

Notification Period, the Employer or the Engineer shall give notice to the Contractor'. The employer must follow the set of procedures if they consider themselves entitled to any payment and must give notice as soon as practicable and provide particulars of the claim.

17.6 The engineer (Clause 3)

Engineer's duties and authority (Sub-clause 3.1)

The engineer is not a party to the contract but essentially acts as an agent for the employer, with all their power to control the contractor described within the contract. The engineer is only liable to instruct the contractor provided one of the clauses in the contract gives them that power. Most of the engineer's powers are derived from Sub-clause 3.3 (Instructions of the engineer), which gives the engineer wide powers to issue to the contractor (at any time) instructions and additional drawings which may be necessary for the execution of the works.

In Sub-clause 3.3 there is an obligation on the engineer to supply such additional or modified drawings which may be necessary for the execution of the works and the remedying of any defects.

Delegation by the engineer (Sub-clause 3.2)

This sub-clause allows the engineer to assign duties and authority to *assistants*, i.e. representatives permanently based on site. The assistants might include the resident engineer (RE) and/or independent inspectors. On larger projects there might be additional assistant resident engineers in order to support the RE. The authority of the engineer's assistants should be made in writing.

Note that 'the Engineer shall not delegate the authority to determine any matter in accordance with Sub-clause 3.5 [Determinations]'.

The principal duties of the resident engineer are to:

- supervise and check that the works conform to the drawings and specification;
- organize and supervise any tests;
- keep daily records: progress, labour and plant, problems, weather;
- examine the contractor's programme and method statement;
- check temporary works design;
- ensure that the site operations do not prejudice the safety of their own staff;
- measure the quantities of work;
- ensure that satisfactory records are kept (for payment);
- keep *as built* drawings.

Determinations (Sub-clause 3.5)

Under this sub-clause the engineer, after consultation with the other parties, is required to agree and determine any matter including employer's claims, contractor's claims, evaluation of variations and evaluation of the value of the works. 'If agreement is not achieved the Engineer should make a fair determination in accordance with the Contract taking into account all the relevant factors.' In practice, the quantity surveyors representing the employer and contractor will prepare much of the documentation forming the basis of the final negotiation.

The engineer's role

The engineer has many roles under the FIDIC *Red Book* – administration, certification, supervision including quality control, decision-making, making determinations, communication of information to the parties and principal designer, as well as acting as the employer's agent. Some of the key clauses in the FIDIC *Red Book* which identify the involvement of the engineer include:

Clause 7. Plant, materials and workmanship

7.2 Samples, 7.3 Inspection, 7.4 Testing, 7.5 Rejection, 7.6 Remedial work.

Clause 8. Commencement, delays and suspension

8.1 Commencement of works, 8.3 Programme, 8.4 Extension of time for completion, 8.6 Rate of progress, 8.8 Suspension of work, 8.9 Consequences of suspension, 8.11 Prolonged suspension, 8.12 Resumption of work.

Clause 12. Measurement and evaluation

12.1 Works to be measured, 12.3 Evaluation, 12.4 Omissions.

Clause 13. Variations and adjustments

13.1 Right to vary, 13.2 Value engineering, 13.3 Variation procedure, 13.5 Provisional sums, 13.6 Dayworks, 13.7 Adjustments for changes in legislation, 13.8 Adjustment for changes in cost.

Clause 14. Contract price and payment

14.1 The contract price, 14.2 Advance payment, 14.3 Application for interim payment certificates, 14.4 Schedule of payments, 14.5 Plant and materials intended for the works, 14.6 Issue of interim payment certificates, 14.7 Payment, 14.9 Payment of retention money, 14.10 Statement at completion, 14.11 Application for final payment certificate, 14.13 Issue of final payment certificate.

Clause 20. Claim, disputes and arbitration

20.1 Contractor's claims.

In practice the client's quantity surveying team will often be responsible for carrying out much of the work in connection with Clauses 12 – Measurement and evaluation, 13 – Variations and adjustment and 14 – Contract price and payment, and assisting with Clause 20 – Claims, disputes and arbitration.

17.7 The contractor (Clause 4)

The contractor's general obligations (Sub-clause 4.1)

The contractor is required to construct and complete the works (permanent and temporary), design the works (to the extent specified in contract), comply with engineer's instructions, within the time stated, and remedy any defects. Significantly, if the contract specifies that the contractor should design any part of the permanent works, then this should 'be fit for such purposes for which the part is intended' (Sub-clause 4.1(c)). It is noted that, under English Law or Common

Law, this obligation is more demanding than the employer's designers' obligation to design with reasonable skill and care. This could lead to some interesting disputes should difficulties arise as a result of any conflicts or anomalies between the employer's and contractor's designs.

The contractor is responsible for setting out, safety and quality, providing the plant and contractor's documents specified in the contract, giving all notices, providing performance security and taking out the necessary insurances. Sub-clause 4.2 requires that 'The Contractor shall obtain (at his cost) a Performance Security for proper performance, in the amount and currencies stated in the Appendix to the Tender'; the Annexes to the *Red Book* provide six different types of security which the contractor might be required to provide. Additionally, Sub-clause 4.4 states that 'The Contractor shall be responsible for the acts or defaults of any Subcontractor' (including nominated). It is noted that 'The prior consent of the Engineer shall be obtained to other proposed Subcontractors' (Sub-clause 4.4(b)).

Under Sub-clause 1.12 'The Contractor shall disclose all such confidential and other information as the Engineer may reasonably require to verify the contractor's compliance with the Contract'.

Site data (Sub-clause 4.10)

Under Sub-clause 4.10 'The Employer shall have made available to the Contractor for his information, prior to the Base Date, all relevant data in the Employer's possession on sub-surface and hydrological conditions at the Site, including environmental aspects'.

Sufficiency of the accepted contract amount (Sub-clause 4.11)

Sub-clause 4.11 covers two closely related matters – the provision of information on the site by the employer and obligation of the contractor to inspect and examine the site to ensure 'the correctness and sufficiency of the Accepted Contract Amount'.

The contractor is responsible for interpreting any information on the nature of the ground, subsoil and hydrological conditions, pipes and cables. Opinions, which may be included in such information, should not be relied upon. It is normally the case that soils reports are not part of the contract.

The contractor is only deemed to have satisfied himself as regards the nature of the ground, subsoil and hydrological conditions so far as practicable and reasonable. A contractor would not be expected to execute addition boreholes prior to tender. The contractor is deemed to have based his tender on the information made available from the employer and on his own inspection and examination.

Unforeseen ground conditions (Sub-clause 4.12)

'If the Contractor encounters adverse physical conditions, which he considers to have been Unforeseeable, the Contractor shall give notice to the Engineer as soon as practicable' (Sub-clause 4.12 Unforeseeable physical conditions). Unforeseeable is defined by Clause 1.1.6.8 as 'not being reasonably foreseeable by an experienced contractor by the date of the submission of the Tender'. In this sub-clause physical conditions means 'natural physical conditions and man-made and other physical obstructions and pollutants, including sub-surface and hydrological conditions . . . but excluding climatic conditions'.

Thus the employer is responsible for adverse physical conditions. Such conditions could be due to: lakes, high water table, geological faults, running sand, etc., or services, mine workings, old structures, etc. However, such conditions should not be due to climatic conditions. Thus, a flood after heavy rain would be a climatic condition, but running sand probably not.

It becomes necessary to ask if an experienced contractor could have reasonably foreseen the adverse condition. This question causes no end of arguments. If the engineer did not foresee and allow for conditions in his design, then it could be said that an experienced contractor could not reasonably foresee the conditions. The FIDIC *Contracts Guide* (FIDIC, 2000: 117) gives the following guidance:

> For example, if the Time for Completion is three years, an experienced contractor might be expected to foresee an event which occurs (on average) once in every six years, but an event which occurs only once in every ten years might be regarded as Unforeseeable.

Under Sub-clause 4.12 'the Contractor shall give notice to the Engineer as soon as practicable' which:

a) Shall describe the physical condition, so that they can be inspected by the Engineer; and
b) Shall set out reasons why the Contractor considers them to be Unforeseeable.

If the contractor suffers delay and/or incurs cost due to these conditions, the contractor should be entitled, subject to Sub-clause 20.1 (Contractor's claims), to:

- An extension of time for any delay, if completion would be delayed, under Sub-clause 8.4 [Extension of time for completion], and
- Payment of any such Cost, which should be included in the Contract Price.

(Note the definition of 'Cost' in Sub-clause 1.1.43 – it includes overheads and similar charges, but does not include profit.)

However, there is a sting in the tail in this sub-clause in that the penultimate paragraph allows the engineer to reduce the cost if they consider that 'more favourable conditions were encountered' than could reasonably have been foreseen. Furthermore, a new concept allows the engineer to take account of any evidence of physical conditions foreseen by the contractor when submitting the tender, but the engineer is not bound by such evidence.

Panel 17.1 Legal case: Unforeseeable physical conditions

The case C.J. Pearce & Co Ltd v Hereford Corporation (1968*) 66 L.G.R. 647* concerned the construction of a sewer in a heading underneath a road crossing, under the terms of the 1955 ICE Conditions. The 'approximate line' of an ancient sewer was shown as diagonally crossing the line of the new sewer but its depth was not stated. However, the witnesses for both parties accepted 'approximate', meant that the line of the old sewer might be 10 to 15 feet one side or other of the line shown.

Pearce, the contractor, fractured the old sewer, which was full of water, resulting in flooding of the works. Following a meeting on site with the engineer the contractor was required to cap off the old sewer at some distance from the site, sink a shaft at the far side of the road and work back using the open cut method of excavation.

It was held that the contractor was bound to do the work and was not entitled to any additional expense. Even if a notice had been served under Clause 12 it would have failed as the condition could have been 'reasonably foreseen'.

Encountering unforeseen physical obstructions is almost inevitable on major construction works. Even if the employer has instigated an extensive pre-contract site investigation, it is physically impossible to cover every square metre on the site with boreholes.

The history of tunnelling is littered with claims for unforeseeable physical conditions. Tunnelling contractors develop their method statement and order their construction equipment based on the ground condition information given at tender stage. If rock is anticipated, then drilling machines or a drill and blast approach may be appropriate. If there is a high water table or poor ground conditions, a tunnelling shield working in compressed air may be chosen. These major items of construction equipment are usually purchased specifically for the job at hand and may take anything up to 6 months to manufacture.

If the contractor encounters different ground conditions than those anticipated, this could have major repercussions on the costs and the completion date. On the Carsington Dam tunnelling project for Severn Trent Water in the late 1970s Mowlem ordered four large drilling machines. In the event the ground conditions proved worse than anticipated and the drilling rigs were discarded as being unsuitable. A tunnelling shield using compressed air was introduced, but progress was slow due to isolated pockets of rock. Three years into the Carsington project the Engineer instructed additional site investigation! Indeed the only tunnels that went as planned on this large project were the hand-dug tunnels. There is a saying in the world of tunnelling that the only accurate ground investigation survey is the tunnel itself!

On the first stage of the Hong Kong MTR, the Gammon Kier Lilley JV had planned to construct the external perimeter walls to the station boxes in North Nathan Road using large-diameter piling equipment specially manufactured for the project in the UK. In order to accommodate these massive piling rigs it was necessary first to remove all the overhanging canopies in the tightly congested high street. In the event, isolated granite boulders were encountered which meant that the expensive equipment could not perform the work as planned.

The contractor developed a solution for the outer wall construction involving a combination of grout curtains around the outer box walls and hand-dug caissons based on a tried and tested approach which had been used in China and elsewhere for centuries. The substantial additional costs became the subject of a major claim under the Unforeseeable physical conditions Sub-clause.

Postscript: Peter Fenn undertook a survey of the international practice on the allocation of unforeseen ground conditions in standard forms of construction contract (Fenn, 2000). He found that:

- In Australia, Germany, Italy, Japan and Romania the owner bore the risk.
- In France in the public sector the doctrine of unforseeability (*théorie de l'imprévision*) covered ground conditions, so the owner was allowed to rescind the contract but was obliged to compensate the contractor.
- In Canada, China, India, Indonesia, Ireland, New Zealand, Portugal, Sri Lanka, Sweden, United Kingdom and United States the risk was shared.
- Only in Hong Kong and Malayasia did the contractor bear the risk.

The FIDIC *Red Book* conditions are essentially the same as Clause 12 in the standard *ICE Conditions of Contract*, i.e. the risks are shared with the application of the 'reasonably foreseeable' test.

Progress Reports (Sub-clause 4.21)

Sub-clause 4.21 states, 'Unless otherwise stated in the Particular Conditions, monthly progress reports shall be prepared by the Contractor and submitted to the Engineer in six copies'. The regular and timely production of this detailed list of documents is critical. Not only do they act as a monitor on progress, but they also act as a condition of payment. Under Sub-clause 14.3 payment will only be made within 28 days of receipt of the application for payment and the supporting documents. This report will be a substantial document and must be submitted within 7 days from the last day of the relevant month, which means 5 working days (Totterdill, 2006).

17.8 Commencement, delays and suspension (Clause 8)

Commencement of works (Sub-clause 8.1)

Sub-clause 8.1 states:

> The Engineer shall give the Contractor not less than 7 days notice of the Commencement Date. Unless otherwise stated in the The Particular Conditions, the Commencement Date shall be within 42 days after the Contractor receives the Letter of Acceptance.

Time for completion (Sub-clause 8.2)

Sub-clause 8.2 states: 'The Contractor shall complete the whole of the Works, and each section if any within the Time for Completion for the Works or Section (as the case may be)'.

The programme (Sub-clause 8.3)

The contractor makes assumptions based on the borehole logs and soil investigation reports. They plan the mode, manner and methods of working; design the temporary works; and estimate the subsequent productivity rates based on the information given to them at tender stage. This information thus forms the basis for their tender as well as their programme. If the contractor does extra work they are entitled to reasonable payment.

A project is required to be programmed many times, with different levels of detail, throughout the project cycle. One of the most important means by which the contractor can increase their profit is by finishing a project early, thus saving on site overheads.

Sub-clause 8.3 states:

> The Contractor shall submit a detailed time programme to the Engineer within 28 days after receiving the notice under Sub-clause 8.1 [Commencement of works]. The Contractor shall also submit a revised programme when the previous programme is inconsistent with actual progress or the Contractor's obligations. Each programme shall include:
>
> - the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design (if any), Contractor's Documents, procurement, manufacture of plant, delivery to site, construction, erection and testing;
> - each of the stages for work by each nominated subcontractor (as defined in Clause 5 [Nominated subcontractors]);
> - the sequence and timing of inspections and tests specified in the Contract; and
> - a supporting report which includes: general description of the methods which the contractor intends to adopt, and of major stages, in the execution of the works, and details showing the contractor's reasonable estimate of the number of each class of contractor's personnel and of each type of contractor's equipment, required on the site for each major stage.

Points to note:

- The programme is not a contract document.
- The programme is not for approval of the engineer.
- Form of the programme is not dictated; however, some employers and engineers might wish to specify the format, e.g. Asta Powerproject or Primavera.

Note that the engineer has 21 days from receipt of the programme to check the programme to ensure that it complies with the contract. If at any time the engineer gives notice to the contractor that a programme fails to comply with the contract or to be consistent with actual progress and the contractor's stated intentions, the contractor should submit a revised programme.

The author (Potts) recollects that, whilst working for the Hong Kong MTRC, a contractor submitted a grossly over-optimistic programme in terms of productivity. No approval was given for this programme; the employer, through the engineer, prepared a realistic version of the programme which was later used for the validation of claims for extension of time.

Under Sub-clause 8.3 'The Contractor shall promptly give notice to the Engineer of specific probable future events or circumstances which may adversely affect the Works, increase the Contract Price or delay execution of the Works'. This requirement indicates a desire on behalf of the employer to instil a proactive team-based philosophy to solving problems.

The engineer requires the construction programme to:

- organize their office re: drawings, schedules, nominated subcontractors;
- organize their engineering staff and inspectors;
- monitor the contractor's progress;
- establish the cash flow (for the employer);
- monitor claims for extension of time.

The contractor requires a construction programme to:

- organize subcontractors, procure construction equipment, labour and materials;
- plan and control the works;
- establish the basis of claims (extension of time);
- establish the cash flow.

Contractors often develop strategies in order to support delay claims by: detailing early requirements for all further design information; showing all items as critical on the network (with no float); and including an early date for completion. However, in the case of *Glenlion Construction Ltd v The Guinness Trust* (1987) 39 BLR 89 it was held that an architect was under no obligation to provide the contractor with information early even though the contractor's programme showed them completing in 101 weeks in contrast to the 114 weeks in the contract.

Some employers (and/or their engineers) require tenderers to include details of their methods and their intended programme with their tender. The reasons for this include:

- obtaining information to be used in the appraisal of tenders;
- obtaining information to assist the employer and/or engineer in fulfilment of their own obligations;
- obtaining information to assist the employer and/or engineer in coordinating the contract works with other activities;
- obtaining information in the hope of controlling the contractor's operations and their scope for claims.

Panel 17.2 Legal case: Contractual effect of construction programme and method statement

The case of *Yorkshire Water Authority v Sir Alfred McAlpine Ltd (1985)* 32 BLR 114 concerned a dispute on the £7 million outlet tunnel at Grimworth Reservoir in North Yorkshire under the ICE 5th edition. The contractor was required to submit with their tender a programme in bar chart format together with a method statement showing that they had taken note of certain specified phasing requirements – in particular that the upstream work preceded the downstream requirements.

In the event, this proved impossible and the contractor proceeded with the downstream work and sought a variation under Clause 51(1): 'such changes may include . . . changes in the specified sequence method or timing of construction'.

The court held that:

- *The incorporation of the method statement into the contract imposed an obligation on the contractor to follow it so far as was legally or physically possible.*
- *The method statement, therefore, became a specified method of construction and the contractor was entitled to a variation order and payment accordingly.*

Mr Justice Skinner commented, 'The plaintiff (Yorkshire Water) could have kept the programme and methods as the sole responsibility of the contractor under Clause 14(1) and (3) – the risks would then have been the respondent's (McAlpine) throughout.'

Extensions of time for completion (Sub-clause 8.4)

The contractor is under strict duty to complete on time except to the extent that they are prevented from doing so by the employer or are given relief by the express provisions of the contract. The effect of extending time is to maintain the contractor's obligation to complete within a defined time, and failure by the contractor to do so leaves them liable to damages, either liquidated or general according to the terms of the contract (Egglestone, 2001).

Sub-clause 8.4 defines the events which entitle the contractor to an extension of time and sets out the procedures and rules for the contractor and engineer to follow.

Extension of time clauses have various purposes:

- to retain a defined time for completion;
- to preserve the employer's right to liquidated damages against acts of prevention;
- to give the contractor relief from their strict duty to complete on time in respect of delays caused by designated neutral events.

Under Sub-clause 8.4 items giving grounds for an extension of time include:

a) A variation (unless an adjustment to the Time for Completion has been agreed under Sub-clause 13.3 [Variation procedure]) or other substantial change in quantity of an item of work included in Contract;
b) A cause of delay giving an entitlement to extension of time under a Sub-clause of these Conditions;
c) Exceptionally adverse climatic conditions*;

d) Unforeseeable shortage in the availability of personnel or Goods caused by epidemic or governmental actions; or
e) Any delay, impediment or prevention caused by or attributable to the Employer, the employer's Personnel, or the Employer's other contractors on the Site.

If the Contractor considers himself to be entitled to an extension of the Time for Completion the Contractor shall give notice to the Engineer in accordance with Sub-clause 20.1 [Contractor's claims].

* Totterdill (2006) suggests that 'It will be necessary to submit records for the normal weather over a period of, say, five years'.

Of itself, an extension of time under the new *Red Book* gives no entitlement to payment to the contractor, and the question of whether a particular delay is reimbursable or non-reimbursable is properly determined from the cause of delay (and proof of cost arising) rather than whether or not an extension of time has been granted (Eggleston, 2001). If the contractor also seeks reimbursement of additional costs and reasonable profit, then the claim has to be made under that particular sub-clause.

Glover *et al.* (2006) identify which sub-clauses give grounds for extension of time, with costs and reasonable profit. The following carry an entitlement to an extension of time plus cost and a reasonable profit:

1.9 Delayed drawings and instructions
2.1 Right of access to site
4.7 Setting out
7.4 Testing
10.3 Interference with tests on completion
16.1 Contractor's entitlement to suspend work.

The following sub-clauses will permit an entitlement to an extension of time plus cost only:

4.12 Unforeseeable physical condition
4.24 Fossils
8.9 Suspension initiated by the employer
13.7 Adjustment for changes in legislation
17.4 Consequences of employer's risks
19.4 Consequences of *force majeure*.

The following sub-clause will permit an entitlement to an extension of time only:

8.5 Delays caused by authorities.

Rate of progress (Sub-clause 8.6)

'If, at any time, actual progress is too slow to complete within the Time for Completion, and/or progress has fallen (or will fall) behind the current programme' the engineer can require the contractor to produce a revised programme and revised working methods in order to expedite progress and complete within the time for completion. The engineer can only do this if the reason for the delay is other than a cause listed in the Sub-clause 8.4 (Extension of time for completion). Unless the engineer objects, the contractor should adopt the revised working methods at their own risk and cost.

Delay damages (Sub-clause 8.7)

If the contractor fails to complete within the time for completion calculated from the commencement date, they should pay to the employer a sum specified in the *Appendix to Tender* as a percentage of the accepted contract price per day. It is noted that the *FIDIC Guide* recommends a maximum amount of delay damages on international projects, generally varying between 5 per cent and 15 per cent.

17.9 Measurement and evaluation (Clause 12)

Works to be measured (Sub-clause 12.1)

The engineer is responsible for measuring the works; they are required to give notice to the contractor's representative to assist in making the measurement and supplying any particulars. If the contractor fails to attend the measurement made by or on behalf of the engineer, the measurement is accepted as accurate. It is noted that the contractor only has 14 days to give notice of any disagreement.

The new *Red Book* is essentially a *measure and value* contract with the works being subject to remeasurement upon completion. The measurement is normally calculated using the latest approved engineer's drawings valued based on the rates in the bill of quantities or schedules. However, some measured items will need to be measured in-situ on site, based upon agreed records, e.g. excavation in rock.

It is noted that if a lump sum contract is to be adopted the Particular Conditions recommend that amendments are made to the wording of Clauses 12, 13 and 14.

Method of measurement (Sub-clause 12.2)

Sub-clause 12.2 states:

> Except as otherwise stated in the Contract and notwithstanding local practice:
>
> (a) measurement shall be made of the net actual quantity of each item of the Permanent Works, and
> (b) the method of measurement shall be in accordance with the Bill of Quantities or other Schedules.

It is important that the rules of measurement are clearly defined in the contract.

The case studies below indicate two different methods of measurement, one based on partial remeasurement in accordance with the terms defined in the schedules and the other on full remeasurement based on a specially written standard method of measurement.

Evaluation (Sub-clause 12.3)

Under this sub-clause the engineer is required to agree or determine the contract price by evaluating each item of work, applying the measurement agreed and the appropriate rate or price for the item.

Sub-clause 12.3 states:

> For each item of work, the appropriate rate or price shall be the rate or price specified in the Contract or, if there is no such item, specified for similar work. However, a new rate or price shall be appropriate for an item of work if:

Panel 17.3 Case Studies: Typical measurement provisions within FIDIC contracts

Case Study 1: Teesside Jetties Marine Terminal for US client Phillips Petroleum

The tender documents included a detailed specification and drawings of the permanent works. An activity schedule was included which listed the major components in the project; bidding contractors were required to insert lump sum prices against the activities described.

Two elements of the work were further analysed and measured in detail in a mini bill of quantities – the 36-inch-diameter steel tube piles, together with the integral sea-bed anchorages. These items were selected for remeasurement due to the uncertain nature of the ground conditions and anticipated varying lengths required. The piling and anchorages were remeasured on completion based on the agreed driven records and priced at the tender rates where appropriate. New rates were negotiated for pile extensions.

Case Study 2: HKMTRC – Stage 3 (Island Line)

The project was designed in detail by the client's design consultants. Comprehensive bills of quantities covering all the permanent work designed were prepared. Some critical temporary works, which were designed by the client's designers, e.g. ground water control systems, were measured and included in the bill of quantities.

The bills of quantities were prepared based on the MTRC's own Method of Measurement; this was similar to CESMM2, but had expanded sections covering tunnelling and architectural finishes. All work was subject to remeasurement on completion based on the permanent works finalised design drawings or records agreed on site; e.g. records were produced for every linear metre of tunnel excavation.

(a) (i) the measured quantity of the item is changed by more than 10% from the quantity of this item in the Bill of Quantities or other Schedule.
(ii) this change in quantity multiplied by such specified rate for this item exceeds 0.01% of the Accepted Contract Amount.
(iii) this change in quantity directly changes the Cost per unit quantity of this item by more than 1%, and
(iv) this item is not specified in the Contract as a 'fixed rate item'
or
(b) (i) the work is instructed under Clause 13 [Variations and adjustments]
(ii) no rate or price is specified in the Contract for this item, and
(iii) no specified rate is appropriate because the item of work is not of similar character, or is not executed under similar conditions, as any item in the Contract.

The new *Red Book* identifies that each new rate or price should be derived from any relevant rates or prices in the contract, with reasonable adjustments to take account of matters described in sub-paragraph (a) and/or (b). If no rates or prices are relevant for the derivation of a new rate, it should be derived from the reasonable cost of executing the work, together with a reasonable profit, taking account of other relevant matters.

Contractors frequently submit accounts for varied work in the form of *daywork sheets*. Such a valuation frequently suits contractors, as reimbursement is essentially made on a cost plus profit basis, with no incentive for efficient working. However, this basis is only formally applicable where the engineer orders that a variation be executed on a daywork basis (Sub-clause 13.6).

There are several general principles when negotiating the value of variations: try to follow the same principles that the contractor used in calculating his rates for the tender; and establish a valuation fair to both parties, i.e. cost plus a reasonable percentage for profit, with a deduction of any proven inefficiency by the contractor. The market rate should be taken into consideration or used completely. However, only in exceptional cases should the basis of the valuation from BofQ rates be abandoned.

Omissions (Sub-clause 12.4)

In essence, this sub-clause entitles the contractor to compensation for costs reasonably incurred in the expectation of carrying out work subsequently omitted under the variation.

17.10 Variations and adjustments (Clause 13)

Right to vary (Sub-clause 13.1)

Sub-clause 13.1 states: 'Variations may be initiated by the Engineer at any time prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal.'

Each variation may include:

(a) changes to the quantities of any item of work included in the Contract (however such changes do not necessarily constitute a variation)
(b) changes to the quality and other characteristics of any item of work
(c) changes to the levels, positions and/or dimensions of any part of the Works
(d) omission of any work, unless it be carried out by others
(e) any additional work, Plant, Materials or services necessary for the Permanent Works, including any associated Tests on Completion, boreholes and other testing and exploratory work, or
(f) changes to the sequence or timing of the execution of the Works.

Note: The engineer cannot order changes to the contract itself; wherever practicable all variations should be in writing; changes in quantity (where a correction of an error in the BofQ) do not need a variation order; for oral instructions – see Sub-clause 3.3.

Value engineering (Sub-clause 13.2)

Value management and value engineering are important project management concepts which encourage the parties to innovate and seek best-value solutions throughout design and construction phases of a project.

Under Sub-clause 13.2 the contractor is encouraged to submit proposals which may accelerate completion, reduce the cost to the employer, improve the efficiency or value to the employer, or otherwise be of benefit to the employer. If the proposal is accepted the contractor may claim half of the saving in contract value. Corbett (2002) highlights the importance of including future whole-life costs in the calculation, e.g. a cheaper turbine may mean increased maintenance costs.

Panel 17.4 Case study: LimeHouse Link road tunnel, London Docklands

In order to secure maximum benefit, value engineering is best carried out at an early stage in the design process. However, there are many examples of value engineering undertaken on major projects during the construction process. For example, on London Dockland's £250 million Limehouse Link highway tunnel project innovative thinking and value engineering were used to eliminate the substantial temporary steel strutting system for the diaphragm walls on the major cut and cover project.

Work started on site in November 1989 but soon encountered problems that caused delay and increased costs. A variation agreement between the London Docklands Development Corporation and the contractor Balfour Beatty-Amec was subsequently negotiated. This included the addition of a value engineering clause to the contract in March 1991. The value engineering clause facilitated the introduction of the observational method and created opportunities to introduce design changes that increased the speed of construction and substantially decreased cost. Operational safety was also enhanced. The principal need was to reduce delay to the programme (Powderham, 2002).

Variation procedure (Sub-clause 13.3)

Sub-clause 13.3 states:

> If the Engineer requests a proposal, prior to instructing a Variation, the Contractor shall respond in writing as soon as practicable, either by giving the reason they could not comply, or by submitting:
>
> (a) a description of the proposed work and a programme for its execution,
> (b) the Contractor's proposal for any necessary modifications to the programme and to the Time for Completion, and
> (c) the Contractor's proposal for evaluation of the Variation.

The engineer should, as soon as practicable, respond with approval, disapproval or comments.

'Variations shall be evaluated in accordance with Clause 12 [Measurement and evaluation], unless the Engineer instructs or approves otherwise in accordance with this Clause.'

Traditionally variations have been valued after the works are completed, with initial valuation based on the rates contained in the bill of quantities or pro-rata thereto. These rates are often considered inappropriate, and the variation is then valued on a 'fair and reasonable basis'.

The FIDIC new *Red Book* introduces the concept of requiring the contractor to submit a proposal before the varied work is instructed. This is a fundamental change in philosophy, for if the value of the variation and associated programme implications are accepted by the engineer prior to instruction, the risk is shifted from the employer to the contractor. The contractor thus has the incentive to work efficiently on the varied work.

The author (Potts) recollects on a project based on the FIDIC form the contractor's representative being asked by the engineer to give a quotation for a major variation. The initial lump sum quotation of £300,000 was rejected; likewise a more detailed quotation in the sum of £400,000. Eventually the Contractor was instructed to carry out the work on a dayworks basis – final sum £500,000! From the employer's viewpoint settling early often means settling cheaply. It is easy for contractors to underestimate the anticipated final cost and time implication of a variation, particularly if subcontractors are involved.

Payment in applicable currencies (Sub-clause 13.4)

This sub-clause permits reimbursement in more than one currency, if appropriate for a variation under Sub-clause 13. The contract currency proportions may or may not be appropriate to the variation, however, they should still be taken into account in the evaluation of the variation.

The author (Potts) recollects that the contractor was required to include for three currencies in the tender bid on the Teesside Jetties project for Phillips Petroleum. Under this FIDIC contract the bid included: UK Sterling for the main work, German Deutschmarks (which covered the purchase of 24 54-inch large-diameter piles from Mannesmann) and Dutch Guilders (which covered the purchase of the oil loading arms from OWEco in Holland).

Provisional sums (Sub-clause 13.5)

Each provisional sum should only be used in whole or part in accordance with the engineer's instructions. Provisional sums are often included in the bill of quantities for parts of the works which are not required to be priced at the contractor's risk, e.g. for uncertain works, removal of contaminated ground, etc.

The provisional sum can be executed by the contractor and valued under Clause 13.3 (Variation Procedure) or by a nominated subcontractor, as defined in Clause 5 (Nominated Subcontractors) and valued on a cost plus basis.

Daywork (Sub-clause 13.6)

For work of a minor or incidental nature the engineer may instruct that a variation be executed on a daywork basis to be valued in accordance with the daywork schedule included in the contract.

Daywork is usually instructed for work which cannot easily be measured, e.g. search for and locate services – if location not as per drawings. The labour, materials and construction equipment involved in the work should be recorded on a daily basis and signed by the engineer. A priced summary of the dayworks should be submitted to the engineer prior to their inclusion each month in the next statement under Sub-clause 14.3 (Application for interim payment certificates).

It is important that the daywork record sheets are accurately recorded by the site engineer and accurately priced by the quantity surveyor. The site engineers should be familiar with the daywork schedule as included in the contract and should ensure that all reimbursable items are included on the agreed record sheets. Likewise the contractor's quantity surveyor should ensure that the rates are calculated accurately in accordance with the definitions in the contract. It is noted that Spon's *Civil Engineering and Highway Works* (updated each year) identifies a number of items which might not have been included on the daily record sheets and recommends the addition of appropriate percentages to cover these items:

- general servicing of plant;
- fuel distribution;
- welfare facilities;
- handling and offloading materials.

If the engineer/engineer's assistants cannot agree that the work is additional, then the records should be checked on a daily basis and signed, 'Agreed for record purposes only'.

In practice, the dayworks schedule in the contract may not be fully comprehensive and include all the types of labour and construction equipment on site. The following documents, which are used under the *ICE Conditions* in the UK, might prove useful in the negotiation process:

- The Civil Engineering Contractors' Association *Schedules of Dayworks Carried out Incidental to Contract Work* (latest version).
- *The Reference Manual for Construction Plant* (incorporating *The Surveyors' Guide to Civil Engineering Plant*) (published by the Institution of Civil Engineering Surveyors).

In the past daywork records have been used by contractors on civil engineering projects to justify the amount due under claims. This approach should only be considered as a last resort, and the employer's representatives might seek discounts on the rates quoted depending on the circumstances; e.g. the hourly rates for contractor-owned construction equipment might not be appropriate on long-term hire.

Adjustment for changes in legislation (Sub-clause 13.7)

This sub-clause protects the parties from the consequences of changes in legislation in the country made after the base date (28 days prior to the latest date for submission of the tender). It is noted that this sub-clause also allows the employer to reduce the contract price under Sub-clause 2.5 (Employer's claims). Therefore both the contractor's and employer's cost managers should be alert to changes in legislation.

Adjustment for changes in cost (Sub-clause 13.8)

Under a fixed-price contract no adjustments are made for escalation costs. The introduction of this sub-clause provides a formula to adjust the contract value to reflect increased costs due to inflation.

The formula includes the following components: non adjustment element; coefficients representing the estimated proportion of each cost element such as labour, equipment and materials; the current monthly cost indices or reference prices for the period; base cost indices or reference prices.

This sub-clause is appropriate for complex long-term contracts and/or where there is high inflation in the country concerned. The indices and formula might also be appropriate in establishing the amount due for additional payment under Sub-clause 20.1 (Contractor's claims) where there has been severe delay outside the control of the contractor.

17.11 Contract price and payments (Clause 14)

The contract price (Sub-clause 14.1)

Unless otherwise stated in the Particular Conditions:

(a) The Contract Price should be agreed or determined under Sub-clause 12.3 [Evaluation] and subject to adjustments in accordance with the Contract;
(b) The Contractor should pay all taxes, duties and fees; the Contract Price should only be adjusted for costs valued under Sub-clause 13.7 [Adjustments for changes in legislation];
(c) Any quantities set out in the Bill of Quantities or other Schedule are the estimated quantities and are not to be taken as the actual or correct quantities;

(d) The Contractor should submit to the Engineer within 28 days after the Commencement Date, a proposed breakdown of each lump sum price in the Schedules. The Engineer might take account of the breakdown when preparing Payment Certificates, but is not bound by them.

Advance payment (Sub-clause 14.2)

In accordance with this sub-clause 'The Employer shall make an advance payment, as an interest-free loan for mobilisation, when the Contractor submits a guarantee. The number and timing of instalments and the applicable currencies shall be stated in the Appendix to Tender.' Thus, the right to advance payment for mobilization is not automatic.

> The Engineer shall issue an Interim Payment Certificate for the first instalment after receiving a Statement under Sub-clause 14.3 [Application for interim payment certificates] and after the Employer receives (i) The Performance Security in accordance with Sub-clause 4.2 [Performance security] and (ii) a guarantee in amounts and currencies equal to the advance payment.

The advance payment is repaid through percentage deductions in the payment certificates, which commence when the total of certified interim payments exceeds 10 per cent of the accepted contract amount less any provisional sums. Deductions are then made at a rate of 25 per cent from each subsequent payment certificate.

This sub-clause enables the contractor to recover the substantial additional costs involved in mobilizing international projects. These costs can include staffing costs including flights and accommodation, rented offices and site accommodation; fabrication yards and workshops; manufacture and shipping of construction equipment, including specialist earthmoving equipment and dumptrucks, cranage, piling equipment, tunnelling shields, rock drills and grouting equipment.

Application for interim payment certificates (Sub-clause 14.3)

This sub-clause requires the contractor to submit a statement in six copies to the engineer after the end of each month, in a form approved by the engineer, showing in detail the amounts to which the contractor considers himself entitled, together with supporting documents, which include the report on progress during this month in accordance with Sub-clause 4.21 (Progress reports).

Sub-clause 14.3 states:

> The Statement shall include the following items, expressed in the various currencies in which the Contract Price is payable, in the sequence listed:
>
> (a) the estimated contract value of the Works and the Contractor's Documents produced up to the end of the month (including variations but excluding items described in sub-paragraphs (b) to (g) below);
> (b) any amounts to be added and deducted for changes in legislation and changes in cost, in accordance with Sub-clause 13.7 [Adjustment for changes in legislation] and Sub-clause 13.8 [Adjustment for changes in cost];
> (c) any amount to be deducted for retention, calculated by applying the percentage of retention stated in the Appendix to Tender to the total of the above amounts, until the

amount so retained by the Employer reaches the limit of Retention Money (if any) stated in the Appendix to Tender;

(d) any amounts to be added or deducted for the advance payment and repayments in accordance with Sub-clause 14.2 [Advance payment];
(e) any amounts to be added and deducted for Plant and Materials in accordance with Sub-clause 14.5 [Plant and materials intended for the works];
(f) any other additions or deductions which may have become due under the Contract or otherwise, including those under Clause 20 [Claims, disputes, and arbitration]; and;
(g) the deduction of amounts certified in all previous Payment Certificates.

The engineer considers this statement and supporting documents and, within 28 days after receiving the statement, after making any correction or modification deemed appropriate, issues to the employer an interim payment certificate showing the amount due to the contractor.

Schedule of payments (Sub-clause 14.4)

This sub-clause takes effect when the contract states the interim payments are to be made in accordance with a specific schedule of payments. The sub-clause allows the engineer to agree or determine revised instalments if the progress is less than that on which the instalments were based.

'If it is intended that the Schedule of Payments is based on achievement of specific Milestone Events then this should be expressly stated. Otherwise, payments would be based on actual value of work done' (EIC, 2003:19).

If the contract does not include a schedule of payments, the final paragraph requires the contractor to submit non-binding estimates of the payment amount that they anticipate becoming due during each quarterly period.

Plant and materials intended for the works (Sub-clause 14.5)

If this sub-clause applies, interim payment certificates should include an amount for plant and materials which have been sent to site for incorporation in the permanent works. Note that only those items which are listed on the Appendix to Tender are eligible for inclusion. The contractor is required to keep satisfactory records and submit a statement of cost supported by evidence. Payment will be based on 80 per cent of the engineer's determination of the cost. As with Sub-clause 14.2 (Advance Payment), a guarantee must be provided by the Contractor.

Issue of interim payment certificates (Sub-clause 14.6)

This sub-clause requires the engineer to issue to the employer an interim payment certificate stating the amount which the engineer fairly determines to be due. This certificate should be issued to the employer within 28 days after receiving the contractor's statement and supporting documents.

However, it is noted that the interim payment Certificate can be withheld if the employer has not received the performance security or if the amount to be certified is less than the minimum amount stated in the Appendix to the Tender. Furthermore the engineer can make deductions if the work is not carried out in accordance with the contract or if the contractor is failing to perform any obligation in accordance with the contract. It is clear that the engineer cannot withhold the issue of an interim payment certificate because the progress report had not been submitted (Totterdill, 2006).

Payment (Sub-clause 14.7)

This important sub-clause sets out the dates when

> The Employer shall pay the Contractor:
>
> (a) the first instalment of the advance payment within 42 days after issuing the Letter of Acceptance or within 21 days after receiving documents in accordance with Sub-clause 4.2 [Performance security] and Sub-clause 14.2 [Advance payment], whichever is later;
> (b) the amount certified in each Interim Payment Certificate within 56 days after the Engineer receives the Statement and supporting documentation; and
> (c) the amount certified in the Final Payment Certificate within 56 days after the Employer receives this Payment Certificate.

Delayed payment (Sub-clause 14.8)

If payment from the employer is received late, Sub-clause 14.7 entitles the contractor the right to automatically claim finance charges calculated at a rate of 3 per cent above the base rate.

Payment of retention money (Sub-clause 14.9)

This sub-clause identifies the dates for the release of the retention monies:

- The first half is released after the issue of the taking-over certificate.
- If the taking-over certificate is for part of the works, then the retention should be calculated based on 40 per cent of the value of the section.
- The outstanding balance is released after the expiry of the Defects Notification Period.

However, if any work remains to be executed under Sub-clause 11 (Defects liability), the engineer would be entitled to withhold certification of the estimated cost of the work.

The contractor's quantity surveyor should ensure that the application for retention release is made in the next application following the receipt of the taking-over certificate for the works or parts of the works (Sub-clauses 10.1 and 10.2).

Statement at completion (Sub-clause 14.10)

This sub-clause requires the contractor to submit to the engineer six copies of its completion statement within 84 days after receiving the taking-over certificate. The completion certificate should show: the value of all work done in accordance with the contract; any further sums to which the contractor considers himself entitled; and an estimate of any other amounts.

Application for final payment certificate (Sub-clause 14.11)

This sub-clause requires the contractor to submit six copies of the draft final statement to the engineer within 56 days after receiving the performance certificate. The draft final statement should show the value of all work done and the value of all further sums which the contractor considers due.

17.12 Claims, dispute and arbitration (Clause 20)

Contractor's claims (Sub-clause 20.1)

Sub-clause 20.1 states:

> If the Contractor considers himself entitled to any extension of time of the Time for Completion and/or any additional payment, under any Clause of these Conditions or otherwise in connection with the Contract, the Contractor shall give notice to the Engineer, describing the event or circumstances giving rise to the claim. The notice shall be given as soon as practicable, and not later than 28 days after the Contractor became aware of the circumstances, or should have become aware of the event or circumstance.

It is essential that the contractor gives notice within the 28-day period, as failure to give such notice will result in the employer being discharged from liability.

The contractor should keep contemporary records to substantiate any claim. Without admitting liability the engineer may, after receiving any notice of claim, monitor the record-keeping. The new *Red Book* also requires the contractor within 42 days to send to the engineer a fully detailed claim which includes full supporting particulars.

Facts could be based on: measurements, labour and plant time sheets, daily diaries, reports, photographs, site minutes, correspondence, etc.

Within 42 days after receiving the claim the engineer responds with approval, or disapproval and detailed comments. He may also request further particulars but should respond on the principles of the claim within the timescale.

When such amounts for any claim have been reasonably substantiated they should be included in the payment certificate. Updated claims should be submitted on a monthly basis with the final claim submitted within 28 days of the end of the event unless otherwise agreed.

Compared to a traditional building sector contract, e.g. the JCT SBC 2011, there are two striking differences regarding contractor's claims. First, only the 1999 *Red Book* contains strict time bars. Second, the clauses which contain events that justify claims are spread throughout the whole contract and are not contained in comprehensive lists.

Appointment of the Dispute Adjudication Board (Sub-clause 20.2)

The Dispute Adjudication Board (DAB) is a feature intended to improve harmony between the contractor and employer by resolving disputes promptly (Roe, 2007). The DAB comprises one or three members who are suitably qualified. The DAB procedure is the primary method for resolving disputes under the contract. It replaces the process of decision-making by the engineer and must occur prior to any reference to arbitration. One of the innovative features of the DAB is that its members can visit the site on a regular basis to enable them to become familiar with progress and with any actual or potential problems and claims.

The *Guidance to the Preparation of Particular Conditions* provided as part of the new *Red Book* identifies that the parties from common law jurisdictions may opt to retain the traditional concept of the engineer as a sole-member DAB where the engineer is an independent professional consulting engineer with the experience and resources required for the administration of all aspects of the contract.

It is noted that the DAB decision is binding on both parties, unless revised by amicable settlement or an arbitral award (Sub-clause 20.4). However, in practice, most funding agencies prefer that claims are resolved in accordance with Sub-clause 20.5 (Amicable settlement) (Papworth, n.d.).

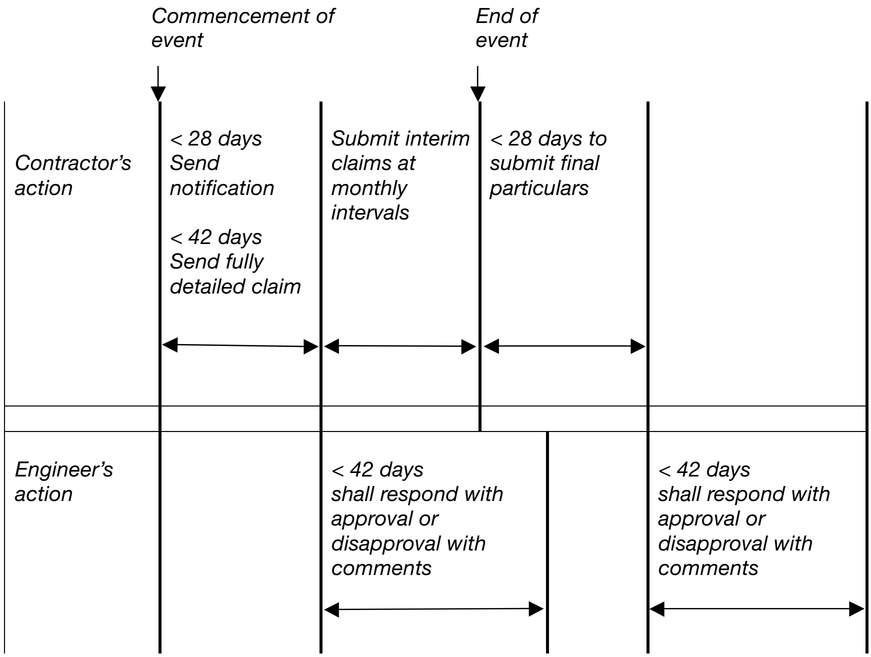


Figure 17.1 Typical sequence of principal events envisaged in Sub-clause 20.1 (Contractor's claims)

17.13 Conclusions

This chapter has summarized briefly some of the key provisions under the new *Red Book* where the employer (or engineer) does most of the design and the contractor constructs the works. The engineer has a key role to play under these conditions in administration of the contract, monitoring the construction works and certifying payments.

This traditional form of construction contract forms the basis for contract conditions on many major projects executed throughout the world. The quantity surveyor, either representing the client or contractor, has a key role to play under this form of contract and is a valuable member of the commercial team.

Important pre-contract duties could include preparation of the tender documents, schedules or detailed bills of quantities and assisting with tender evaluation. Post-contract duties could include remeasurement, preparing interim valuations, valuing variations, assisting with value engineering submissions, assisting with claims evaluation, settling the final account and financial reporting. A brief overview comparing the FIDIC new *Red Book* with the *NEC Engineering and Construction Contract*, 3rd edition (NEC3) is shown in Table 17.1.

17.14 Questions

Question 1

Identify five risks carried by the employer under the new *Red Book* and state how these might be avoided or minimized.

Table 17.1 Comparison of NEC3 and FIDIC 1999 new *Red Book*

	NEC ECC (NEC3)	*FIDIC Conditions of Contract for Construction (1999) new Red Book*
Background	Developed by the Institution of Civil Engineers in 1993; need to move away from adversarial contracts towards one encouraging a foresighted cooperative approach; NEC3 endorsed by the UK Office of Government Commerce in 2005	First introduced in 1957, originally based on *ICE Conditions of Contract* for civil engineering works; well tried and tested contract particularly on major infrastructure projects; FIDIC suite of contracts now embraces nearly all construction works; used as a basis by many governments and international banks
Clarity	NEC drafted in plain English, long sentences avoided; accompanied by extensive Guidance Notes and Flow Chart	Clear layout with 'contents' and 'index' sections; substantial cross-referencing throughout; Guidance Notes limited to preparation of particular conditions within tender
Flexibility	Designed for UK and international use on all types of engineering, construction and m&e works; degree of contractor design can be varied between 0 per cent and100 per cent; allows for different allocation of risks through use of six main payment options, including priced and target contracts, and 20 secondary options; secondary Option Z allows for amendments	Designed for international use on building and engineering works; work designed by employer under *Red Book*; limited pricing options – either lump sums in the schedules or BofQ (in part or whole); 'Particular Conditions' allow for amendments to contract; diverse range of options in the 1999 'Rainbow Suite'
Effective management	NEC not only a legally binding document but also a set of modern best practice project management processes and procedures	FIDIC is essentially a legally binding agreement focusing on the roles, responsibilities and liabilities of the parties, and processes and procedures, particularly if things change
Partnering	NEC encourages collaboration through Clause 10.1; Secondary Clauses X12 – Partnering and X20 – Key performance indicators reinforce this strategy	Contains no partnering provision but parties can embrace the 'partnering ethos'
Roles and responsibilities	The project manager is responsible for managing the contract on the employer's behalf; the supervisor ensures quality of construction meets works information/specification	Separate sections for employer, engineer and contractor (Clauses 2, 3 and 4); engineer, who manages on behalf of the employer, may assign duties or delegate authority to assistants, including the resident engineer and inspectors (Clauses 3.1 and 3.2)
Programme	Programme at the heart of the contract showing order and timing, key dates, float, time risk allowances; resourced method statement identifying principal equipment also required (Clause 31)	Detailed time programme required plus supporting report including description of methods and estimate of each class of contractor's personnel and equipment for each major stage (Clause 8.3)

continued . . .

Table 17.1 Continued

	NEC ECC (NEC3)	*FIDIC Conditions of Contract for Construction (1999) new Red Book*
Variations	Dealt with under 'compensation events' – Clauses 60–65; contractor required to submit quotations assessed based on forecast of 'defined cost' plus fee; all compensation events give potential for recovery of extension of time, costs plus profit; strict time bar limits apply (Clauses 61.3, 61.4)	Traditional approach to valuing variations – use rates in contract, or with reasonable adjustments, consider 10 per cent change, where no appropriate rates or not of similar character and similar conditions, based on reasonable costs plus reasonable profit or value on a daywork basis if instructed by engineer (Clauses 12, 13.3 and 13.6)
Claims	Dealt with under 'compensation events' – Clauses 60–65; all as Variations section above	Clause 20.1 – 'Contractor's claims' refers. Contractor required to give notice, keep contemporary records, send fully detailed claim to engineer; interim monthly and final intervals; payment certificate to include reasonably substantiated claims; strict time bar limit Some causes of claim give grounds for extension of time, plus cost and profit, e.g. Delayed drawings and instruction (Clause 1.9) and others to extension of time plus cost only, e.g. Unforeseeable physical conditions (Clause 4.12)
Extension of time	Dealt with under 'compensation events' – Clauses 60–65); all as Variations section above	Dealt with under Clause 20.1 (Contractor's claims)
Innovative features	Early warning procedure (Clause 16.1); risk reduction meetings, risk register (Clauses 16.2–16.4)	Value engineering (Clause 13.2); payment linked to requirement for monthly progress report (Clause 14.3, 4.21)
Dispute Resolution	Adjudication (Option W1 or W2)	Dispute Adjudication Board (Clause 20.2)

Question 2

Identify the sub-clauses within the contract which provide the employer with the right to claim from the contractor.

Question 3

Identify the items for consideration by the engineer after receiving a notice of unforeseeable physical conditions from the contractor.

Question 4

Compare and contrast how FIDIC new *Red Book* and the NEC3 contract deals with risks for unforeseen site conditions.

Solution: Refer to Ndekugri and McDonnell's (1999) article which compared the provisions in FIDIC 1987 with those in the NEC 2nd edition.

Question 5

Identify those items which should be included in the progress report and state who should provide the information to the contractor and when.

Question 6

Identify the main contractor's site overheads on a typical civil engineering project.

Question 7

Summarize the procedures with which the contractor must comply in order to convert an oral instruction received from the engineer/delegated assistant into a valid engineer's Instruction.

Question 8

Identify how each of the items (a) to (g) in Sub-clause 14.3 will be evaluated each month.

Questions 9

Draw a diagram, which clearly shows the typical sequence of payment events envisaged in Clause 14.

Question 10

Identify the innovations in the new *Red Book* which (a) favour the contractor, and (b) favour the employer. For solution see Seppala (2001).

17.15 References/further reading

Abrahamson, M.W. (1985) *Engineering Law and the ICE Contracts*, 4th edition, Elsevier Applied Science.

Booen, P.L. (2000) 'The three major FIDIC books', *The International Law Review*, pp. 24–41.

Corbett, E. (2002) 'Delivering Infrastructure: International best practice – FIDIC's 1999 Rainbow: Best Practice?', *Society of Construction Law*, London, Paper D023, www.scl.org.

Eggleston, B. (2001) *The ICE Conditions of Contract Seventh Edition*, Blackwell Scientific.

European International Contractors (EIC) (2003) EIC Contractor's Guide to the FIDIC Conditions of Contract for Construction, EIC.

Fenn, P. (2000) 'Review of international practice on the allocation of risk of ground conditions', *International Construction Law Review*, pp. 439 – 453.

FIDIC (2000) *The FIDIC Contracts Guide, Conditions of contract for construction, conditions of contract for plant and design-build, conditions of contract for EPC/Turnkey projects*, 1st edition, International Federation of Consulting Engineers.

Glover, J., Hughes, S. and Thomas, C. (2006) *Understanding the New Red Book: A clause by clause commentary*, Sweet & Maxwell.

Hillig, J.-B., Dan-Asabe, D., Donyavi, S., Dursun, O. and Thampuratty, A. (2010) 'Fidic's Red Book 1999 edition: a study review', *Proceedings of the Institution of Civil Engineers, Management, Procurement and Law*, 163, August, pp. 129–133.

Knutson, R. (ed.) (2005) FIDIC, *An Analysis of International Construction Contracts*, Kluwer Law International.

Lord, W., Liu, A., Tuuli, M.M. and Zhang, S. (2010) 'A modern contract: developments in the UK and China, *Proceedings of the Institution of Civil Engineers, Management, Procurement and Law*, 163, November, pp. 151–159.

Ndekugri, I. and McDonnell, B. (1999) 'Differing site conditions risks: a FIDIC/engineering and construction contract comparison', *Engineering Construction and Architectural Management*, Vol. 6. No. 2, pp. 177–187.

Ndekugri, I., Smith, N. and Hughes, W. (2007) 'The engineer under FIDIC's conditions of contract for construction', *Construction Management and Economics*, July, Vol. 25, pp. 791–799.

Papworth, J. (n.d.) 'Claims under the new FIDIC Conditions of Contract', www.scribd.com/doc/22225659/Claims-Under-New-Fidic-John-Papworth – accessed 30 November 2012.

Powderham, A. (2002) 'The observational method – learning from projects', *Proceedings of the Institution of Civil Engineers, Geotechnical Engineering*, Vol. 115, No. 1, January, www.tunnels.mottmac.com/files/page/1614/OM-LearningProjects.pdf – cited 19 November 2012).

Roe, M. (2007) 'FIDIC and recent infrastructure developments', *Pinsent Masons Press Article*, www.pinsentmasons.com/media/1116563774.htm – cited 30 November 2012.

Seppala, C.R. (2001) 'New standard forms of international construction contract', *International Business Lawyer*, February, pp. 60–65.

Thomas, C., Hughes, S. and Glover, J. (2006) *Understanding the New FIDIC Red Book: A clause by clause commentary*, Sweet & Maxwell.

Totterdill, B.W. (2006) *FIDIC Users' Guide: A practical guide to the 1999 Red and Yellow Books – Incorporating changes and additions to the 2005 MDB Harmonized Edition*, Thomas Telford.

Websites

European International Contractors: www.eicontractors.de.
FIDIC: http://fidic.org.
Institute of Civil Engineers: www.ice.org.uk/knowledge.

Acknowledgements

The author is deeply grateful to FIDIC for allowing the Clauses in the *Conditions of Contract* to be reproduced and for guidance from the FIDIC *Contracts Guide*. Copies of the *Conditions of Contract* and other FIDIC publications can be obtained from the FIDIC bookshop, Box 311 CH-1215 Geneva 15, Switzerland (tel: +41 22 799 49 00; fax: +41 22 799 49 01; fidic.pub@pobox.com; website: http://fidic.org/bookshop).

18 Case study: Heathrow Terminal 5

18.1 Introduction

The BAA Heathrow Terminal 5 (T5) was one of Europe's largest and most complex construction projects. Terminal 5 was approved by the Secretary of State on 20 November 2001 after the longest public inquiry in British history (46 months) and, when completed in March 2008, it added 50 per cent to the capacity of Heathrow and provided a spectacular gateway into London. Designed and engineered by Arup, with architects Richard Rogers Partnership and steel manufacturer Severfield Rowen, T5 has been described as engineering of *Brunellian* proportions.

The project included not only a vast new terminal and satellite buildings, but nine new tunnels, two river diversions and a spur road connecting to the M25; it was a multi-disciplinary project embracing civil, mechanical, electrical systems, communications and technology contractors with a peak monthly spend of £80 million employing up to 8,000 workers on site. The construction of T5 consisted of 18 main projects divided into 140 sub-projects and 1,500 work packages on a 260 hectare site.

Phase 1 construction of Terminal 5 was programmed for 5 years and broken down into five key stages:

1. *Site preparation and enabling works (July 2002–July 2003)* – preparing the site for major construction activity. The work included a significant amount of archaeological excavation, services diversions, levelling the site, removing sludge lagoons and constructing site roads, offices and logistics centres.
2. *Groundworks (Nov 2002–Feb 2005)* – this included the main earthworks, terminal basements, connecting substructures and drainage and rail tunnels.
3. *Major structures (Nov 2003–Sept 2006)* – the main terminal building (concourse A), first satellite (concourse B), multi-storey car park and ancillary structures.
4. *Fit out (Feb 2005–Sept 2007)* – significant items of fit out, including building services, the baggage system, a track transit people-mover system and specialist electronic systems.
5. *Implementation of operational readiness (Oct 2007–Mar 2008)* – ensuring phase 1 infrastructure was fully complete and that systems were tested, staff trained and procedures in, ready for operation in spring 2008.

Phase 2, which included a second satellite and additional stands, started in 2006 when the residual sewage sludge treatment site had been vacated and completed in 2011. The two phases combined have boosted Heathrow's passenger-handling capacity by an additional 30 million passengers per year (BAA T5 fact sheet, 'The key stages of Terminal 5').

18.2 Project management philosophy

The project management approach was developed based on the principles specified in the *Constructing the Team* (Latham, 1994) and *Rethinking Construction* (Egan, 1998) reports, but went further than any other major project with two underlying principles:

1. The client always bears the risk – no matter which procurement option is chosen.
2. Partners are worth more than suppliers – BAA developed an *Integrated Project Team Approach*.

The history of the UK construction industry on large-scale projects suggested that, had BAA followed a traditional route, T5 would have ended up opening 2 years late, costs would have been 40 per cent over budget and there would have been six fatalities (Riley, 2005). This would have been unacceptable to BAA as their funding is determined by 5-yearly reviews of landing charges by their regulator, who allows BAA a set rate of return, but in order to satisfy shareholders BAA are required to beat that. 'Massive cost overruns would have wrecked the company's reputation and sent the share price plummeting' (comment by Riley, M. within Wolmar, 2005).

Significantly, BAA expected a high degree of design evolution throughout the project in order to embrace new technological solutions and changes in security, space requirements or facilities functionality. On such a complex project early freezing of the design solution was not realistic.

BAA realized that they had to rethink the client's role and therefore decided to take the total risk of all contracts on the project. Under traditional contracts (JCT and ICE forms) the parties are reactive and manage the effect (the consequences) of risk, resulting in claims where up to 40 per cent of the total cost of the claims could be paid to quantity surveyors and lawyers. BAA thought differently and introduced a system under which they actively managed the causes (the activities) through the use of integrated teams.

This strategy was implemented through the use of the T5 Agreement, under which the client takes on legal responsibility for the project's risk. In effect, BAA envisaged that all suppliers working on the project should operate as a virtual company. Executives were asked to lose their company allegiances and share their information and knowledge with colleagues in other professions.

BAA's aim was to create one team, comprising BAA personnel and different partner businesses, working to a common set of objectives by the following means:

- The T5 Agreement with suppliers did not specify the work required; they were a commitment from the partner and a statement of capability, capacity and scope to be provided.
- The organization was based on the delivery of products, seen as operational facilities, not a set of buildings.
- BAA selected the best people to suit the project's needs including 160 highly experienced and capable professionals from other organizations.
- By using collaborative software key information such as the timetable, the risk reports, and the work scope was freely available to the integrated project team.
- An Organisational Effectiveness Director with a team of 30 change managers provided training and support in order to implement the culture change required to work in an open and collaborative way (NAO, 2005).

Panel 18.1 BAA's approach to risk management

BAA's approach to risk management was a key factor in keeping the project on budget and ahead of schedule. Terminal 5 was constructed under the T5 Agreement, which meant that BAA acted as the prime client and accepted most of the risk. With this burden removed from contractors and suppliers, it enabled everyone working on T5 to:

- focus on managing the cause of problems, not the effects if they happen;
- work in truly integrated teams in a successful, if uncertain environment;
- focus on proactively managing risk rather than devote energy to avoiding litigation.

Source: BAA T5 fact sheet, 'Risk management'

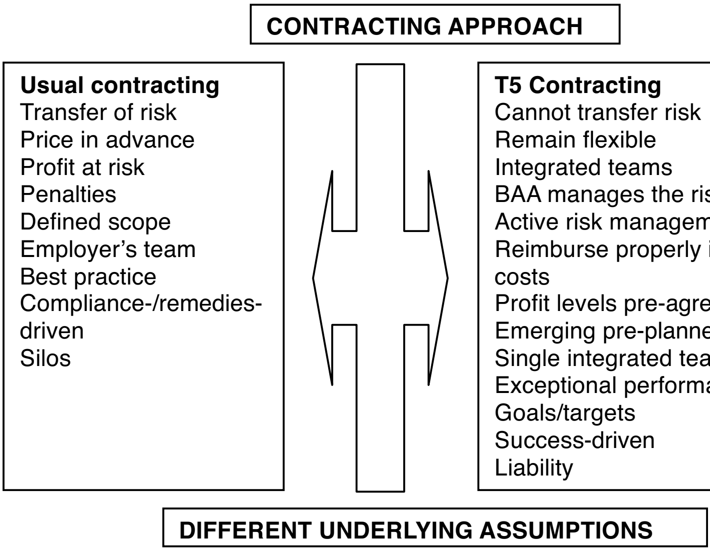


Figure 18.1 T5 Contracting philosophy (BAA document)

Many of the suppliers involved in Terminal 5 were brought on board at the earliest stages of the planning process. This enabled completely integrated expert teams to work together to identify potential problems and issues before designs were finalized and fabrication and construction began. As a result, the teams of suppliers and consultants were in a position to add value whilst designing safe solutions within the time, quality, cost and safety targets. This approach encouraged innovation, e.g. the development of pavement concrete led to a 25 per cent reduction in bulk materials required for the aircraft stands and pavement areas.

18.3 T5 Agreement

The T5 Agreement was a unique legal contract in the construction industry – in essence it was a cost reimbursable form of contract in which suppliers' profits are ring-fenced and the client retains the risk. It focused in non-adversarial style on the causes of risk and on risk management through integrated team approaches. The reimbursable form of contract meant that there were no claims for additional payments, and no payment disputes on the project (NAO, 2005). This move away from a lump sum contract transferred a significant level of risk to the client and required client-driven and owned systems to manage risk and facilitate collaborative behaviour amongst the project actors. Sharon Doherty, the HR and Organisational Effectiveness Director for Heathrow airport, records that:

> Suppliers would receive a guaranteed margin that ranged from 5–15% depending on trade for delivering at least industry best practice, and a team incentive plan would be put in place, so that all suppliers would have to succeed for additional bonuses to be paid if exceptional performance was achieved.
>
> (Doherty, 2008: 237)

The T5 Agreement focused on managing the cause and not the effect and ensured success in an uncertain environment. High performance levels and high benchmarking standards were demanded from all parties. Innovation and problem-solving within the supply chain was actively encouraged. 'The idea is to have the best brains in all companies working out solutions to problems, not working how best to defend their own corner' (comment by T5's Commercial Director, Matthew Riley – within Broughton, 2004).

For example, BAA benefited under the T5 Agreement as a result of the M&E suppliers pooling their purchasing power for cabling and other products to secure discounts, resulting in savings up to 30 per cent on some packages (Broughton, 2004).

BAA used cost information from other projects, validated independently, to set cost targets. If the out-turn costs were lower than the target, the savings were shared with the relevant partners. This incentivized the teams to work together and innovate. It was the only way to improve profitability: all other costs, including the profit margin, were on a transparent open book basis (NAO, 2005). BAA took precautions against risk of the target being too high through a detailed 'bottom-up' analysis by independent consultants.

The T5 Agreement created a considerable incentive for performance. If the work was done on time, a third went to the contractor, a third went back to BAA and a third went into the project-wide pot to be paid at the end (Douglas, 2005). Any payment was dependent on meeting milestones set in that agreement. Suppliers also benefited from ring-fenced profit and an incentive scheme that rewarded both early problem-solving and exceptional performance. Doherty (2008) notes that the T5 Agreement was a contract that explicitly addressed organizational and cultural issues. She records how in 2005 the T5 directors spent time at Templeton College, Oxford exploring *The Prisoner's Dilemma*. This classic gaming theory looks at whether two prisoners will cooperate or defect; each player gains when both cooperate, but if only one cooperates, the other one, who defects, will gain more.

> When looking at this theory, what became apparent about T5 was that those suppliers with whom BAA had long-term relationships were more likely to see the big picture and trust the other to co-operate, whereas for smaller suppliers the psychology did not stack up, signalling that a more vigilant approach was required.
>
> (Doherty, 2008: 240)

The final strand to the T5 Agreement was the insurance policy. BAA paid a single premium for the multi-billion project for the benefit of all suppliers, providing one insurance plan for the main risk. The project-wide policy covered construction all-risk and professional indemnity.

Panel 18.2 Designing value into the roof

As T5's main roof was a large element in the structure, designing a cost effective solution was critical to the project's success.

Richard Roger's Partnership's (RRP) competition-winning design envisaged a glorious expensive-looking waveform roof supported on four rows of branched structural columns. This proved to be too complex and beyond the capability of the contractors – or, in other words, too expensive for BAA.

Critically, in December 1999, a major value engineering exercise was undertaken involving all the key players: architects RRP, structural engineer Arup, steelwork contractor Severfield-Rowen, cladding specialist Schidlin and Hathaway roofing.

The development of the successful design became something of a saga with a solution developed through an iterative process. Buildability was a major issue due to the restrictions on site – at its highest point the roof towers 37 m above the apron; however, the airport's radar is in operation 2 m above that, thus prohibiting the use of cranes.

In the end the design team came up with a solution that satisfied all criteria: a single span tied (or bowstring) arch supported high above the concourse on inclined structural columns. The roof is assembled on the ground in bays using 3,000 pre-assembled cassettes. The bays are then jacked up using the support abutments – in all, five lifts of three bays each and one single-bay lift.

Source: Pearson, *Building*, 2003

Postscript: The positive approach to designing value into the roof is in complete contrast to the approach used on the Scottish Parliament building, where the value engineering exercises took place at a relatively late stage in the design and were considered ineffective.

The T5 agreement had the following key features:

- It was a legally binding contract between Heathrow Airport Ltd and its key suppliers.
- It stated that culture and behaviour were important. Innovatively, culture was specifically mentioned in the legal contract. The values – commitment, teamwork and trust – were key.
- It addressed risk and reward. BAA held the overall delivery risk. Suppliers took their share of the financial consequences of any risk to the project. And they also shared in the financial rewards of success (like the project finishing on time and within budget).
- Risk payments, which would normally be costed into a supplier's quote, instead went into an incentive fund.
- Key project risks were insured – loss or damage to property, injury or death of people and, innovatively, professional indemnity for the project as a whole.

The T5 agreement allowed the project to adopt a more radical approach to the management of risk, including early risk mitigation. Key messages included: 'working on T5 means everyone anticipating, managing and reducing the risks associated with what we're doing' (OGC, nd).

The legally binding contract centred on a 250-page handbook, containing the same set of conditions for each supplier. Beneath that were a series of 2–3 page supporting documents defining particular capacities. These supporting documents were designed to evolve as the working environment changed – flexibility was built in.

Table 18.1 How the T5 documents fit together

The document	*What it is*
T5 AGREEMENT	The terms and conditions everyone working on T5 is bound by
SUPPLEMENTAL AGREEMENT	The detail of the agreement which is signed by the suppliers. It defines the work they're doing on T5
FUNCTIONAL EXECUTION PLAN	The support required to enable projects to deliver
SUB-PROJECT EXECUTION PLAN	The team's plan of work
WORK PACKAGE EXECUTION PLAN	This is the breakdown of work by the supplier (combines preliminaries, specifications and drawings)
Supporting documents: COMMERCIAL POLICY PROGRAMME HANDBOOK CORE PROCESSES AND PROCEDURES INDUSTRIAL RELATIONS POLICY	

Source: BAA document

18.4 The approval process

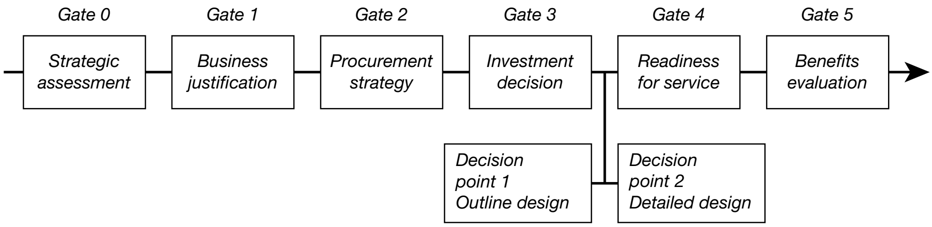
BAA operated a five-stage approval process, which was based on the changing levels of risk during the development of the project. An important feature of this process was that BAA was prepared to move forward into the next stage without having completed production design. This dynamic streamlined decision process is in contrast to the linear *Gateway* process recommended by the UK Government for the procurement of public works (see Figure 18.2). The NAO recommend that only clients who have strong in-house capacity as an *intelligent client* should use this form of procurement and management (NAO, 2005).

18.5 Controlling the time, cost and quality

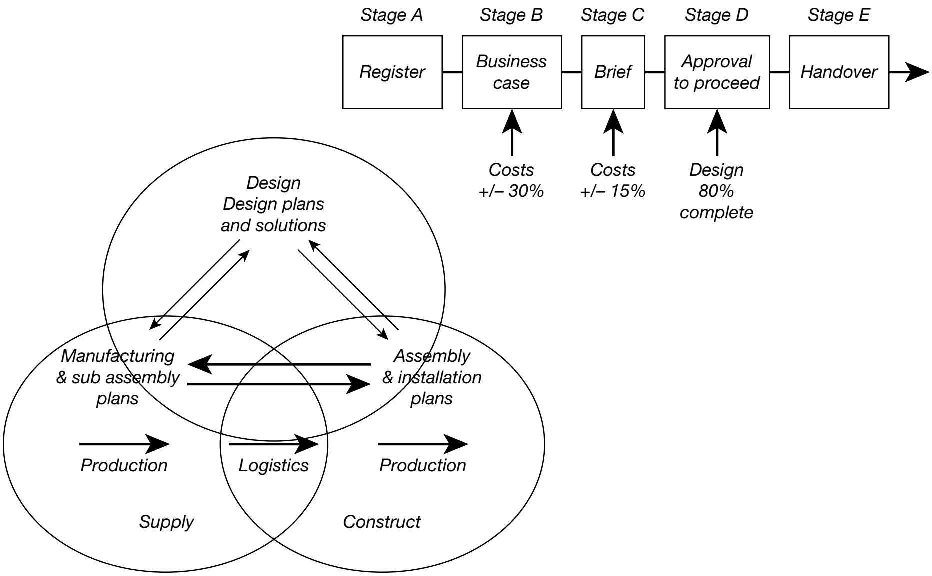
Keeping the project on schedule and within budget is obviously critical on a project this size. Traditionally the two elements tend to run separately, often in two separate sections – planning and costing.

T5 aimed to be at the forefront of project control and was one of the first major users of the *Artemis* project management system in UK construction. The system is very robust and can show how each area of the project is performing relative to target, on both schedule and costs. A further key point of the *Artemis* system is that it can give information at programme or at individual project level or sub-project level. Cost and performance data can be analysed in various ways including the production of two highly useful indices, the Schedule Performance Index and the Cost Performance Index, which are generated for all the levels and for each package (New Civil Engineer, 2004). This enables trends to be identified, highlights where performance is not as planned and, most importantly, enables informed management decisions to be made to keep the project on track.

The Terminal 5 project had a culture of *right first time with no waste*. To implement this theme BAA decided to pick up the costs if a contractor got something wrong, arguing that they would be much more likely to own up quickly to the mistake and hence save a great deal more money (and time) when the mistake came to light anyway. However, a contractor was not reimbursed for getting the same thing wrong twice; neither does it include fraud.



The OGC Gateway process offers a more 'linear' series of control points in a project's life



The T5 approach enables supply and production to proceed concurrently with design

Figure 18.2 OGC Gateway compared to BAA process (National Audit Office, 2005)

Overall quality governance was implemented via monthly review meetings for each of the 16 main projects and a monthly audit schedule workshop (Geoghegan, 2005).

> Key performance indicators were measured and given a red, amber, green or purple status. Red represented below par, amber industry average, green best practice and purple exceptional performance. In quarterly supply chain reviews the appropriate project leader and the supplier would sit down and review performance. Monthly subsets of this data were consolidated and shared with 10–15 key suppliers and reviewed at the monthly principal contractor meetings. The power of peer-group pressure was significant on a project where the reputational impact, with peers both internally and externally, of being seen to let the side down was probably more important than the contract.
>
> (Doherty, 2008: 242).

On a practical level BAA organized Quality Weeks and Quality Benchmark and Interface Centres – small on-site showrooms in which supervisors showed their workers what standards were called for before the work started.

18.6 Logistics

Despite being equivalent in size to London's Hyde Park, the T5 site itself was very physically constrained. To the north and south of the site were two of the world's most heavily utilized runways. Existing terminals were situated to the east and Europe's busiest motorway interchange (M25/M4) to the west. As a result, space on the site was at a premium, this together with the need to minimize construction traffic on local roads and the requirement for a single entrance and exit point through which all construction-related vehicles and people enter and leave, presented the project team with immense logistical challenges.

Deliveries were made to the site only between 9.00 a.m. and 5.00 p.m. through one entrance and exit. It is recorded that there were 170 deliveries per hour during the 5-year construction period (Black, 2005).

The project team's solution was based on methods used in factory-based manufacturing, so that materials were brought to site only when the site was ready to receive them. This 'just-in-time' or 'pull' strategy was a first for a construction project of this scale. It was supported by extensive use of prefabrication and pre-assembled components and was facilitated by the use of two consolidation centres close to the main site.

This lean-thinking strategy generated certain benefits as follows:

- it eliminated the need for lay down space for materials;
- it increased reliability and efficiency in the use of materials which, in turn, increased productivity levels (from a typical construction site average of 55–60 per cent to an unprecedented 80–85 per cent);
- it drove out the traditional waste created by conventional practices;
- it enabled BAA to uphold environmental commitments by reducing transport movements to and from the site while strictly controlling the timing of deliveries.

Panel 18.3 Proactive risk management – trial assembly roof abutment structure

The roof of the main T5 building comprised six sections each weighing 2,500 tonnes which had to be jacked up over a 10-month period.

To minimize any chance of mishaps and to ensure that the roof erection proceeded smoothly on site, the T5 roof team, including designers, suppliers and fabricators, pre-erected one of the 22 major roof abutment structures at the steel fabricator's (Severfield-Rowen) base near Thirsk in Yorkshire.

The pilot exercise proved to the design team that the erection method was workable and helped the construction team better understand the sequencing and tolerances required.

As a result the T5 team identified 140 significant lessons resulting in each having a risk mitigation plan enabling faster construction on site.

This exercise cost BAA £4 million but saved 3 months' work on the Heathrow site, enabling delays that had previously arisen due to the wet winter of 2001/2002 to be recovered.

Source: NAO, 2005; BAA Terminal 5 DVD, 2004

Project teams were required to plan their requirements for materials up to 6 weeks in advance. A software system called *Project Flow* was developed, which collated the team's demands and drove materials through the system. The materials were then delivered either just before or on the day that they were required (BAA T5 Fact sheet, 'Logistics').

18.7 3D project model

BAA set itself a target of using technology to reduce the total project cost of Heathrow Terminal 5 by 10 per cent. This was largely to be achieved by creating a single 3D computer model that BAA and its project partners used to design, build and ultimately maintain the terminal building.

Major projects, involving multiple design teams, frequently suffer from poor collaboration and ambiguous design detail resulting in delays and increased costs. BAA used *NavisWorks* software to review 3D design data, particularly where design models from different disciplines were brought together.

Conventionally, the architect designs the building and passes the CAD drawings over to the engineer. The engineer then draws the building over again for engineering analysis, as do the subcontractors, and the result is that the building and the elements within it are redrawn hundreds of times. BAA found in its research into the construction process that by the time the project gets to site these drawings are bound to contain inconsistencies, meaning that if different parts don't fit together they have to be reworked on site. The estimated cost of wasted time and materials alone is at least 10 per cent of total project cost. If the costs of disruption to the programme are factored in, the figure is even higher.

The idea behind the single project model was thus to derive an unambiguous set of data through the sharing of data. Using this approach the engineer never redraws the information; he reuses the architect's data and add to it. This approach drives out errors and improves efficiency.

A 3D model incorporating intelligent object technology was used at T5 to improve efficiency even more. This meant that objects in the CAD drawing *knew* what they were, and how they fitted with other objects in the building.

The massive roof nodes connecting the roof structure were a good example of how the single-model environment worked in practice. Richard Rogers Partnership designed the node and passed it over to structural engineer Arup. The engineer used the architect's drawing to carry out structural analysis; RRP then modified the design to fit the analytical requirements using the same set of data. The model was passed to the steel fabricator Rowen Structures who used it to fine-tune the design of the parts of the node that had to be specially made. Finally they used the model to control the machinery that made the roof parts (Pearson, 2003).

Lessons learned at T5 in this regard are being disseminated to the rest of industry. The Construction Project Information Committee has published the *Code of Practice for Production Information*, which contains the processes and protocols used at T5 (CPIC, 2003).

18.8 The use of the NEC

Around 10 per cent of the Heathrow Terminal 5 value was procured under NEC contracts. The 70 first-tier suppliers, contractors and consultants were contracted under BAA's bespoke T5 Agreement. Under this arrangement each first-tier supplier was responsible for developing their supply chain to deliver the work. BAA recommended they use its version of the NEC Engineering and Construction Contract for contracts with the thousands of second-tier suppliers – the only form recommended. This form was amended to work in line with the T5 Agreement and ensured that certain risks, i.e. insurance excess deductibles were not passed down the supply chain.

Panel 18.4 Construction facts

Capacity

Phase one opened in 2008 and included the main terminal and the first of two satellite buildings. The second satellite was completed in 2011.

Passengers accommodated (total) 30 million per year

Dimensions

Area of T5 site	260ha (around the same size as Hyde Park)
The main terminal	396m long by 176m wide by 40m high (the interior space could accommodate around 50 football pitches)
The satellite building	442m long by 52m wide by 19.5m high (bigger than Terminal 4)
Twin river diversion	6km of new river channels
Multi-storey car park	4,000 spaces

Bored tunnels

The T5 project included a total of 13.5km of bored tunnels

Construction stats

Length of site roads	6km
No. of tower cranes	30 at peak
Total volume of earthworks	6.5 million m^3
Pavement quality concrete	335,000m3 poured (4,700m3 per week at peak)
Structural concrete	1.2 million m3 (14,000m3 per week at peak)
Steel reinforcement	150,000t
Structural steel	80,000t (Wembley stadium has 23,000t)
Number of lifts	175
Number of escalators	131
Number of site facilities	6 site compounds

Source: BAA T5 fact sheet, ‘Construction facts’

BAA also used various NEC contracts, particularly the Professional Services Contract, for around 50 direct relationships with consultants and other suppliers.

18.9 Role of the cost consultants

BAA selected a consultancy framework for cost consultancy on the T5 project comprising a collaborative joint venture of Turner & Townsend and EC Harris (the collaborative vehicle known as TechT). Both companies were selected under the same terms of commission and each provided 50 per cent of the staff. On this project these two major consultancies became ‘joined at the hip’. At its peak the cost consultancy team comprised 120 staff, approximately two-thirds of whom were quantity surveyors. TechT provided both strategic and delivery services from inception through to the construction phase and supported the BAA commercial team in:

- designing the incentivized procurement strategy, business case and master plan;
- preparation of the project and resultant contract terms and conditions, processes and procedures, and the implementation of a project controls system;
- cost and commercial management based on a target cost philosophy within a cost reimbursable incentivized framework.

Principal activities undertaken included:

- development of cost models allowing option appraisals within the master-planning phase and international benchmarking of airport functionally based cost planning;
- development of indicators (operational and construction measures) to assist with target;
- identification of the performance standards within a value management setting;
- development of the business case framework and instigating stakeholder trading process;
- sensitivity analysis to test each option's rate of return on investment.

The result of these activities supported the selection of an option and the procurement development of the functional brief within the budget parameters (Turner & Townsend website). These activities give a real indication of the changing role of the cost consultant in the new environment. For an in-depth review of the role of the quantity surveying team on the Heathrow T5 project see chapter by author (Potts) in Smyth and Pryke (2008).

18.10 Lessons learned

The key lessons learned from this significant project have been:

- The client always carries the risk – the key issue is the importance of managing risk and the proactive role taken by BAA in developing the T5 Agreement, in which they took all the risk.
- Project management is a tool for risk and opportunity management, not the other way round.
- Put risk management in the hands of those best able to manage the risk and adopt forms of contract that support a risk management approach.
- Use of integrated supply teams with equality between all members has substantial benefits for all parties – this approach encouraged joint problem-solving and innovation; the project was managed from open-plan offices on site, incorporating integrated management teams comprising BAA's staff with management teams from the key suppliers.
- Leadership and sponsorship at Board level is vital.
- Using technology to cut 10 per cent off the overall cost through the use of the single 3D project model.
- The considerable investment in temporary infrastructure without remaining value, e.g. the £25 million temporary rail head to accommodate delivery of bulk raw materials.
- The materials consolidation centres in close proximity to the site enabled the implementation of a *just-in-time* strategy supporting and reducing the requirement for storage from 3 weeks to 3 days.
- The extensive use of pre-fabrication and pre-assembled components leading to an increase in productivity of between 10 and 15 per cent when compared to the average building site.

Panel 18.5 Off-site prefabrication and pre-assembled components

Services – 60 per cent assembled off-site in modules (5,000 modules based on 11 standard types); steel roof – 30m sections; roof covering – based on 3m x 6m cassettes; traffic control tower – the top 27m of the tower including the visual control room constructed and partially fitted out 2km from final location; steel reinforcement – 80 per cent use of pre-fabricated cages; river diversions – 5km constructed using precast concrete sections.

Advantages: increase in productivity; reduced overall programme time; improved quality of assembly; safer and quicker working in factory than on site; reduced risk of adverse weather; reduced on-site labour, thus side-stepping skills shortages in South East of England.

Source: Pearson, *Building*, 2004

- Aim to standardize and simplify, e.g. aim to have eight types of light bulbs only.
- Specialist environmental team to monitor and control potential environmental impacts.
- Community liaison – aim to be a good neighbour with public exhibitions, regular contact with local villages and support for local facilities.
- Culture of benchmarking to measure performance based on industry KPIs developed in the Construction Best Practice Programme.
- Development of precise logistical strategy – this was an immense challenge.
- Accredited health and safety test centre (all new workers coming on to the site had to pass the CSCS test within 3 months of starting on site).
- Development of a safety culture with a safety record four times better than the industry average – thus attracting skilled workers.
- Health awareness and promotion campaigns, including free medicals.
- Time and money spent on planning is time and money well spent.
- Linking incentive payments to the supply teams to the achievement of visible milestones (70 milestones in total, e.g. diversion of the twin rivers and lifting the roof).
- Construction Training Centre producing 80 new modern apprentices per year.
- Seek excellent highly experienced people to work on major projects and minimize confrontation through establishing trust and openness in working relationships.

For a comprehensive review of the development of BAA's procurement philosophy from 1994 until the completion of Heathrow Terminal 5, see Potts (2009).

18.11 BAA's new procurement strategy

In June 2009 *Building* magazine reported that BAA had turned its back on the alliancing approach with BAA as an expert client at its core. In future, for projects worth more than £25 million there would be limited competition between two, three or four framework contractors. Projects valued at more than £25 million would be opened up to competition through the EU's Most Economically Advantageous Tender model (Wright, 2009).

In October 2009, *Building* magazine captured the highly significant comments of Steven Morgan, Capital Director of BAA:

> A technique that has been used in the US for many years is the award fee contract, where many incentives are offered. An award fee pool of 2–5 per cent of a target cost is set aside to create rewards for the contractors to pursue. Either semi-annually or quarterly, the client evaluates contractor performance against previously established criteria and grants an award on a totally unilateral basis. The award is not subject to appeal or dispute but it the client's right to define just how happy he is with the contractor.
>
> Indeed, award fee criteria can cover not only objective factors such as schedule, safety and quality, but should also address subjective factors include co-operativeness and innovation. Even the mitigation of failures can be rewarded when problems emerge, so that pulling the project out of the fire can be recognized too.
>
> Under an award fee contract, the contractor is afforded an opportunity to make a concise and objective self-assessment, but all stakeholders can have some input into how much award fee should be granted. If cost savings are realized during a project, the award fee pool can even be increased so that the incentive pot becomes partly self-funded by the contractor's own performance.
>
> Through the award fee process linked with cost-based incentives, the responsibilities and objectives of the client and contractor are each defined. In my view, it is this clarity that we have all sought over the last decade or so, not really partnership or alliances.
>
> (Morgan, 2009)

A news item in *Building* magazine (5 March 2010: 12) further clarified the new BAA procurement approach, identifying that the first element of the plan is a bonus for any firm that suggests a cost saving. Second, contractors could also win an extra fee every 6 months based on the firm meeting a set of criteria including working on time and budget, health and safety record and the level of cooperation with BAA. Third, contractors could share the client's savings if a project finishes early or comes in under budget, although they would be charged for any cost or time overruns.

It is clear that, whilst this new approach represents a shift towards the more traditional arm's length approach, fundamental principles of performance measurement and benchmarking, target cost strategies, gain/pain share and value management are still being maintained by BAA as essential elements of effective project delivery.

18.12 Conclusions

The T5 project was the watershed in embracing the principles of lean construction in the UK and required a complete change in the mindset and culture of the participants. The client has a huge role to play in the project success. Instead of writing into its contracts penalties for failure, BAA accepted all the risk from the outset and guaranteed its suppliers an agreed margin, thus sending out a positive message to the whole project team. This approach is at the opposite end of the spectrum when compared to the UK Government's preferred PFI/PPP model, which puts as much risk as possible onto its contractors.

BAA is an *informed client* that knows how to run an airport and appreciates that those who know how to build took the leadership role. They created a single entity harnessing the 'intellectual horsepower', working to get the job done rather than poring over contracts to find excuses. In return for its goodwill, BAA demanded absolute transparency in the books of its suppliers in order to minimize waste (Douglas, 2005).

This approach created an environment in which all team members were equal. Furthermore, it encouraged problem-solving and innovation in order to drive out all unnecessary costs, including claims and litigation, and drive up productivity levels. Doherty (2008) notes that the aim was to have the team settle any disputes or 'issues'. If that failed, a meeting of the 'star chamber' was called, bringing together key players from BAA and the supply chain. If that failed, an independent mediator was involved and, if that failed, the matters would go to adjudication. In the event, the £4.3 billion project, with 20,000 suppliers, was completed without any formal dispute – a considerable achievement.

BAA's enlightened approach created a collaborative environment which led to the implementation of industry best practices and world-class performance. This approach is particularly relevant to long-term projects with high risk and high complexity, valued at £200 million and above, but might not be so relevant for smaller more straightforward projects.

So does Terminal 5 represent history in the making? In his 2005 lecture at the Royal Academy of Engineering, Andrew Wolstenholme, BAA's Project Director, confirmed that he believes it does and that the new approach to project management as set out in the T5 Agreement will help the industry change for the better. However, it will require a massive culture change to become the norm.

18.13 References/further reading

Black, D. (2005) 'BAA's lean construction innovations', *LCI's 7th Annual Lean Construction Congress*, 20–23 September, San Francisco, California, USA.

Boultwood, J. (2005) 'Heathrow T5: a case study', *NEC Annual Seminar*, ICE London, 26 May.

Broughton, T. (2004) 'T5 a template for the future: how Heathrow Terminal 5 has rebuilt the building industry', Supplement within *Building*, 27 May.

CPIC (2003) *Code of Practice for Production Information*, Construction Project Information Committee.

Doherty, S. (2008) *Heathrow's Terminal 5: History in the making*, John Wiley & Sons Ltd.

Douglas, T. (2005) 'Interview: Terminal 5 approaches take-off', *Times*, Public Agenda Supplement 6 September.

Egan, J. (1998) *Rethinking construction: The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction*, London, Department of the Environment Transport and Regions Construction Task Force.

Fullalove, S. (ed.) 'NEC helps BAA deliver Heathrow Terminal 5', *NEC Newsletter*, No. 30.

Geoghegan, M. (2005) 'Quality governance and management of Heathrow T5 construction', Meeting London Branch IQA, May.

Lane, R. and Woodman, G. (2000) 'Wicked problems, righteous solutions: back to the future on large complex projects', *International Group for Lean Construction Eighth Annual Conference* (IGEC), Brighton, England, July.

Latham, M. (1994) *Constructing the team: Final report of the government/industry review of procurement and contractual arrangements in the UK construction industry*, HMSO.

Morgan, S. (2009) 'The right kind of bribe', *Building*, 9 October, pp. 24–25.

National Audit Office (NAO) (2005) *Improving Public Services through Better Construction*, Report by the Comptroller and Auditor General, HC 364-II Session 2004–2005, 15 March.

New Civil Engineer (2004) 'NCE Terminal 5 Supplement', *New Civil Engineer*, February.

Office of Government Commerce (OGC) (nd) *Managing Risks with Delivery Partners: A guide for those working together to deliver better public services*, OGC.

Pearson, A. (2003) 'T5 satisfying hells hounds wrestling with serpents', *Building*, 25 July.

Pearson, A. (2004) 'The big picture', *Building*, 8 October.

Potts, K. (2009) 'From Heathrow Express to Heathrow Terminal 5: BAA's development of supply chain management', in Pryke, S. (ed.) *Construction Supply Chain Management Concepts and Case Studies*, Wiley-Blackwell, pp. 160–181.

Riley, M. (2005) Interview, Turner & Townsend News, Issue 31.

Smyth, H. and Pryke, S. (2008) *Collaborative Relationships in Construction*, Blackwell Publishing.

Wolmar, C. (2005) 'Project management at Heathrow Terminal 5', Public Finance, April 22.

Woodman, G.R., Moore, R., Lucas, G. and Lane, R. (2002) 'Development of a design and cost optimisation model for Heathrow Airport Terminal 5', *Federal Aviation Administration Airport Technology Transfer Conference*, Paper 71, www.airporttech.tc.faa.gov/att04/2002%t20TRACK%20P.pdf/P-71.pdf – accessed 21 November 2012.

Wright, E. (2009) 'I will not be taken for granted', *Building*, 26 June, pp 26–28.

Websites

www.nao.org.uk/publications/nao_reports/04-05/0405364case_studies.pdf – National Audit Office Reports.
www.neccontract.com/news/index.asp?Type=Newsletters – New Engineering Contract Newsletters.
www.raeng.org.uk/news/publications/ingenia/issue22/Kimberley.pdf – Royal Academy of Engineering.
www.turnerandtownsend.com Case Studies: BAA – Terminal 5 Heathrow.

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