

Construction Planning, Programming and Control

Brian Cooke
Peter Williams

Fourth Edition

WILEY



Construction Planning, Programming and Control

Construction Planning, Programming and Control

Fourth Edition

Brian Cooke and Peter Williams

WILEY Blackwell

This edition first published 2025
© 2025 John Wiley & Sons Ltd

Edition History

1e 1998 by McMillan Education, UK; 2e 2004 by Blackwell Publishing, Oxford, UK; 3e 2009 by Wiley-Blackwell, Chichester, UK

All rights reserved, including rights for text and data mining and training of artificial technologies or similar technologies. [For any titles with third-party copyright holders, replace the previous sentence with: All rights reserved.] No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by law. Advice on how to obtain permission to reuse material from this title is available at <http://www.wiley.com/go/permissions>.

The right of Brian Cooke and Peter Williams to be identified as the authors of this work has been asserted in accordance with law.

Registered Office(s)

John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Trademarks: Wiley and the Wiley logo are trademarks or registered trademarks of John Wiley & Sons, Inc. and/or its affiliates in the United States and other countries and may not be used without written permission. All other trademarks are the property of their respective owners. John Wiley & Sons, Inc. is not associated with any product or vendor mentioned in this book

Limit of Liability/Disclaimer of Warranty

While the publisher and authors have used their best efforts in preparing this work, they make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives, written sales materials or promotional statements for this work. This work is sold with the understanding that the publisher is not engaged in rendering professional services. The advice and strategies contained herein may not be suitable for your situation. You should consult with a specialist where appropriate. The fact that an organization, website, or product is referred to in this work as a citation and/or potential source of further information does not mean that the publisher and authors endorse the information or services the organization, website, or product may provide or recommendations it may make. Further, readers should be aware that websites listed in this work may have changed or disappeared between when this work was written and when it is read. Neither the publisher nor authors shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

Library of Congress Cataloging-in-Publication Data

Names: Cooke, Brian, author. | Williams, Peter, 1947- author.

Title: Construction planning, programming and control / Brian Cooke, Peter Williams.

Description: Fourth edition. | Chester, UK : Wiley, 2025. | Includes index.

Identifiers: LCCN 2024011276 (print) | LCCN 2024011277 (ebook) | ISBN

9781119109457 (paperback) | ISBN 9781119109464 (adobe pdf) | ISBN

9781119109471 (epub)

Subjects: LCSH: Building-Planning.

Classification: LCC TH153 .C597 2025 (print) | LCC TH153 (ebook) | DDC

690.068 – dc23/eng/20240409

LC record available at <https://lcn.loc.gov/2024011276>

LC ebook record available at <https://lcn.loc.gov/2024011277>

Cover Design: Wiley

Cover Image: Peter Williams

Set in 9.5/12.5pt STIXTwoText by Straive, Chennai, India

Contents

About the Authors	<i>xxv</i>
Preface	<i>xxvii</i>
Acknowledgements	<i>xxix</i>
Acronyms	<i>xxxi</i>

1	Construction Projects	3
1.1	Introduction	3
1.1.1	Industry Reputation	4
1.1.2	Projects	4
1.1.3	Programmes	5
1.1.4	Portfolios	6
1.1.5	Mega Projects	6
1.2	Why Do Projects Go Wrong?	8
1.2.1	Looking for Reasons	9
1.2.2	Murphy's Law	10
1.2.3	Complexity	10
1.2.4	The Consequences of Late Completion	11
1.2.5	Construction Industry Reports	13
1.3	Managing the Risk of Delayed Completion in the 21st Century	14
1.3.1	Summary of Findings	14
1.3.2	Detailed Observations	15
1.3.3	Claims and Disputes	16
1.3.4	Project Management Software	16
1.3.5	Further Developments	16
1.4	The Latham Reports	16
1.4.1	Trust and Money	17
1.4.2	Constructing the Team	17
1.4.3	Post-Latham	17
1.5	The Egan Reports	22
1.5.1	Rethinking Construction	22
1.5.2	Accelerating Change	24
1.5.3	Post-Egan	24
1.6	The Wolstenholme Report	25
1.6.1	Egan Targets	26

1.6.2	Wolstenholme Conclusions	26
1.6.3	Wolstenholme Blockers	27
1.6.4	Summary	27
1.6.5	Post-Wolstenholme	28
1.7	The Farmer Review	29
1.7.1	Farmer Conclusions	29
1.7.2	Recommendations	30
1.7.3	Farmer Initiatives	30
1.7.4	Post Farmer	31
	References	31
	Notes	32

2 Project Environment 35

2.1	Introduction	35
2.2	Industry Culture	36
2.2.1	Industry Customs and Practices	36
2.2.2	Separation of Design and Construction	37
2.2.3	Late Payment	37
2.2.4	Construction Supply Chain Payment Charter	38
2.2.5	Public Contracts Regulations 2015	39
2.3	Defining the Industry	40
2.3.1	Industry Classification	40
2.3.2	Industry Sector Output	41
2.3.3	Legislative Definition	43
2.3.4	Types of Work	44
2.4	Industry Clients	44
2.4.1	Definitions	45
2.4.2	Types of Clients	45
2.4.3	Professional Advisers	45
2.4.4	Funding	46
2.5	Construction Firms	46
2.5.1	Industry Output	46
2.5.2	Micro Firms	47
2.5.3	SMEs	47
2.5.4	Large Firms	47
2.5.5	Very Large Contractors	48
2.5.6	The Top 100	48
2.5.7	Margins	49
2.5.8	Suppliers	50
2.6	Industry Leadership	51
2.6.1	The Influence of Clients	51
2.6.2	The Construction Clients' Group	52
2.6.3	Main Contractors	52
	References	53
	Notes	53

3 Project Risk 57

3.1	Introduction	57
-----	--------------	----

3.1.1	Risk	58
3.1.2	Uncertainty	58
3.2	Risk Management	59
3.2.1	Principal Risks and Uncertainties	59
3.2.2	Developers	60
3.2.3	Managing Risk	60
3.2.4	Crossrail	62
3.2.5	Heathrow Terminal 5	62
3.3	Risk Assessment	63
3.3.1	Risk Categories	63
3.3.2	Hazards	64
3.3.3	Assessing Risk	65
3.4	Design Stage	66
3.4.1	Feasibility	66
3.4.2	Funding	67
3.4.3	Design	68
3.4.4	Tender Documentation	69
3.4.5	Quantity Risk	69
3.5	Tender Stage	70
3.5.1	Tender Risk	70
3.5.2	Tender Risk Allowances	72
3.5.3	Programme–Time Risk	73
3.5.4	Method Risk	74
3.6	Construction Stage	74
3.6.1	Delay	75
3.6.2	Health and Safety	76
3.6.3	Fire Risk	76
3.6.4	Supply Chain Risk	77
3.6.5	Defects	78
3.6.6	Insolvency	80
3.7	Managing Project Risk	81
3.7.1	Risk Allocation	82
3.7.2	Reactive Risk Management	83
3.7.3	Proactive Risk Management	83
3.7.4	Dynamic Time Modelling	84
3.7.5	Risk Registers	86
3.7.6	Early Warning Registers	87
	References	87
	Notes	87

4 Managing Construction Projects 91

4.1	Introduction	91
4.1.1	Definition	92
4.1.2	Scope, Delivery and Deliverables	93
4.2	Projects and Programmes	94
4.2.1	Programme and Portfolio Management	94
4.2.2	Phased Projects	94
4.2.3	Project-Based Working	95

4.2.4	The Size of Projects	95
4.3	Management	96
4.3.1	The Principles of Management	96
4.3.2	Organisation	97
4.3.3	Organisation Structures	97
4.3.4	Operational Divisions	99
4.3.5	Business Units	100
4.4	Team Building	102
4.4.1	Complexity	103
4.4.2	Trust	104
4.5	Project Management	105
4.5.1	Decision Making	105
4.5.2	Project Managers	106
4.5.3	Client's Project Manager	106
4.5.4	Contractor's Project Manager	107
4.5.5	Project Manager Duties	108
4.6	Collaboration	109
4.6.1	Common Data Environment	110
4.6.2	Enterprise Resource Planning	112
4.6.3	Construction Management Software	112
4.6.4	Workflows	114
4.7	Design Management	114
4.7.1	Design Manager	115
4.7.2	Pre-construction Manager	116
4.8	Project Management Models	116
4.8.1	APM Competence Framework	117
4.8.2	PMBOK Guide	117
4.8.3	Prince2	117
4.9	Project Stages	117
4.9.1	Process Models	118
4.9.2	Types of Process Models	118
4.9.3	OGC Gateway Process	118
4.9.4	RIBA Plan of Work	119
4.9.5	The Guide to Rail Investment Process	120
4.9.6	The Project Control Framework	121
4.9.7	The Construction Playbook	121
4.9.8	TfL Pathway	122
4.9.9	Infrastructure and Projects Authority Cost Estimating Guidance	122
4.10	Digital Construction	123
4.10.1	Building Information Modelling	123
4.10.2	BIM Models	124
4.10.3	Benefits of BIM	124
4.10.4	BIM Standards	126
4.10.5	BIM Levels	126
4.10.6	BIM Level 3 Benefits	127
4.10.7	BIM Downsides	128
4.10.8	BIM Managers	128

4.10.9	Digital Twins	129
4.10.10	Augmented and Virtual Reality	129
4.11	Managing the Supply Chain	130
4.11.1	Supply Chain	131
4.11.2	Supply Chain Management	131
4.11.3	Supply Chain Integration	132
4.12	Managing Construction	133
4.12.1	Types of Subcontractors	134
4.12.2	Subcontract Scope	135
4.12.3	Attendances	135
4.12.4	Scoping of Work Packages	136
4.12.5	Invitations to Tender	136
4.12.6	Resources and Programme	137
4.12.7	Subcontract Coordinator	137
4.12.8	Lean Construction	138
4.12.9	Fast-track Construction	138
	References	139
	Notes	139
5	Modern Methods of Construction	143
5.1	Introduction	143
5.1.1	DfMA	143
5.1.2	Modern Methods of Construction	145
5.1.3	Definitions	145
5.2	MMC Categories	146
5.2.1	MMC Definition Framework	146
5.2.2	MMC Spectrum	146
5.2.3	Pre-manufactured Value	146
5.3	Modular Construction	148
5.3.1	Volumetric Modular – Structural	148
5.3.2	Volumetric Modular – Non-structural	151
5.4	Panelised Construction	152
5.4.1	Open and Closed Systems	153
5.4.2	SIPs	153
5.4.3	Cross-laminated Timber	154
5.5	Component-Based Systems	155
5.5.1	IKEA	155
5.5.2	Site Assembly	155
5.6	Hybrid Construction Systems	155
5.6.1	Low-Rise Construction	156
5.6.2	Medium-Rise Construction	156
5.6.3	High-Rise Construction	158
5.6.4	Civil Engineering	159
5.7	Digital Technologies	161
5.7.1	3D Printing	161
5.7.2	Drones	164
5.7.3	Wearable Technology	164
5.7.4	Concrete Monitoring	164

5.8	Planning for Modular Construction	165
5.8.1	The Early Stages	165
5.8.2	Construction Schedule	166
5.8.3	Erection Sequence	166
5.8.4	Installation	166
5.8.5	Site Work	166
5.8.6	Tolerance and Fits	167
	References	168
	Notes	168

6 Procurement and Contracts 171

6.1	Introduction	171
6.1.1	Definitions	171
6.1.2	Public Sector and Private Sector Procurement	172
6.1.3	Procurement Strategy	172
6.1.4	Design Procurement	173
6.1.5	Contractor Selection	174
6.2	Tendering	175
6.2.1	Tender Documents	175
6.2.2	Approved Lists	175
6.2.3	Frameworks	176
6.3	Special Relationships	179
6.3.1	Partnering	179
6.3.2	Alliances	180
6.3.3	Joint Ventures	181
6.4	Procurement Routes	182
6.4.1	General Contracting	182
6.4.2	Design and Build/Construct	183
6.4.3	Prime Contracting	188
6.4.4	Management Procurement	188
6.4.5	Public–Private Partnerships	189
6.4.6	Turnkey and EPC	191
6.5	Contractual Arrangements	192
6.5.1	Law of Contract	192
6.5.2	Letters of Intent	194
6.5.3	Forms of Contract	194
6.5.4	Subcontracts	194
6.5.5	Legal Jurisdiction	195
6.5.6	Housing Grants, Construction and Regeneration Act 1996	195
6.6	Standard Forms of Contract	196
6.6.1	JCT Contracts	196
6.6.2	NEC Contracts	196
6.6.3	FIDIC Contracts	197
6.6.4	ICC Contracts	198
6.6.5	CIOB Time and Cost Management Contract	198
6.6.6	ICChemE Contracts	199
6.6.7	Other Contracts	199
6.6.8	Overseas Contracts	200

6.6.8.1	Australia	200
6.6.8.2	Hong Kong	200
6.6.8.3	South Africa	201
6.6.8.4	United States	201
6.7	Types of Contract	202
6.7.1	Lump Sum Contracts	203
6.7.2	Measure and Value Contracts	203
6.7.3	Cost Reimbursement Contracts	204
6.7.4	Target Cost Contracts	205
6.8	Time Management	206
6.8.1	Time in Contracts	206
6.8.2	Project Master Schedule	206
6.8.3	Site Possession	208
6.8.4	Progress, Completion and Extensions of Time	208
6.8.5	Liquidated and Ascertained Damages	209
6.8.6	Obligations Following Completion	209
	References	210
	Notes	210

7 Estimating and Bidding 213

7.1	Introduction	213
7.1.1	Definitions	213
7.1.2	Tendering	214
7.1.3	Estimating and Tendering	214
7.1.4	The Construction Market	215
7.2	Approaches to Estimating	215
7.2.1	Micro Companies	215
7.2.2	Small Companies	216
7.2.3	Medium-size Companies	216
7.2.4	Large-size Companies	216
7.2.5	Estimating Methods	216
7.2.6	Classification	217
7.2.7	Early Cost Advice	217
7.3	Measurement	219
7.3.1	Pricing Documents	219
7.3.2	Quantities	219
7.3.3	Link with Planning	222
7.3.4	Software	223
7.4	Estimating Software	223
7.4.1	Trade Apps	224
7.4.2	Price-a-Job	224
7.4.3	ConX	224
7.4.4	Cubit Estimating	224
7.4.5	Bidcon	225
7.4.6	CATO	226
7.5	Top-down Estimating	227
7.5.1	Definition	227
7.5.2	Traditional Procurement	227

7.5.3	Non-traditional Procurement	227
7.5.4	Principles	228
7.5.5	Floor Area Method	228
7.5.6	Functional Unit Method	229
7.5.7	Elemental Method	230
7.5.8	Hybrid Method	231
7.6	Cost Information	234
7.6.1	Historic Data	234
7.6.2	Sources	235
7.6.3	Indices	236
7.6.4	Inflation	237
7.7	New Rules of Measurement	239
7.7.1	Comparative Cost Planning	239
7.7.2	Cost Checking	240
7.7.3	Cost Reconciliation	241
7.8	Bottom-up Estimating	241
7.8.1	Modern Trends	242
7.8.2	Builders' Quantities	242
7.8.3	Bottom-up Estimating Methods	243
7.8.4	Unit Rate Estimating	243
7.8.5	Operational Estimating	244
7.9	Bidding	248
7.9.1	Estimating	248
7.9.2	Subcontract Enquiries	249
7.9.3	Bid Preparation	251
7.9.4	Integrated Software Platforms	252
7.9.5	Bid Submission and Formal Tender	253
7.9.6	Bid Documentation	253
7.9.7	Other Procurement Methods	255
7.9.8	Bid Management	255
7.9.9	Bid Manager	255
7.9.10	Bid Submission Documents	256
	References	257
	Notes	257

8 The Planning Process 261

8.1	Introduction	261
8.1.1	The Role of Planning	261
8.1.2	Client View	262
8.1.3	Project Team View	263
8.1.4	Contractor View	263
8.1.5	Types of Programme	265
8.2	Strategic Planning	266
8.2.1	Key Appointments	266
8.2.2	Key Dates	267
8.2.3	Statutory Approvals	267
8.2.4	Financing	267
8.2.5	Land Purchase	268

8.2.6	Design Procurement	268
8.2.7	Time and Cost	268
8.2.8	The Construction Period	269
8.3	Design Planning	269
8.3.1	The Design Team	269
8.3.2	Design Development	270
8.3.3	Design Management	270
8.4	Development Case Study	271
8.4.1	Project Master Schedule	271
8.4.2	Development Appraisal	272
8.4.3	Design Programme	272
8.4.4	Due Diligence	273
8.4.5	Hand-Down Document	273
8.4.6	Pre-construction Programme	274
8.5	Construction Planning	274
8.5.1	Tender Stage	274
8.5.2	Pre-construction	275
8.5.3	Construction Stage	276
	Reference	276
9	Scheduling Techniques	279
9.1	Introduction	279
9.1.1	Definitions	279
9.1.2	Work Versus Time	280
9.1.3	Gantt Charts	280
9.1.4	Scheduling Techniques	281
9.1.5	The Critical Path Method	281
9.1.6	CPM Software	283
9.2	Linked Bar Charts	285
9.2.1	Useful Features	285
9.2.2	Basic Principles	287
9.2.3	Worked Example	289
9.3	Arrow Diagrams	290
9.3.1	Basic Principles	290
9.3.2	Worked Example	291
9.4	Precedence Diagrams	291
9.4.1	Basic Principles	294
9.4.2	Worked Example	294
9.5	Arrow, Precedence and Linked Bar Chart Relationships	296
9.5.1	Common Features	296
9.5.2	Networks	296
9.5.3	Overlapping Activities	297
9.6	Line of Balance	302
9.6.1	Basic Principles	302
9.6.2	Worked Example	303
9.7	Time-Chainage Diagrams	306
9.7.1	Basic Principles	307
9.7.2	Worked Example	308

10	Construction Sequences	315
10.1	Introduction	315
10.1.1	Programme versus Work Sequence	315
10.1.2	Construction Methods	317
10.2	Resources	318
10.2.1	Labour	318
10.2.2	Construction Plant	319
10.2.3	Health and Safety	319
10.2.4	Continuity of Work	319
10.3	Temporary Works	321
10.3.1	Definitions	322
10.3.2	Legislation	322
10.3.3	Guidance	323
10.3.4	Management of Temporary Works	323
10.3.5	Temporary Works Designers	324
10.3.6	Temporary Works Coordinator	324
10.3.7	Temporary Works Supervisor	325
10.3.8	Types of Temporary Works	325
10.4	Work Sequences	326
10.4.1	Demolition	326
10.4.2	Façade Retention	327
10.4.3	Trenches	327
10.4.4	Soil Engineering	329
10.4.5	Pile Caps	331
10.4.6	Piled Walls	332
10.4.7	Basements	333
10.4.8	Core Walls	333
10.4.9	Top-Down Construction	334
10.4.10	Top-down, Bottom-up Construction	336
10.4.11	Offline Construction	338
10.5	Sequence Study	339
10.5.1	Sequence Diagram	339
10.5.2	Construction Cycles Times	344
	References	344
	Notes	344

11	Method Statements	347
11.1	Introduction	347
11.1.1	Definition	347
11.1.2	Uses of Method Statements	348
11.1.3	Clients	348
11.1.4	Consultants	349
11.1.5	Main Contractors	349
11.1.6	Subcontractors	350
11.1.7	Specialist Contractors	350
11.2	Format of Method Statements	351
11.2.1	Tabular	351

11.2.2	Written or Prose	352
11.2.3	Generic	352
11.3	Types of Method Statement	352
11.3.1	Tender Method Statement	353
11.3.2	Construction or Work Method Statement	354
11.3.3	Safety Method Statement	355
11.3.4	Lift Plans	355
11.4	Preparing Method Statements	357
11.4.1	Contents	357
11.4.2	Layout	358
11.4.3	Structure	359
11.4.4	Safe Systems of Work	360
11.4.5	Link with the Programme	360
11.4.6	Changing Method Statements	360
11.5	Worked Example	361
11.5.1	Project Description	361
11.5.2	Tender Method Statement	361
11.5.3	Construction Method Statement	365
11.5.4	Safety Method Statement	367
	Notes	370
12	Planning for Safety	373
12.1	Introduction	373
12.1.1	Human Factors	373
12.1.2	Pressures on Health and Safety	374
12.1.3	Definitions and Context	375
12.1.4	Planning for Health and Safety	376
12.2	Hazard and Risk	377
12.2.1	Definitions	378
12.2.2	Types of Hazard	378
12.2.3	Common Hazards in Construction	379
12.2.4	Identifying Hazards	380
12.2.5	Guidance	380
12.2.6	Persons at Risk	381
12.2.7	Risk Evaluation	381
12.2.8	Control Measures	382
12.2.9	Risk Assessment	383
12.3	Legal Framework	387
12.3.1	Primary Legislation	387
12.3.2	Subordinate Legislation	387
12.3.3	Goal Setting versus Prescriptive Legislation	388
12.3.4	Health and Safety Policy	390
12.3.5	Approved Codes of Practice	390
12.3.6	Guidance	392
12.4	Managing Health and Safety	392
12.4.1	HSG65	392
12.4.2	The Four Cs	392

12.4.3	Preventative and Protective Measures	393
12.5	Planning the Work	393
12.5.1	Task-Based Approach	394
12.5.2	Hazard-Based Approach	394
12.5.3	Utilising the Programme	395
12.5.4	Statutory Duties	396
12.5.5	Safe Place of Work	398
12.5.6	Safe Systems of Work	398
12.5.7	Method Statements	399
12.6	Industry-Specific Legislation	401
12.6.1	European Union Directives	401
12.6.2	The CDM Regulations	401
12.7	The CDM Regulations 2015	402
12.7.1	Application	402
12.7.2	Notification	402
12.7.3	Duty Holders	403
12.7.4	Client Duties	403
12.7.5	Designers	404
12.7.6	Principal Contractors	404
12.7.7	Other Contractors	405
12.7.8	Principles of CDM	405
12.7.9	Welfare Facilities	405
12.7.10	Pre-construction Information	406
12.7.11	Construction Phase Plan	406
12.7.12	Site Rules	408
12.7.13	Health and Safety File	408
12.8	Health and Safety Training	408
12.8.1	Site Induction	409
12.8.2	Toolbox Talks	409
12.8.3	Task Talks	410
12.8.4	Walk-through/Talk-through	410
12.9	Measuring Performance	410
12.9.1	Monitoring	411
12.9.2	Audit	411
12.10	Enforcement of Legislation	412
12.10.1	Enforcement Action	412
12.10.2	Prosecution	413
12.10.3	Corporate Manslaughter	414
12.10.4	HSE Prosecutions Database	415
12.10.5	HSE Enforcement Notices Database	416
12.11	Accidents and Incidents	416
12.11.1	RIDDOR 2013	416
12.11.2	Accident Book	417
12.11.3	The Cost of Accidents	417
	References	418
	Web References	418
	Notes	418

13	Planning the Project	421
13.1	Introduction	421
13.2	Principles of Project Planning	421
13.2.1	Getting a Feel for the Project	421
13.2.2	Establishing Key Project Dates	422
13.2.3	Completion	422
13.2.4	4D BIM	423
13.2.5	Establishing Key Activities or Events	424
13.2.6	Work Breakdown Structure	425
13.2.7	Activity Durations	425
13.2.8	Programming Techniques	427
13.2.9	Calendars	428
13.2.10	Timescales	428
13.3	Pre-construction Planning	428
13.3.1	Pre-contract Planning	429
13.3.2	Pre-contract Meetings	429
13.3.3	Procurement	430
13.3.4	Procurement Programme	430
13.3.5	Procurement Programmes	431
13.3.6	Lead Times	431
13.3.7	Site Layout Planning	435
13.3.8	The Master Programme	435
13.4	The Baseline Programme	436
13.4.1	Managing Change	438
13.4.2	Progress	438
13.5	Requirement Schedules	441
13.5.1	Key Materials Schedules	441
13.5.2	Plant Schedules	441
13.5.3	Subcontract Schedules	442
13.5.4	Information Requirement Schedules	442
13.5.5	Requests for Information (RFIs)	444
13.6	The Target Programme	445
13.6.1	Legal Implications	445
13.6.2	Practical Implications	447
13.7	Contract Planning	447
13.7.1	Subcontract Programmes	448
13.7.2	Stage Programme	450
13.7.3	Short-term Programme	450
13.7.4	As-built Programme	453

14	Planning Cash Flow	457
14.1	Introduction	457
14.1.1	Insolvency	457
14.1.2	Cash Flow	458
14.1.3	Working Capital	458
14.1.4	Work in Progress	458
14.1.5	Client Cash Flow	459
14.1.6	Contractor Cash Flow	459

14.1.7	Cash Flow Forecasts	459
14.2	Earned Value Analysis	461
14.2.1	Earned Value	462
14.2.2	Quarter-third Rule	463
14.2.3	Cumulative Percentage Value	463
14.2.4	The Bar Chart Programme	467
14.3	Cash Flow Forecasting	468
14.3.1	Preparing a Forecast	468
14.3.2	Credit Terms	471
14.3.3	Retentions	472
14.3.4	Payment	472
14.3.5	Payment Terms	473
14.3.6	JCT SBC	473
14.3.7	Other Contracts	473
14.3.8	Reflecting Payment Terms in Forecasts	474
14.4	Improving Cash Flow	476
14.4.1	At Tender Stage	476
14.4.2	During the Contract	476
14.4.3	Post-contract	477
14.5	Movement of Money	477
14.5.1	Money In and Money Out	477
14.5.2	Retention	477
14.5.3	Payment Delay	479
14.5.4	Credit	479
14.5.5	Late Payments	480
14.6	Working Capital	480
14.6.1	Forecasting Working Capital	480
14.6.2	Worked Example	482
	References	486
	Notes	486

15 Project Control 489

15.1	Introduction	489
15.2	Budgetary Control	489
15.2.1	Budgets	490
15.2.2	Reporting	490
15.2.3	The Reason for Budgets	490
15.2.4	Types of Budgets	491
15.2.5	Presenting Budgets	491
15.2.6	Construction Management Software	492
15.2.7	The Basis of Budgets	492
15.3	Establishing Budgets	493
15.3.1	Labour Budget	493
15.3.2	Plant Budget	493
15.3.3	Preliminaries Budget	493
15.4	Site Records	499
15.4.1	Site Diary	500
15.4.2	Labour Records	500

15.4.3	Instructions	501
15.4.4	Programme	501
15.4.5	Site Measurements	501
15.4.6	Variations	501
15.4.7	Delay and Disruption	502
15.4.8	Daywork	502
15.5	Meetings	502
15.5.1	Purpose	502
15.5.2	Types	503
15.5.3	Formal and Informal Meetings	504
15.5.4	Monthly Site Meetings	505
15.5.5	Weekly Progress Meetings	505
15.5.6	Subcontract Coordination Meetings	506
15.6	Key Performance Indicators	507
15.6.1	Types of KPIs	507
15.6.2	Uses of KPIs	508
15.6.3	Practical Applications	508
	Reference	508

16 Controlling Time 511

16.1	Introduction	511
16.1.1	Duty to Complete	511
16.1.2	Time for Completion	512
16.2	The Contractor's Programme	512
16.2.1	Milestones	513
16.2.2	Early Warning Systems	514
16.3	Progress and Delay	514
16.3.1	Delay	516
16.3.2	Delay Events	516
16.3.3	Change Control	516
16.4	Recording Progress	517
16.4.1	Progress Reporting	517
16.4.2	Cloud Based Reporting	519
16.4.3	Using the Bar Chart	520
16.5	Delay and Disruption	523
16.5.1	Reasons for Delay and Disruption	523
16.5.2	Definitions	524
16.5.3	Delay	525
16.5.4	Disruption	525
16.5.5	Types of Delay	525
16.6	Extensions of Time	526
16.6.1	Contract Provisions	526
16.6.2	Establishing Entitlement	527
16.6.3	Time and Money	527
16.6.4	Concurrent Delay	528
16.6.5	Mitigation	528
16.6.6	Float	529

16.7	The 'As-Planned' Programme	530
16.7.1	Shortcomings	532
16.8	The 'As-Built' Programme	532
16.9	Delay Analysis	532
16.9.1	Delay and Disruption Protocol	533
16.9.2	Delay Analysis Methodologies	534
16.10	Delay Analysis in Practice	534
16.10.1	Showing Delay on the Programme	535
16.10.2	Software	535
16.10.3	Worked Example	537
16.11	Project Acceleration	539
16.11.1	Time–Cost Optimisation	541
16.11.2	Terminology	541
16.11.3	Worked Example	544
	References	549
	Web References	550
17	Controlling Money	553
17.1	Introduction	553
17.1.1	Forecasting Revenues and Profits	553
17.1.2	Declaring Profits	554
17.1.3	Corporate Governance	555
17.2	Reporting Procedures	555
17.2.1	Small Firms	556
17.2.2	Medium-Sized Firms	557
17.2.3	Large Firms	557
17.2.4	Financial Control Methods	558
17.3	Earned Value Analysis	558
17.3.1	EVA Process	559
17.3.2	Limitations	560
17.3.3	Benefits	560
17.4	Cost Value Reconciliation	561
17.4.1	CVR Terminology	561
17.4.2	Reconciliation Date	561
17.4.3	CVR Process	561
17.5	Cost Value Reports	565
17.5.1	Cumulative Value	565
17.5.2	Reconciled Value	565
17.5.3	Reconciled Cost	566
17.5.4	Cumulative Value and Cumulative Cost	567
17.5.5	Provisions	567
17.5.6	Profit	567
17.5.7	Variance Analysis	569
17.5.8	Date of Report to Management	571
	References	571
	Note	572

18	Controlling Resources	575
18.1	Introduction	575
18.1.1	Targets	575
18.1.2	Head Office	575
18.1.3	Resources	576
18.1.4	Preliminaries	576
18.1.5	Resource Management	576
18.2	Subcontractors	577
18.2.1	Prequalification	577
18.2.2	Subcontract Prices	578
18.2.3	Subcontract Attendances	578
18.2.4	Subcontract Programme	579
18.2.5	Subcontract Liaison	579
18.2.6	Benchmarking	579
18.3	Labour Control	581
18.3.1	Directly Employed Labour	581
18.3.2	Self-employed Labour	583
18.3.3	Resource Histogram	583
18.3.4	Resource Levelling	584
18.4	Materials Control	587
18.4.1	Materials Management	589
18.4.2	Waste	591
18.4.3	Planning for Waste	591
18.4.4	Improving Waste Management	592
18.4.5	Duty of Care	592
18.4.6	Site Waste Management Plans	594
18.5	Plant Control	596
18.5.1	Legislation	597
18.5.2	Organisation	597
18.5.3	Planning	598
18.5.4	Inspection and Maintenance	598
19	Hotel and Commercial Centre	599
19.1	Project Description	599
19.1.1	Project Details	599
19.1.2	Site Constraints	599
19.1.3	Procurement Strategy	600
19.1.4	Project Organisation	602
19.2	Design	603
19.2.1	BIM	603
19.2.2	Modular Design	603
19.2.3	Developer/Client Role	604
19.2.4	Advantages of Modular	605
19.3	CIMS-MBS Off-Site Manufacture	605
19.3.1	Modular Procurement	605
19.3.2	Design Stage	606

19.3.3	Prototype	607
19.3.4	Mass Manufacture	607
19.3.5	Payment	608
19.3.6	Installation	609
19.4	Construction	609
19.4.1	Construction Programme	610
19.4.2	Module Installation	613
19.4.3	Modular Interface	614
19.4.4	Defects	615
19.5	Legal Matters	615
19.5.1	Payments	616
19.5.2	Milestone Payments	616
19.5.3	Insolvency	617
	Reference	617

20 Motorway Bridge Replacement 619

20.1	Project Description	619
20.1.1	Project Background	619
20.1.2	Project Location	619
20.1.3	The Existing Bridge	619
20.1.4	Project Procurement	620
20.2	Project Scope	621
20.2.1	Enabling Works	621
20.2.2	Permanent Works	623
20.2.3	Off-site Works	623
20.2.4	Demolition	623
20.3	Project Organisation	624
20.4	Programme	626
20.4.1	Pre-construction Phase	626
20.4.2	Tender Period and Contract Award	627
20.5	Detailed Design Development	627
20.5.1	Design of the Permanent Works	627
20.5.2	Temporary Works Design	628
20.5.2.1	Bridge Abutments and Central Pier	628
20.5.2.2	Bridge Deck	629
20.5.3	4D BIM	630
20.6	Construction Planning	631
20.6.1	Major Milestones	631
20.6.2	Motorway Possessions and Road Closures	632
20.6.3	Bridge Abutments and Central Pier	633
20.6.4	Bridge Deck	634
20.6.5	Demolition	636
	Notes	640

21 High Speed 2 641

21.1	Project Description	641
21.1.1	Business Case	641
21.1.2	Project Delivery	642

21.2	Route	642
21.2.1	Oakervee Review	642
21.2.2	Integrated Rail Plan	644
21.3	Project Scope	644
21.3.1	Phase 1	644
21.3.2	HS2–HS1 Link	645
21.4	Legal Framework	645
21.4.1	Parliamentary Bills	646
21.4.2	Acts of Parliament	646
21.4.3	Planning Permission	647
21.4.4	The Secretary of State for Transport (SoST)	647
21.4.5	HS2 Ltd	648
21.4.6	Formal Agreements	649
21.4.7	Development Agreement	649
21.4.8	The Core Programme	649
21.4.9	The Wider Programme	650
21.5	Funding and Governance	650
21.5.1	Spending Oversight	650
21.5.2	Programme Governance	650
21.5.3	Programme Governance at HS2 Ltd	652
21.6	Roles and Cooperation	652
21.6.1	Secretary of State for Transport	653
21.6.2	HS2 Ltd	654
21.6.3	The Client Board	654
21.6.4	Programme Representative	654
21.6.5	Senior Responsible Owner	655
21.6.6	Programme Board	655
21.6.7	DfT Board Investment Commercial Committee	655
21.6.8	The Sponsor or Project Boards	656
21.6.9	Principal Accounting Officer	656
21.6.10	HS2 Ltd Accounting Officer	656
21.7	Order of Cost	656
21.7.1	National Audit Office Reports	656
21.7.2	Parliamentary Reports	656
21.7.3	Funding Envelopes	657
21.7.4	Oakervee Review	657
21.7.5	Forecasting Costs	657
21.7.6	Contingency	658
21.7.7	Schedule	658
21.7.8	Oakervee Review	659
21.7.9	Phase 1 Programme	659
21.8	Project Design	660
21.8.1	Design Vision	660
21.8.2	Design Panel	660
21.8.3	Design Review	661
21.8.4	Design Strategy	661
21.8.5	Design Stages	662

21.8.6	Design Critique	663
21.8.7	Station Design	663
21.9	Procurement	664
21.9.1	Design Procurement	665
21.9.2	Construction Procurement	665
21.9.3	Labour and Plant Procurement	666
21.9.4	Forms of Contract	666
21.9.5	Payments	667
21.9.6	Procurement Critique	667
21.10	HS2 Works Areas	667
21.10.1	Enabling Works	667
21.10.2	Main Civils Works	668
21.11	Construction Management	669
21.11.1	Area Organisation	669
21.11.2	Area North Joint Ventures	669
21.11.3	Administrative Support	670
21.11.4	Construction Planning	670
21.12	Construction Methods	671
21.12.1	Long Itchington Wood Tunnel	671
21.12.2	Colne Valley Viaduct	675
21.12.3	Old Oak Common Station	678
21.13	Innovation	682
21.13.1	Logistics Hub	682
21.13.2	Conveyors	683
21.13.3	Access Roads	683
21.13.4	Diesel-Free Site	684
21.13.5	Green Tunnels	684
21.14	Epilogue	686
	References	686
	Notes	687

Index	689
--------------	------------

About the Authors

Brian Cooke (MSc) is a former chartered civil engineer, chartered builder, quantity surveyor and principal lecturer in construction management. He has extensive industry experience and has lectured widely on management and financial topics in the United Kingdom and overseas. Brian is now retired.

Peter Williams (MSc) is a former chartered builder and chartered quantity surveyor with many years of experience in building and civil engineering contracting. He was also a principal lecturer in construction management, quantity surveying and construction health and safety management. Peter is currently a writer, researcher, lecturer and consultant.

Preface

The world has changed considerably since the previous edition of this book was published in 2009.

Not only have we all suffered a hugely damaging pandemic, the United Kingdom has left the European Union, and the world is seeing unimaginable levels of conflict and social change.

World supply chains remain unpredictable post-pandemic, and UK debt is more than £2.5 trillion – almost 100% of GDP – with industry output seriously impacted by reduced levels of public sector spending.

On a more positive note, a huge transformation in digital technology in the past 10 years has revolutionised communications generally and construction design and management in particular such that construction projects can now be seen in virtual reality before they are built. Building Information Modelling (BIM) has transformed the interface between design, planning and construction, thereby facilitating a ‘what-if’ approach to planning pre-construction that was hitherto not possible.

Mobile technology has also changed unrecognisably since the first iPad was released in 2010. Mobile devices have transformed the way in which construction projects are managed and progressed, meaning that site progress and requests for information can now be processed in real time.

This period of exciting development has taken place against a background of sobering change in the UK construction scene which has witnessed the collapse of Carillion, the United Kingdom’s second largest contractor and the consequently seismic effect that this has had on the construction supply chain. Official reports suggest that significant numbers of insolvencies resulted from this catastrophe and call into question the robustness and reliability of auditing standards and practices. Since then, other large contractors have suffered grinding profits and financial instability – causing disquiet amongst shareholders – and other top 100 contractors have followed Carillion into insolvency.

Despite these winds of change, the aims of the first edition have not changed.

This is a book for students of construction-related professional and degree courses – construction management, building, civil engineering, quantity surveying and building surveying alike. Students and young professionals of all these disciplines need a basic understanding of the culture and methodologies of the industry. They need to know how construction projects are procured, planned and managed, and they need to appreciate the

link between construction technology and the methods, order and sequence of work on site. This book aims to fulfil this need.

The fourth edition is a major rewrite necessitated by the tide of progress and changes in industry practice. The basic structure of the book is unchanged, but there are seven completely new chapters, three new major case studies and the remaining 11 chapters have been extensively rewritten and updated.

The ambit of the book has been broadened and deepened and the early chapters have been refocused on the management of projects and project risk. Major and mega-projects have been given suitable prominence in the book including the Shard, Crossrail, Heathrow T5, Hinkley Point C and HS2, and new material has been included covering joint ventures, frameworks and collaborative working.

The case studies and sequence studies in this edition cover a much wider variety of construction methods than previously and include modular construction, slip forming, tunnelling and top-down construction. In common with previous editions, health and safety and the provision of safe systems of work are integral to the book and retain their importance in a revised and fully updated dedicated chapter.

In this edition, particular emphasis has been placed on work sequences and method statements, and these chapters have been extensively revised and extended. The book is also illustrated with colour photographs for the first time to add realism to the case studies and the numerous worked examples.

Coverage of construction industry reports has been updated to include reflections on how the industry has responded to the challenges posed by Latham, Egan and so on. This includes the Farmer Review which has prompted a new chapter on modern methods of construction and a new case study dealing with modular construction. The topics of contracts and procurement have been amalgamated into a new, extensive and fully-revised stand-alone chapter. This includes coverage of a number of international contracts and the role of the programme in a wide variety of contract conditions.

Finally, this edition includes coverage of common data environments, enterprise resource planning, construction management software and the use of 4D BIM in construction scheduling.