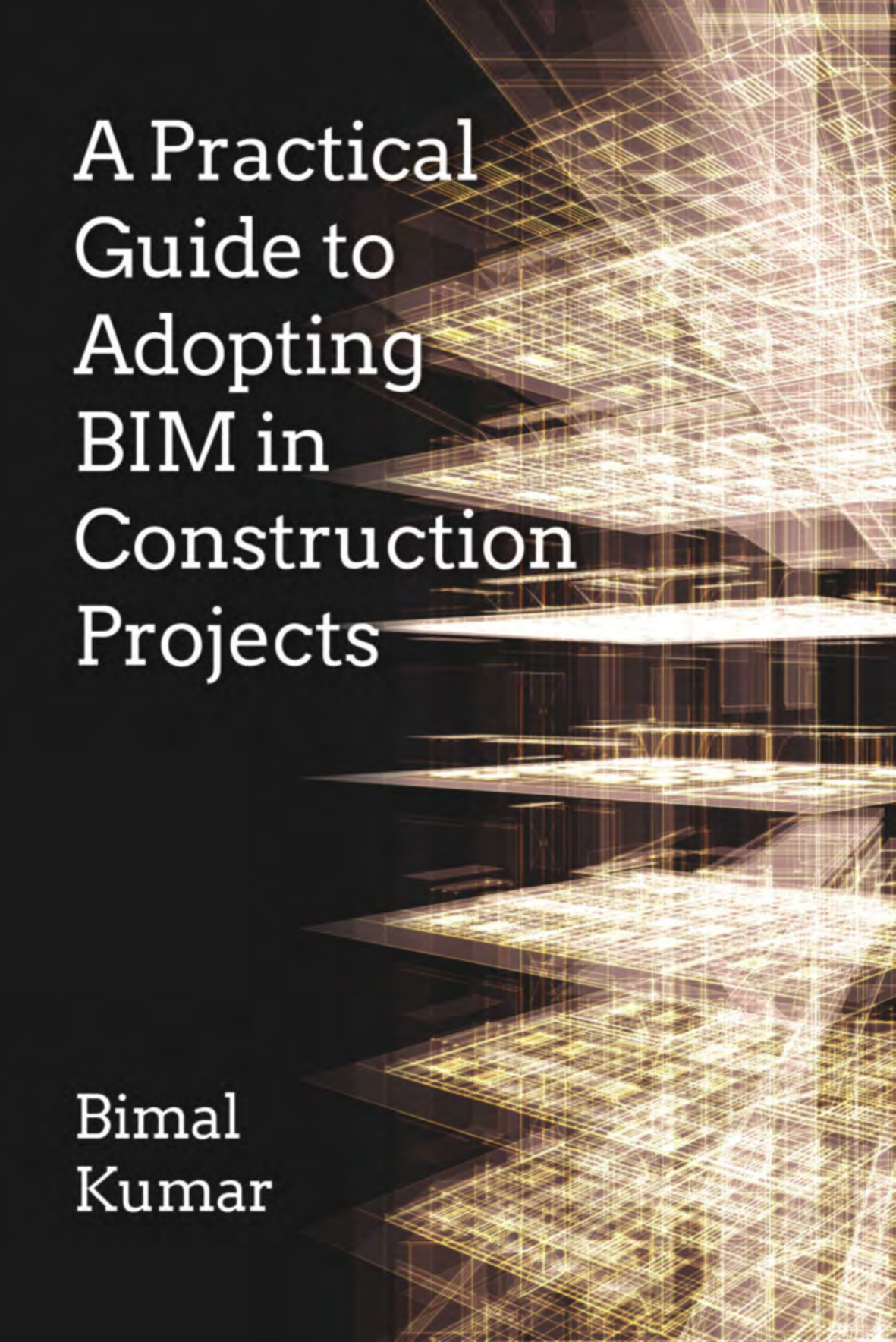
A Practical Guide to Adopting BIM in Construction Projects



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Foreword

Since the UK Government Construction Strategy was launched in 2011 with its ambitions for BIM and the beginnings of a digitised construction sector there has been significant progress made in developing a wrapper to enable this collaborative approach. Clients and supply chain organisations are starting to use their data to better design, procure assets and create a more efficient built environment that is more sustainable with better places to live and more intelligent infrastructure.

As industry moves from BIM mobilisation to implementation it is essential that there is practical information at hand to help them successfully execute digital projects and understand how to instil Level 2 BIM across their business. This book offers real-world advice on how you can create that digital transformation and successfully realise the benefits that BIM will bring through more efficient and innovative ways of working.

It's not a matter of if, but when your firm will implement BIM. Are they on the right track and are they moving fast enough?

David Philp FRICS, FCIOB
Head of BIM, UK BIM Task Group

Preface

Building Information Modelling (BIM) is currently the most talked about term within the construction industry all over the world. The UK government has made the use of BIM technologies and processes mandatory on all public sector projects from 2016 regardless of size. Inevitably, this has given rise to a high level of interest in BIM within the UK and elsewhere.

Whilst BIM technologies have been used in a 'lonely' mode for a few years now in several countries, there is generally a lack of proper understanding and appreciation of processes, standards and protocols that need to be in place before a more holistic implementation can take place potentially benefitting all stakeholders in the procurement and operation & maintenance of an asset. There have been innumerable books, papers and reports published on the theoretical underpinnings of BIM technologies but relatively few have dealt with the more mundane practical issues around implementing BIM technologies and processes in a construction project.

This books aims to fulfil that need. Most of the material is country or technology-agnostic although some material may seem to be UK-centric. Even those parts of the book which may appear to be UK-centric will be relevant for any other country and could well be easily adapted. This book attempts to be of practical use to practising engineers, architects, contractors as well as client organisations. However, it will also be of use to students of more advanced built environment courses. The book is organised into seven chapters and four appendices. They are organised purposely in such a way that any one of them could be read almost entirely on its own. However, it is recommended that the first four introductory chapters (1–4) should be read before embarking upon the other chapters individually. The first four chapters should hopefully help the reader develop an understanding of the main drivers and background behind BIM-driven asset life cycle management. In the process, it is hoped that a number of misconceptions and myths about BIM will be addressed helping the reader develop a proper understanding of the key issues and put the whole BIM story into perspective. The four appendices provide some very practical advice and material for implementation of BIM in projects.

The central message of this book is that BIM is all about seamless information *management* for the entire life cycle of an asset rather than simply information *modelling* at the design and construction stages.

Bimal Kumar

1

Introduction and background

1.1 Introduction

BIM (Building Information Modelling) is an acronym that many people in the construction industry are becoming increasingly interested in. BIM is not a new concept, but the current frenzy within the United Kingdom construction industry is driven by the UK Government's directive on using BIM in all public sector projects from 2016.

This book is intended to act as a practical guide for a typical practitioner in the industry. Of late, there has been an explosion of publications, CPD (Continuing Professional Development) courses, seminars and other forms of dissemination activities on BIM in the UK. Therefore, this book does not intend to replicate what has been said or written umpteen times before on the subject. Instead, it aims to be a 'useful' document that can provide guidance on how to deliver BIM-enabled projects. Much of what is dealt with here should be considered as a starting point before embarking on a typical BIM-based project. However, to put things into perspective, a certain amount of basic introductory material and background to the BIM 'story' will be provided in this chapter.

1.2 Common myths about BIM

Right up front, here are some commonly held misconceptions:

- BIM is a piece of software
- BIM will save my firm 20%+ if I use BIM software
- A client is asking me to use BIM on their project – let's buy some Revit (BIM software) licences
- We have been doing BIM for at least 30 years ever since CAD (Computer-aided Design) came out
- BIM is CAD by another name

Suffice to say that at this stage, these are all incorrect in more ways than one. A more comprehensive analysis of these 'myths' will be presented in the next chapter when a detailed discussion on what is and, more importantly, what is NOT BIM, is provided. However, it is first important to consider the nature and characteristics of the construction industry itself, with a view to introducing BIM into asset life cycles.

1.3 Key characteristics of the UK construction industry

The construction industry in the UK (and also most countries in the world) is a major contributor to the economy, accounting for almost 10% of the country's gross national output (ONS, 2010). However, during the recent financial crisis, this dropped to approximately 7%. The industry employs some 1.5 million people directly, and considerably more indirectly, accounting for about 4.5% of the employed labour force in the UK (ONS, 2010). Despite its relative importance for the UK economy, this is an industry fraught with several deep-rooted problems that go back to its origins in being a craft-based industry. This is a project- rather than a product-based industry, which means that it has a very unique set of characteristics that are often quite complex. For example, the key stakeholders in any construction project are 'forced' to form short-term relationships and collaborate in order to deliver a project successfully. This requires a very responsive and agile approach to working with relatively new partners and developing working relationships quite quickly. By the time these relationships have cemented, the project may well be close to completion, when the stakeholders move on to another project, only to repeat the process with perhaps a totally new set of partners! This is not easily accomplished and yet the success of the industry depends on it. Therefore, the industry needs to have appropriate infrastructure in place for effective partnerships. One way to achieve this is to have effective information exchange strategies in place. However, in an

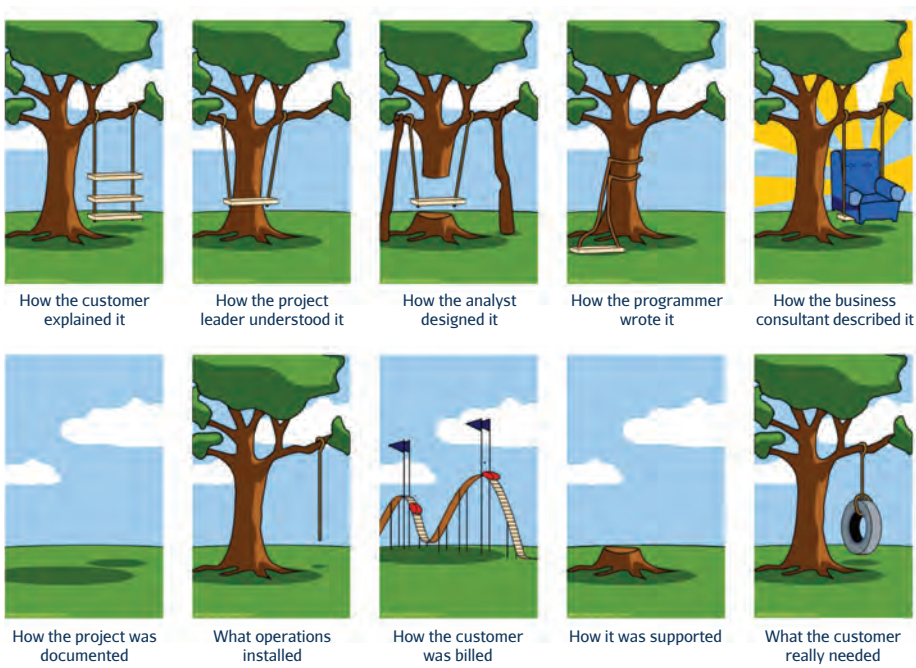

Figure 1.1: Poor information management (reproduced from www.projectcartoon.com)

industry predicated upon people from different organisations collaborating for short periods of time, it is fraught with extremely complex information flows. In order to address this effectively, one of the key ingredients of the required infrastructure to facilitate smooth information flow is the use of standards and protocols for effective information creation, storage, exchange and management. As this is not in place on most projects, the result is that the project outcomes often are not satisfactory, and clients are frequently left accepting an asset that they did not ask for. The other hugely important negative impact of all this is that the industry as a whole ends up with adversarial relationships between the key stakeholders, resulting in claims and counter claims. The industry, rather perversely, exploits the incomplete and fuzzy nature of information that it has to work with by making most (if not all) of its profits from claims and counter claims. Figure 1.1 illustrates this issue of poor information management leading to an outcome that was totally unintended and different from that envisioned to start with.

This section has presented a very brief overview of the nature and characteristics of the construction industry because a more detailed one is outside the scope of this book. For interested readers, there are several other excellent publications (e.g. Crotty, 2012) that discuss these issues in much greater detail.

1.3.1 Role of information exchange in the construction industry

In order to appreciate the importance of information exchange within a typical construction project, figures 1.2 and 1.3 show a few examples of the enormous volumes of information generated during the course of various kinds of typical construction projects. Figure 1.2 is a snapshot of results from analysis of EDMS (Electronic Document Management System) for a PFI (Private Finance Initiative) hospital project. Figure 1.3 shows similar results for a JV (Joint Venture) motorway extension project.

It is plainly obvious that without effective and sophisticated standards, protocols, processes and technologies in place, it will not be possible to exchange such volumes of information effectively in a seamless manner. If the information is not managed effectively, the side effects are all too familiar to anyone involved with the industry: significant time and money lost on claims and other forms of litigation, as well as substantially escalated costs and schedules of projects.

1.4 Issues of interoperability within the construction industry

As discussed in section 1.3, the role of high-quality information is vital for successful delivery of a construction project. This includes efficient methods of generation, storage, sharing and management of information. One of the key requirements for this is effective and good interoperability of information between systems used by different stakeholders in a project. However, it is a matter of common experience and knowledge that interoperability is a major issue in the construction industry, not just in the UK but also worldwide. Most systems used in the industry do not 'talk' to each other. A major study carried out by NIST (National institute of Standards and Technology) in

Communication Type	# created	# attached	# per month
Builder's work request	90	100	3
Change control proposal	1500	500	50
Client observation record	200	250	7
Company record	450	0	15
Contact record	1300	0	43
D&B contractor's instruction	1500	350	50
Decisions made	1500	3	50
Directive	1500	0	50
Drawing record	35000	0	1166
Fax	3300	1650	110
Impact analysis form	4200	900	140
Incoming documents	8300	8100	277
Letter	2000	600	67
Electronic memo	8300	6400	277
Minutes	2000	1500	67
Site direction	150	10	5
Site instruction	10	10	0.3
Sign-off notification	550	1115	18
Telephone call notes	100	10	3
Technical query	4000	2550	134
Transmittal	16000	200	534
Totals	**91950**	**24248**	**306**

Figure 1.2: Volume of information generated in typical projects (from Sommerville and Craig, 2002)

Communication Type	# created	Communication Type	# created
Telephone notes	78	Site instructions	7
Meeting minutes	1855	Final design drawings	2094
Electronic memos	2691	Method statements	122
Letters	7157	Non-conformance reports	3191
Incoming documentation	18329	Project certificates	7000
Faxes	3076	Quality procedures	111
Approval to proceed	20	Requests for inspection	2262
Confirm verbal instruction	3	Site photos	408
Engineer's instructions	1	Technical queries	1670
Instructions to subcontractors	1276	Project contacts	3000
Requests for information	11		
Subtotals	**34497**		**19865**
Totals	**54362**		

Figure 1.3: Volume of information generated in typical projects (from Sommerville and Craig, 2002)

the United States of America (Gallaher *et al.*, 2004) concluded that the cost of lack of interoperability between systems used in this industry was well over US$15 billion per year! A further result of this study was that 68% of this was incurred (US$10.8 billion) in the O&M (Operation and Maintenance) stage. Although these are USA figures, it is likely that the figures for the UK and other comparable developed economies will be proportionately similar. Therefore, the lesson is that the industry has to strive to reach a stage where systems can talk to each other as seamlessly as possible, thus saving the industry very substantial sums of money. This issue of interoperability will be considered again in chapter 4 when different possible solutions to this problem will be discussed.

1.5 Common problems in the construction industry

Fragmentation in the industry:

- Majority of the companies in the construction industry in most industrialised nations consists of less than five people. It is hard to find the kind of investment required for productivity increases through effective collaboration.
- Short-term relationships between 'collaborating' firms in a typical project means there is a lack of sufficiently long engagement to form standard practices for communications.

According to Crotty (2012, p. 26) 'Unpredictability and low profitability are both caused by the same underlying phenomenon in large part – the devastatingly low quality of most of the information used on modern construction projects'.

Another key characteristic of this industry that leads to unsatisfactory outcomes is the lack of a 'holistic' view by the entire project team of the life cycle of the asset they may be building. What this means is that typically the design team normally works in isolation from the rest of the stakeholders, most notably those who are responsible for the asset after construction and handover, i.e. asset and facility managers. This often leads to several issues that the designers do not even consider, whereas some of these issues could be very simple and straightforward to address if the facility managers were involved in the design stage. There are several constructability issues that would be relatively insignificant to tackle at an earlier phase if contractors were involved in the process right at the start of the life cycle. The same simple issues become hugely complicated (and consequently expensive) to fix if left until later. The MacLeamy curve in figure 1.4 and the diagram produced by the BIM Task Group (figure 1.5) illustrate this point very clearly.

Figure 1.6 is an attempt to capture the track record of the construction industry on megaprojects. The pie chart on the right gives a breakdown of the possible causes of failures on large construction projects. It is clear from the pie chart on the left that the vast majority of large projects tend to underperform, whereas the chart on

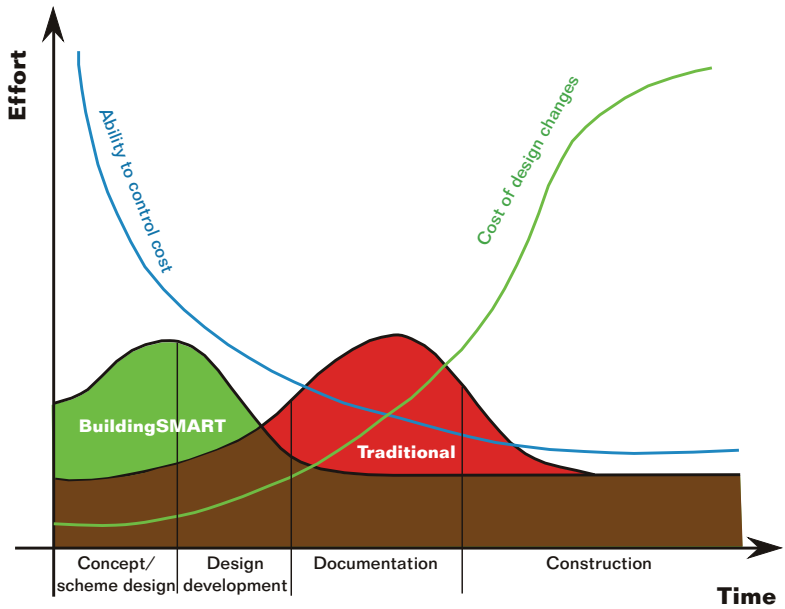

Figure 1.4: MacLeamy curve

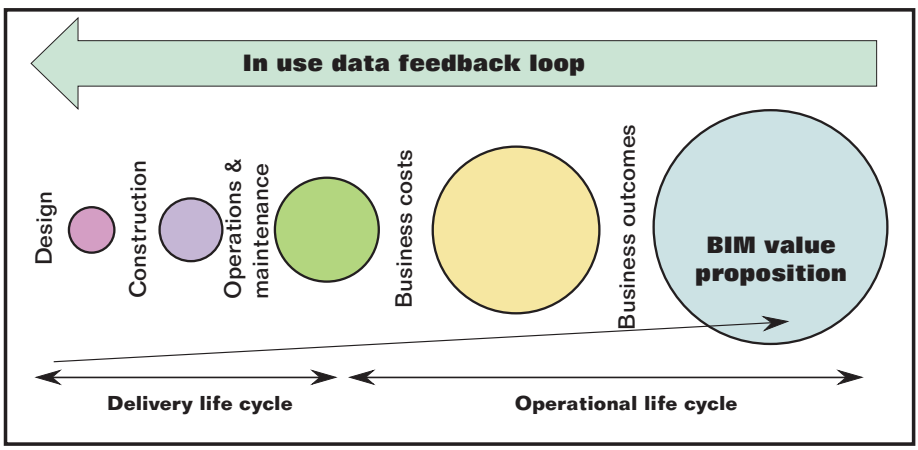

Figure 1.5: Data feedback loop (redrawn with permission from BIM Task Group)

the right suggests that only a small proportion of the failures are due to technical difficulties and that the vast majority of failures are due to non-technical issues. The three largest categories in this chart are Poor Organisation and Project Management Practices, Poorly Defined or Missing Project Objectives and Ineffective Project Planning. Between them, they constitute some 71% of the causes of project failures.

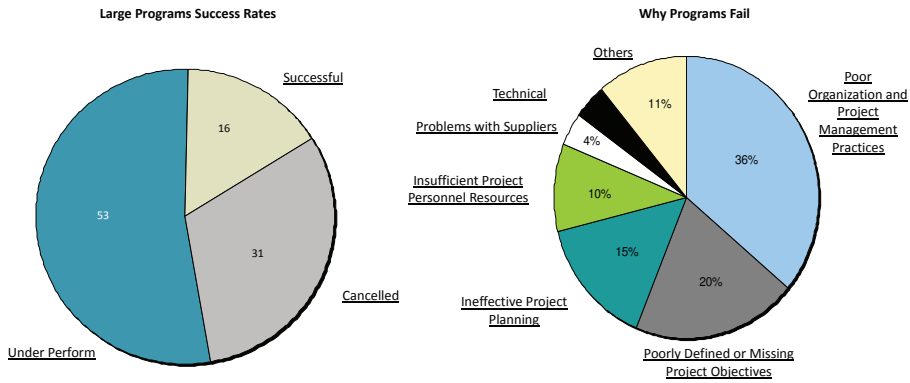

Figure 1.6: Failure on mega projects (Kennerson, 2013)

Interestingly, one can easily attribute all these three categories to lack of high-quality information management in one way or another.

1.6 Latham and Egan reports

In view of the above-mentioned issues with the construction industry, the UK Government has set up various committees over the years to investigate the causes behind these issues and to propose solutions. Among the key reports produced in the recent past, two of the most important are: *Constructing the Team* (Latham, 1994) and *Rethinking Construction* (Egan, 1998).

Latham's report identified several industry inefficiencies, citing the fragmented nature and adversarial model of project delivery prevailing in the industry as two of the main reasons behind them. He proposed 53 recommendations mostly centred around effective teamwork and collaboration between key project stakeholders. It was this report that put forward ideas such as partnering and introducing greater use of information and communication technologies.

Egan's report was published four years after Latham's and was an equally, if not more, influential report in the UK construction industry. The Egan report identified five key drivers of change in order to implement an integrated project:

- committed leadership
- focus on the customer
- integrated processes and teams
- quality-driven agenda
- commitment to people

Many years after the publication of these two influential reports, the industry is