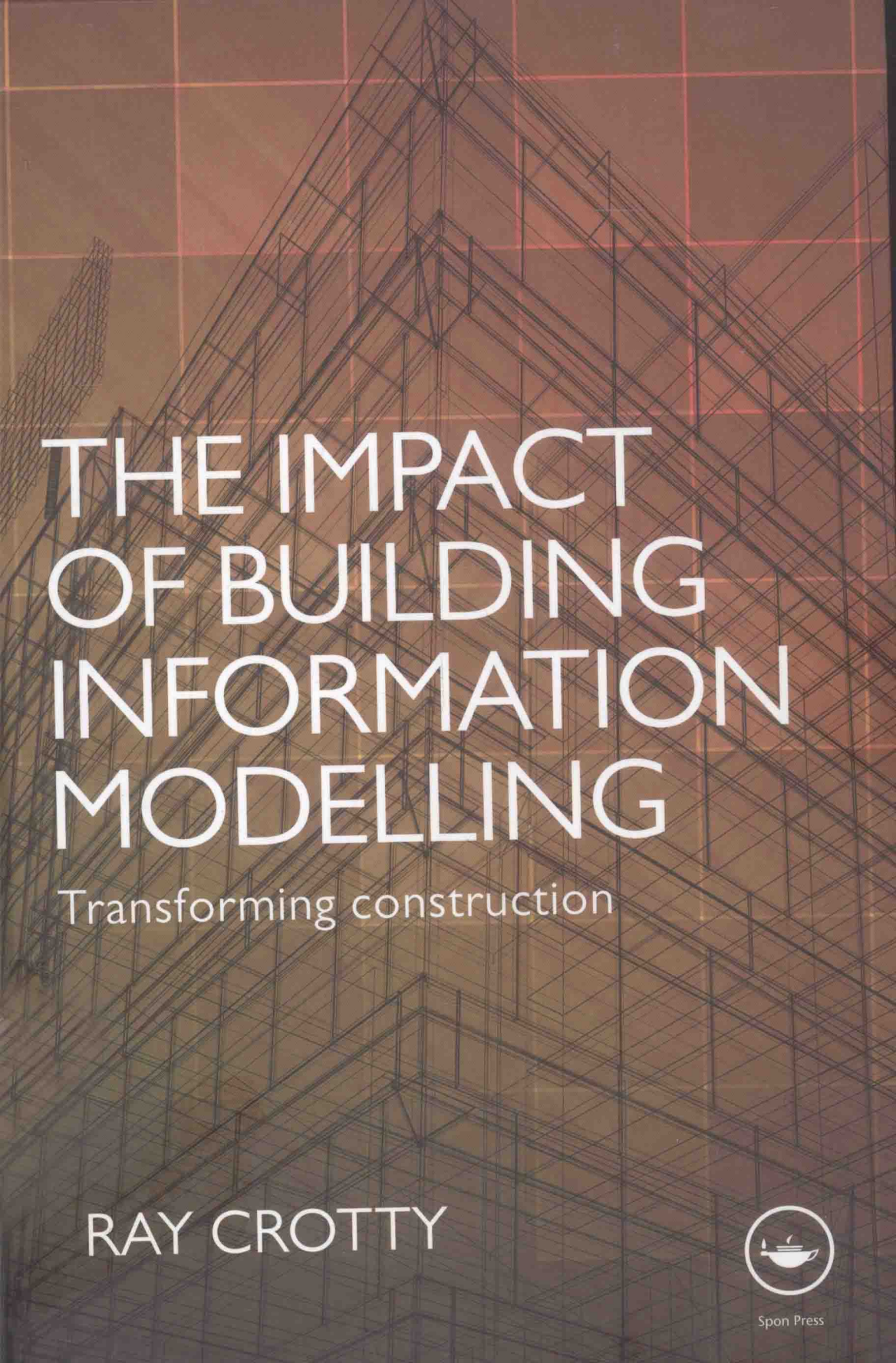
THE IMPACT OF BUILDING INFORMATION MODELLING
Transforming construction
RAY CROTTY
Spon Press

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The Impact of Building Information Modelling

Construction projects involve complex sets of relationships between parties with different professional backgrounds trying to achieve very complex goals. Under these difficult circumstances, the quality of information on which projects are based should be of the highest possible standard. The line-based, two-dimensional drawings on which conventional construction is based render this all but impossible. This is the source of some major shortcomings in the construction industry, and this book focuses on the two most fundamental of these: the failure to deliver projects predictably, to the required quality, on time and within budget; and the failure of most firms in the industry to make a survivable level of profit. By transforming the quality of information used in building, Building Information Modelling (BIM) promises to transform construction more or less completely.

After describing and explaining these problems, the way in which BIM promises to provide solutions is examined in detail. A discussion of the theory and practice of BIM is also provided, followed by a review of various recent surveys of BIM usage in the US, UK and selected European economies. The way in which other industries, including retail and manufacturing, have been transformed by information are explored and compared with current developments in the deployment of BIM in construction. Five case studies from the UK show how BIM is being implemented, and the effects it is having on architects and contractors.

This book is perfect for any construction professional interested in improving the efficiency of their business, as well as undergraduate and postgraduate students wishing to understand the importance of BIM.

Ray Crotty worked in a variety of management control roles on North Sea projects with Bechtel, Phillips Petroleum and Shell, before going on to spend 10 years with Bovis. He devised and implemented the extranet-based document management and communications systems – the earliest known project collaboration system – used on the Bluewater project in Kent, England. He founded C3 Systems Ltd in 1999 to develop the Bluewater ideas and to generalise their use in the industry. He was a founding member of the UK chapter of BuildingSMART (formerly IAI).

For Martha

Foreword

Over the past two or three years, Building Information Modelling has become one of the most widely debated and written about topics in construction. Almost all of this discussion has focused on explaining what BIM is, what the benefits of using BIM might be, and how to use BIM techniques most effectively. In the short term, these probably are the issues the industry most urgently needs to grapple with. However, in the longer term – starting in about five years' time – a much bigger set of questions will come to the fore. These are to do with the way in which the industry responds to the capability of building with perfect information. The discussion becomes less about what we can do with BIM, and more what BIM will do to us.

When I started writing this book, I thought the most important thing to do was to point up the problems associated with drawing-based building design and to demonstrate how BIM could be used to overcome those problems. From the beginning, I had a strong sense that this use of BIM would have many powerful, beneficial effects on the industry, and that seemed to be the key issue to explore. However, as I started to appreciate the effects that advanced information technologies have had on other sectors of the economy, I saw more clearly what I now believe is the most important feature of Building Information Modelling.

These other industries – by one account, comprising nearly 80 per cent of the modern economy – have almost all been transformed by a process that might be called 'digitisation'. In most industries this has been a two-stage process. First, firms improved progressively and fundamentally the quality of the information used in the operation of their production processes and in the management of their businesses. Second, firms, sometimes acting as part of larger industry groupings, introduced fundamental improvements in their internal and company-to-company data exchange and communications processes.

In almost all cases, the changes to which I refer were the culmination of numerous relatively small, incremental steps, undertaken tactically, in response to specific local pressures or opportunities. There is no evidence that the firms in question set out with any sort of big, strategic goal. None had any prior idea of the nature or extent of the transformation they were initiating. Although each step taken at the time represented no more than a relatively minor change to current practice, the cumulative effects have been truly transformative: profoundly disruptive, massive

in scale and often deeply traumatic in terms of their organisational and social consequences. Some observers have described this process as a 'digital revolution', similar in impact to the agricultural and industrial revolutions that shaped earlier eras of human history.

BIM is now beginning the same sort of process in construction. BIM systems generate fundamentally far higher quality information than drawing-based design systems are capable of doing. This improved information quality is already starting to change things in quite subtle ways. As the BIM authoring tools and data-exchange standards and communications protocols continue to mature, as BIM capability reaches a critical mass over the next five to ten years, the concept of end-to-end transmission of computable data throughout the industry's supply networks will gradually become a reality. This is digitised construction; building with perfect information. This form of construction will be as different to today's analogue industry, as today's digital manufacturing and retail industries are different to their 1970s analogue predecessors.

Inevitably perhaps, most people in the industry are leaving the BIM discussion to the 'techies': IT and CAD people. The aim of this book is very specifically to broaden the discussion of BIM futures. It is particularly to encourage non-technical people – business managers, teachers and policy makers – to participate. BIM is no longer a tactical, technical issue – it is far too important to be left to the technicians alone, as I'm sure most technology people would agree.

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The two pioneers of building information modelling who have personally most influenced and stimulated my interest in this subject are Jonathan Ingram and Jim Glymph. To both, my thanks and admiration.

Ray Crotty

Picture credits and sources

Figure 7.1 Source: R. Green, 2011, 'Just How 3D Are We?' *Cadalyst* magazine, February 2011. http://www.cadalyst.com/management/just-how-3d-are-we-part-1-13713 Retrieved 24 February 2011.

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1 Introduction

1.0 Introduction: problems with drawings

When one is immersed in it, working in it every day, it can be difficult to stand back and appreciate just how information-intensive the construction industry is. Modern buildings[1] are amongst the most complex things we create, and the teams required to construct them are amongst the most complicated forms of human organisation. Even on relatively small projects, this combination gives rise to a virtual storm of information: thousands of individual documents – many in a state of continuous revision – circulating rapidly amongst a large, transient array of very different types of individual people and firms.

There are two key challenges in trying to cope with this situation: the quality of the information being generated and used on the project, and the means by which this information is communicated and shared amongst the project team.

There have been countless official and semi-official reviews, investigations and reports on the performance of the construction industry over the past 100 years or so. Almost all of these have pointed to poor standards of information management as being, in one way or another, instrumental in the industry's under-performance. And, although most have suggested fixes, largely of an organisational or contractual nature, none has been able to offer a real solution. Until now, there has been very little that the industry could do about these issues; but with Building Information Modelling (BIM), things may be about to change.

Most of the information used on a construction project originates in the architectural drawings created in the course of the design process. Drawings – even when they are created using CAD systems – are notoriously poor containers, or conveyors, of information. There are two main problems.

First, drawing-based information is inherently untrustworthy; anyone who receives this sort of information cannot assume that it is true. Instead, before using

1 The effects discussed here are not limited to buildings; they include almost all forms of built facilities, including roads, railways, process and petrochemical plants and so on. The word building should therefore be treated as an abbreviation for all these other constituents of the built environment. There are also elements of this overall argument that apply strongly to the operation and maintenance phases of the building life-cycle. Though not addressed explicitly throughout the book, these aspects will be highlighted where relevant.

it, he or she must check to ensure at least that it is clear, consistent, coordinated and correct.

To carry out these checks effectively and consistently takes time and requires high levels of skill, discipline and judgement – qualities not always plentiful on fast-moving projects.

The second major problem with drawing-based information is that it is essentially un-computable; anyone who receives such information and wishes to reuse it for computing, must first decode it, then – usually manually – re-enter it into his or her own system. This is a hugely wasteful activity which introduces a whole new set of errors into the project information flows.

These points are not intended as criticisms of designers or of the techniques they use. The problems are simply unavoidable in drawing-based design; they are inherent in the way in which drawings are created and managed. However, their ultimate effect is to lock construction into a craft-based mode of operation, a way of doing business that would be quite recognisable to medieval builders and their clients.

BIM promises to break that lock, both by improving dramatically the inherent quality of building design information and by improving dramatically the mechanisms and procedures by which information is communicated and shared amongst the members of a project team. It helps to think of the BIM approach as comprising two discrete facets:

- one or more modelling systems in which the actual building design is carried out; and
- a supporting set of data-interchange standards and protocols by means of which the individual models communicate with each other, and with other applications.

The major product and mechanical manufacturing industries moved on from craft production, initially to mass production in the early twentieth century. Towards the end of the century, mass production was superseded by lean production and mass customisation modes of operation. Sophisticated quality assurance techniques, just-in-time methods, and other innovations have contributed to these developments. But arguably the two most important achievements of these industries, in this context, have been the replacement of drawings with models, as the basis of the design process, and dramatic improvements in the integration of information flows throughout their value chains.

The result has been a dramatic transformation in almost all areas of mechanical and product manufacturing, leading to a form of operation called computer integrated manufacturing (CIM). In this mode of working, conventional products can be produced to far higher quality, far less expensively than in the past; and many new products, which would have been impossible to make using earlier techniques, are now commonplace.

BIM does very much the same for buildings. It can be used to produce conventional rectilinear buildings, of greater variety, higher quality, more efficiently