1

Introduction: Foresight and Futures Studies in Construction and Development

Tim Dixon, John Connaughton and Stuart Green

> *'It is far better to foresee even without certainty than not to foresee at all.'*
> Henri Poincare, mathematician, 1854–1912 (Poincare, 1013: 129)

1.1 Background and context

Despite the impact of the Great Recession the construction industry[1] remains a vital and important part of the UK economy. For example, in 2014 construction contributed £103 billion in economic output, which is 6.6% of the total UK output, and 2.1 million jobs, or 6.2% of total jobs in 2015 (Rhodes, 2015). Recent research (GCP Global & Oxford Economics, 2015) suggests that the importance of the construction industry globally is set to grow by 85% to $15.5 trillion by 2030, with three countries (China, the USA and India) leading the way and accounting for 57% of all global growth. Continued high levels of investment are also expected to contribute to a growing built asset value globally. In 2012, the combined stock of built asset wealth in the 30 largest economies totalled $193 trillion, and this is set to grow to $261 trillion by 2022 at a rate of 35% in real terms, with 30–40% of GDP attributable globally to built asset wealth (HM Government, 2015a). With continued growth in the UK operations and facilities management sector, and a growing smart cities market there is also considerable potential in the UK construction industry.

This provides rich opportunities for UK construction, with exports in construction contracting and design services growing fast and worth more than $3.5 billion in 2013 (Jermey, 2015). The UK also has a comparative advantage in several sectors, primarily engineering, architecture and low-carbon environments, and over the last few years as part of the previous Construction 2025 strategy (HM Government, 2015b) the UK has placed the development of Level 2 building information modelling (BIM) programme centre stage as it aspires to develop the Digital Built Britain Level 3 platform for the 2020s (HM Government, 2015a).

1 In some parts of this book the term 'architecture, engineering and construction (AEC) sector' is used to more explicitly include design, engineering and project management consultancies in addition to the contracting firms which comprise Division 45 of the Standard Industrial Classification (SIC) developed by the UK Office for National Statistics.

Sustainable Futures in the Built Environment to 2050: A Foresight Approach to Construction and Development, First Edition. Edited by Tim Dixon, John Connaughton and Stuart Green.

Recent analysis in the Construction 2025 report (HM Government, 2015b) also confirmed this view of opportunities and growth, and highlighted the strengths of UK construction. In particular, the report focused on its key economic role and wider economic significance, the internalised UK supply chain accounting for some £124 billion of intermediate consumption, the UK's world-class design skills in architectural design, civil engineering and sustainable construction, and low entry cost and low capital, which benefit small firms and promote competition in the sector. The more recent Government Construction Strategy 2016–20 (Infrastructure Projects Authority, 2016) also builds on this analysis and reinforces the UK Government's commitment to procurement innovation, BIM, skills development and whole-life sustainability. The opportunities in overseas markets are also clear as a result of rapid growth in BRIC markets, but also the continuing demand for low-carbon construction. For example, green building is now about 25% of total global construction activity (Dodge Data and Analytics, 2016). We are also seeing the development of BIM in the UK and overseas, which is likely to improve productivity and lower costs because of improved information flow and greater collaboration.

Despite the continued focus on UK construction through reports such as Latham (1994), Egan (1998) and Wolstenholme (2009), there is a recurring tendency for the construction industry to be criticised for its lack of forward thinking, poor performance and lack of innovation (Fernie *et al.*, 2006; Goodier, 2013). Indeed, the Construction 2025 report also highlighted supposed weaknesses in the sector, including the lack of sector integration in the supply chain and a reliance on sub-contracting, which can often lead to a disconnection and fracturing between design and construction management, leading in turn to a lack of innovation (HM Government, 2015b). Generally, construction is perceived as having low levels of investment in research and development and new processes because of uncertain demand for new goods and limited collaboration. This lack of collaboration and limited knowledge sharing from previous projects, which are team-based, often results from the break-up of teams when projects are completed, and this therefore compounds a lack of technology transfer. Also, in the UK construction costs are relatively high in comparison with overseas competitors and this is driven by inefficient procurement and processes rather than material costs (HM Government, 2015b). This is also compounded by a frequent lack of access to finance, poor skills levels and a high degree of fragmentation relative to other sectors and other countries. Indeed, the *Farrell Review of Architecture and the Built Environment* (Farrell, 2014) also highlighted the fragmentation of policy making across the field and the skills challenges facing all built environment professionals.

Nor are these issues peculiar to the UK; to take the example of a typical building supply chain, there is typically fragmentation and non-integration, and even the largest players in the supply of buildings are relatively small by international standards, with such companies tending to be international rather than multinational (WBCSD, 2008; Green, 2011). There are also many stakeholders in the building supply chain with complex relationships between them, which can result in functional gaps and management discontinuities between the professional and trade responsibilities and the building delivery process. This creates 'operational islands', characterised by ineffective co-ordination and poor communication (WBCSD, 2008).

It is perhaps surprising therefore that there have been relatively few forward-thinking long-term studies (30 years or more) which have attempted to examine and analyse how the role of the construction industry in the UK and internationally is shaping the built environment of the future (Chan and Cooper, 2011; Goodier, 2013). This is perhaps partly influenced by the reluctance within the industry to plan for the long term because of market volatility, but also a lack of perceived control over external organisational factors (Goodier, 2013). The UK construction industry, however, faces several key strategic challenges as it seeks to set out a long-term vision (HM Government, 2015b).

- *The emergence of smart construction and digital design*: There is a growing convergence between different data sets and different technologies in the digital economy and through a focus on *Digital Built Britain* (HM Government, 2015a). For example, the growth of open data (i.e. data that can be freely used, shared and built on by anyone, anywhere, for any purpose) and big data (i.e. very large, complex and rapidly changing datasets), and the development of the Internet of Things (i.e. the network of physical objects – devices, vehicles, buildings and other items embedded with electronics, software, sensors, and networks – that enables these objects to collect and exchange data) are creating substantive opportunities for innovation. For example, the potential for embedding new technologies in buildings to create 'intelligent assets', where the performance of a building and its components can be constantly monitored and so create more efficient asset management and facilities management (Ellen MacArthur Foundation, 2016). Understanding asset performance will be improved therefore during both construction and throughout the design phase and this could potentially lead to smarter design and more efficient construction, with fewer materials and improved resilience of assets. This is also connecting through the 'smart cities' debate which has gained traction globally (Dixon *et al.*, 2015).
- *The growth of low-carbon and sustainable construction*: The global green and sustainable building industry is set to grow at a rate of 23% as a result of increasing regulatory requirements around low carbon and an increasing demand for greener products (HM Government, 2015b). This has been recognised by the UK Green Construction Board, which has developed a low-carbon route map for the built environment to meet the UK's national carbon emissions target by 2050 (Green Construction Board, 2016). There are clear, identifiable opportunities for retrofitting and other activities at building, neighbourhood and city scale, and across both the domestic and non-domestic property sectors in operational and capital terms (with the latter especially important in infrastructure terms) (Arup, 2015). For example, the construction industry has a critical role to play in meeting climate change targets. Globally, buildings contribute to approximately one-third of global final fuel and power consumption whilst emitting 8.1 Gt of CO_2 per year (Jennings *et al.*, 2011). Similarly, in the UK research (BIS, 2010) has shown that the amount of CO_2 emissions that construction can influence is significant, covering design, manufacture, distribution, and assembly on site, in use and refurbishment/demolition, and accounting for almost 47% of total CO_2 emissions in the UK. Much remains to be done here, however, as a recent report (Arup, 2015) revealed that in 2012 emissions had increased relative to 2009, primarily through increased gas consumption for heating buildings in the UK. If the UK is to achieve its ambitions of a 50% reduction on 1990 levels by 2025 (and ultimately a reduction of 80% by 2050) there needs to be a further 39% reduction by 2025 against the 1990 baseline (Arup, 2015).

- *Growth through improved trade performance*: The UK construction industry is more fragmented than other countries, such as the USA and Germany, and there is only one UK firm in the top 10 European contractors and housebuilders, and only two in the top 20 (HM Government, 2015b). Despite the UK's strong reputation for design and construction services, construction still accounts for only 2% of UK exports. A key challenge facing the UK construction industry is how to take a lead role on overseas projects and compete more effectively in those markets.

These strategic concerns for the UK construction industry are also underpinned by a complex mixture of drivers, or 'megatrends', which are shaping the world in which we live (Ernst and Young, 2015). For example, the growth of digital technologies and the rise of entrepreneurship are creating an increasingly globalised market place. Urban growth continues to be dramatic, with more than 50% of the world's population living in cities today, and this is expected to grow to 66% by 2050 (UN, 2015). Rapid urban population growth in China and India, and further demographic changes to 2050, will produce challenges and opportunities for the global construction industry. This also comes at a time when the built environment professions and their institutions are facing flux and change with increasing challenges to their value and criticism for perceived protectionism, resistance to change, the reinforcement of silos and the preservation of hierarchies (Morrell, 2015).

So now, perhaps more than ever, there is a need for the construction industry, and the related built environment professions, to take a considered long-term view, and look at what sort of future we will see in 2050 in terms of (i) the future shape and form of the built environment, (ii) how the construction industry will need to evolve and change to meet these challenges, and (iii) what the response of the built environment professions should be to these challenges and opportunities. This book therefore aims to address the gap in futures studies in construction by drawing together a wide range of chapters which focus on these three aspects of future change using a foresight-based approach.

1.2 Sustainable futures in the built environment: some important definitions

Before we review the positioning of this book within the wider discourse of futures (and foresight-based) studies in construction, it is helpful to define our field of study and what boundaries we draw in defining the focus for the book. We will therefore define the following terms:

- construction and development
- built environment
- sustainable development
- sustainable futures
- foresight studies.

First, our focus is primarily on the construction and development industries. In statistical (and process-based) terms the UK construction industry can be defined as including general construction and allied construction activities for buildings and civil engineering works. It includes new work, repair, additions and alterations, the erection of prefabricated buildings or structures on the site and constructions of a temporary nature (ONS, 2009). In contrast, a recent UK Department for Business Innovation and Skills report (BIS, 2013) suggested that the UK construction sector[2] was composed in company-based terms of (i) the construction contracting industry, (ii) the provision of construction-related professional services and (iii) construction-related products and materials. Clearly definitions vary, but in this book we are interested in the way in which construction is positioned within the wider development process. For example, for Harvard (2008), property development is taken to be a process 'that involves the transformation of property from one state to another', and for Wilkinson and Reed (2008) it is a process that 'involves changing or intensifying the use of land to produce buildings for occupation'. This invites us to think in a more integrated fashion about the 'real estate' lifecycle (RICS, 2015a) so in this book we take 'construction and development' to be a process which encompasses planning and acquisitions, development, and operations.

Second, our focus is on the built environment context of construction and development. The built environment has been defined in a variety of ways by different researchers. In general, it is defined as the part of the physical environment that is constructed by human activity. In one definition, for example, the built environment consists of the following elements: land use patterns, the distribution across space of activities and the buildings that house them; the transportation system, the physical infrastructure of roads, sidewalk and cycle paths, as well as the service this system provides; and urban design, the arrangement and appearance of the physical elements in a community (Handy *et al.*, 2002). The Smart Cities Council (2015) define built environment as comprising buildings, parks and public spaces, and other components such as streets and utility infrastructure are seen as part of energy and transportation. In this book, we adopt the following definition (Health Canada, 2002, quoted in Srinivasan *et al.*, 2003):

> 'The built environment includes our homes, schools, workplaces, parks/recreation areas, business areas and roads. It extends overhead in the form of electric transmission lines, underground in the form of waste disposal sites and subway trains, and across the country in the form of highways. The built environment encompasses all buildings, spaces and products that are created or modified by people. It impacts indoor and outdoor physical environments (e.g., climatic conditions and indoor/outdoor air quality), as well as social environments (e.g., civic participation, community capacity and investment) and subsequently our health and quality of life.'

Third, we adopt the premise that sustainable development is an area of major concern for the construction and development industries primarily because of the substantive role it plays in producing operational and capital (embodied) carbon emissions. In this sense, a good starting point for understanding what is meant by 'sustainable

2 We use the terms 'sector' and 'industry' interchangeably in this book. Some chapters also focus on what is referred to as the architecture, engineering and construction sector (see footnote 1). These terms should all be treated as synonymous with the wider aspirations of the book, which is to focus on construction and development within the built environment.

development' is the Brundtland Commission definition, which defines the term as (Brundtland Commission, 1987: 27):

> '…development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:
>
> - the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
> - the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.'

This thinking has been at the heart of government policies relating to sustainable development globally, and has been re-emphasised in the UK with policy which has highlighted the importance of improving quality of life for people (e.g. UK Government's *A Better Quality of Life* Report (HM Government, 1999)). As the Pearce (2003) report *The Social and Economic Value of Construction* noted, sustainable development is a process which ensures a rising per capita quality of life over time, and this is reflected in per capita real incomes, better health and education, improved quality of both natural and built environments, and enhanced social stability. For Pearce, sustainability, as the goal of sustainable development, is generated through the possession of four main types of capital assets to advance productivity through technological change:

- human capital, or labour force
- man-made capital, or the built assets
- natural capital, or the environment
- social capital, or interpersonal relationships.

This has also been framed within a 'triple bottom line' approach to sustainable development (Elkington, 1997), which highlights the importance of social, economic and environmental sustainability, underpinned by appropriate governance structures. In this sense, sustainable development can be seen as a pathway to future 'sustainability', and this was at the heart of the UK Government's *Sustainable Development Strategy* report (DEFRA, 2005), which highlights five guiding principles for sustainable development:

- living within environmental limits
- ensuring a strong, healthy and just society
- achieving a sustainable economy
- promoting good governance
- using sound science responsibly.

Fourth, this leads us to the concept of 'sustainable futures'.[3] The Pearce report (Pearce, 2003) highlighted the important role that construction plays in contributing to sustainable development, and the importance of the built environment, as built assets, in the world of construction. In this book, we are interested in highlighting how a sustainable future built environment might look and feel like in 2050, focusing on the physical built

3 See also the discussion on the sustainable built environment in Chapter 17.

environment, the new processes and techniques that are becoming more and more important to understand, and the changing roles that construction and development professionals (and other built environment professionals) will face. In other words, if we use a normative lens for seeing the future in sustainable terms, what are the forces driving these changes, and what are the likely outcomes by 2050?

Fifth, in bringing these concepts of 'built environment', 'construction and development', and 'sustainable development' together within the normative vision of a sustainable future, we have used a conceptual framework for the chapters based on a foresight approach. In the *Oxford English Dictionary* 'foresight' has the following alternative definitions:

- 'The ability to predict what will happen or be needed in the future'
- 'The front sight of a gun'
- 'A sight taken forwards' (in surveying).

For Loveridge (2009: 12) foresight is 'essentially practical and qualitative anticipation' and should be distinguished from the institutional foresight of policy and planning circles. In this sense foresight can also be thought of a conceptual framework involving a range of forward-looking approaches of informed decision-making that include considerations and views of the long term (Kubeczko *et al.*, 2011). Conway (2014) also helpfully distinguishes foresight from futures studies. For Conway (2014: 2) foresight is:

> '…the capacity to think systematically about the future to inform decision making today. It is a cognitive capacity that we need to develop as individuals, as organisations and as a society. In individuals, it is usually an unconscious capacity and needs to be surfaced to be used in any meaningful way to inform decision making, either as individuals or in organisations. It's a capacity we use every day.

In contrast, the term 'futures' refers to (Conway, 2014: 2):

> '…the broad academic and professional field now developing globally as well as research, methods and tools that are available to us to use to develop a foresight capacity. The term "futures" should be viewed as a collective noun, in the same way that we talk of "economics" or "politics". The term is always plural, because there is always more than one future to consider.'

Foresight methodologies can be classified into four levels (Voros, 2003), each with its own guiding questions (Figure 1.1) (Conway, 2014):

- Input: What is going on?: information is gathered on the current environment.
- Analytical: What seems to be happening?: trends and patterns in society are analysed.
- Interpretive: What's really happening?: interpretive methods make sense of the information that has been collected in an in-depth way.
- Prospective: What might happen?: alternative views of the future are identified.

In this book we are interested in addressing all of these questions in relation to sustainable futures in the built environment, looking ahead to 2050. We have therefore commissioned authors using a foresight framework, and in a number of chapters alternative futures are considered. This is important because a lot of thinking about

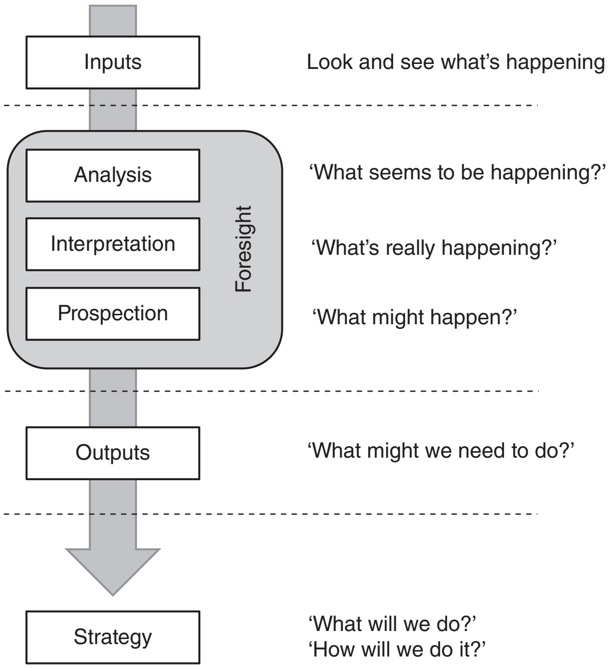

Figure 1.1 Generic foresight process (Voros, 2003).

sustainability is shaped and influenced by the future implications of today's actions. Adopting a precautionary focus also plays to the notion that we should think about desirable future states for our world and the built environment, which brings concepts such as future studies more into focus.

1.3 Futures studies in construction: an overview and critique

1.3.1 Overview of futures studies

The global construction industry has traditionally taken a relatively short-term view of the future. As Goodier (2013: 7) states:

> 'The global construction industry needs to expand its planning horizons to prepare for potential future events, trends and operating environments…yet construction companies appear reluctant to engage in planning beyond a few years, or past the next project, and there is little evidence of a formal process in the formulation of long term strategies.'

This may partly explain the relatively few reports which have focused on long-term trends and the future shape of the industry. There are exceptions, however, which have been reviewed by authors such as Harty *et al.* (2007) and Chan and Cooper (2011),

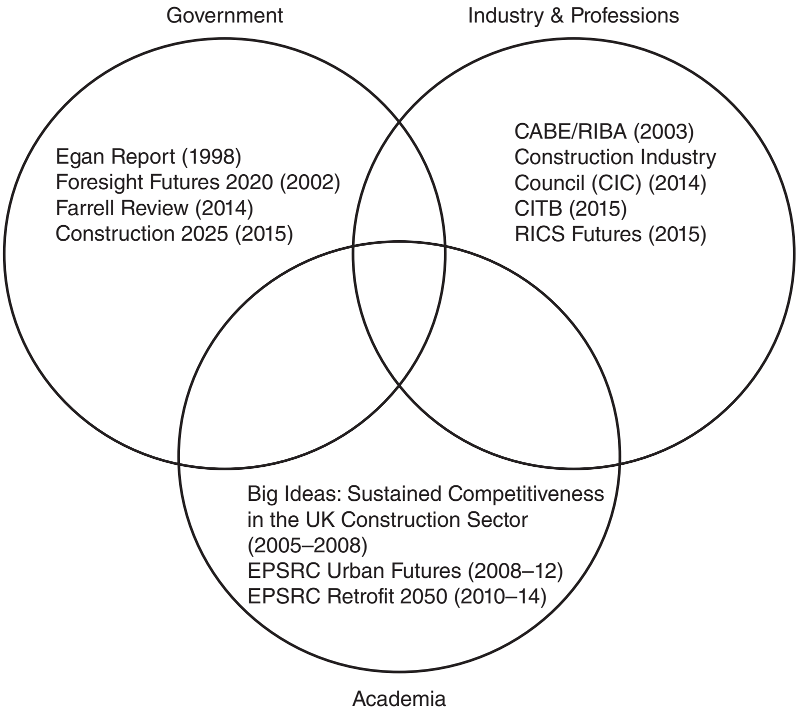

Figure 1.2 Examples of futures studies relating to UK construction and the built environment.

although the studies covered by these authors have tended not to look further ahead than 10–20 years.

There are three main types of futures studies in construction which can be categorised by source (Figure 1.2). First, there are futures studies (which may also have elements of foresight) stemming from government commissioned reviews: examples here include the Egan Report (Egan, 1998), the Fairclough report (Fairclough, 2002), the Foresight Futures report (DTI, 2002), the Farrell review (Farrell, 2014) and the Construction 2025 report (HM Government, 2015b). Second, there are studies which have stemmed primarily from industry and the professions. Examples here include the Commission for Architecture and the Built Environment/Royal Institute of British Architects (CABE/RIBA) review (CABE/RIBA, 2003), the Construction Industry Training Board (CITB) Construction 2030 and Beyond (CITB, 2015), the Royal Institution of Chartered Surveyors (RICS) Futures programme (RICS, 2015b; Cook, 2015) and the Construction Industry Council (CIC) Built Environment 2050 (CIC, 2014). Third, a number of studies have focused primarily on (i) the future of construction and the challenges and opportunities facing it over the next 10–20 years, and (ii) the built environment at city level to identify its future shape and form and the implications of sustainable development for cities. Relevant programmes here include the Big Ideas Sustained Competitiveness in the UK Construction Sector programme (a collaborative programme between the universities of Reading, Loughborough and Salford) and EPSRC Retrofit 2050 and the EPSRC Urban Futures programmes (other examples are covered in Fernandez-Guell and Gonzalez-Lopez (2014)) This latter group of futures studies also has synergy with some of the ideas explored in the futures thinking of Arup at city level (Arup, 2013, 2014).

Figure 1.2 focuses on the UK, but there are other national studies from the USA, Germany and Australia which can be categorised in a similar fashion (see, for example, work referenced in Chan and Cooper (2011) and also Bok *et al.* (2012) and McGrail and Gaziulusoy (2014)). More recently GCP Global and Oxford Economics (2015) have produced global forecasts of the construction industry looking ahead to 2030. Such studies also differ in the way that they approach futures thinking. Harty *et al.* (2007), for example, suggests as far as the first two groups are concerned, that they involve workshops, interviews/consultations, individual or organisational speculation, or reviews of past work. The third group of academic-based studies has used foresight methods (including backcasting techniques) to construct visions and scenarios for cities (Dixon *et al.*, 2014) for example, whilst the Big Ideas research used workshops, causal maps and scenarios (Goodier *et al.*, 2007).

The use of scenarios is an important element in some studies. Definitions of scenarios vary but Godet and Roubelat (1996: 166) understand a scenario as 'a description of a future situation and the course of events, which allows one to move forward from the original situation to the future'. A study by Sami Consulting/Experian (2008) for the CITB, which looked at the future of UK construction to 2020, used four scenarios (based on the UK foresight national 2020 scenarios): 'World Markets' (a world driven by wealth and aspirational values with limited government in a heavily globalised world), 'National Enterprise' (aspirations of personal independence and wealth but rooted within a national context), 'Global Responsibility' (aspirations of high levels of welfare with shared values and equal opportunities) and 'Local Stewardship' (aspirations of sustainable levels of welfare within federal and network communities).

Similarly, a Foresight Project on Intelligent Infrastructure Systems (IIS) included four scenarios (Curry *et al.*, 2006). The IIS project set out to examine the challenges and opportunities for the UK in bringing 'intelligence' to its infrastructure, that is, the physical networks that deliver such services as transport, telecommunications, water and energy. In particular, the project explored how, over the next 50 years (to 2055), science and technology can be applied to the design and implementation of intelligent infrastructure for robust, sustainable and safe transport, and its alternatives. The scenarios comprised 'Perpetual Motion' (a society driven by constant information, consumption and competition), 'Urban Colonies' (investment in technology focuses mainly on minimising environmental impacts), 'Tribal Trading' (a world that has been through a sharp and savage energy shock) and 'Good Intentions' (a world in which the need to reduce carbon emissions constrains personal mobility).

Scenarios therefore have tended to be used in some studies to analyse the possible effect of one particular driver or theme such as sustainability or climate change, and those that offer a more complex mix of factors to develop the scenario (Harty *et al.*, 2007). In contrast, the EPSRC Retrofit 2050 work used backcasting techniques. This is a way of defining a desirable future and then working back to the present to identify policies and practices that will enable the future to be a reality (Eames *et al.*, 2013a). In EPSRC Retrofit 2050[4] a set of three visions (or shared expectations of a desirable future)

---

4 See www.retrofit2050.org.uk.

was developed, based on retrofitting cities (Eames *et al.*, 2013a,b). This research scoped out three generic visions:

- *Vision I 'Smart-networked city'*: The city as a hub within a highly mobile and competitive globally networked society. Pervasive, information-rich virtual environments integrate seamlessly with the physical world. ICTs provide real-time information to drive efficiencies through automation and intelligent control, and advanced market-oriented solutions allow for the internalisation of environment costs. This is an open, outward-looking society in which the mobility of people, goods and services remains high.
- *Vision II 'Compact city'*: The city as a site of intensive and efficient urban living. Urban land use, buildings, services and infrastructure provision are optimised to create dense urban settlement forms that encourage reduced demand and more efficient use of energy and resources. Concentration in urban centres reduces pressures on the periphery. Significant efficiencies are obtained through systems integration and re-design.
- *Vision III 'Self-reliant green city'*: The city as a self-reliant bio-region, living in harmony with nature. A self-replenishing, largely self-reliant system of circular metabolism, where resources are local, demand is constrained, and the inputs and outputs of the city are connected (cradle to cradle). In many ways this is an inward-facing society, but one conscious of its global responsibility to 'live within its limits'.

In the Urban Futures programme of work scenarios were applied to city regeneration projects and an interactive tool developed for futures thinking to help urban designers analyse the resilience of their sustainability solutions[5] (Rogers *et al.*, 2012).

But what do the various futures studies tell us about the key drivers for change associated with the construction industry? These are many and various but Goodier (2013) suggests (based on previous research and existing knowledge) that the main forces for change which affect the construction industry are climate change, energy demand and supply, resilience (the ability to bounce back from extreme shocks), sustainability, and the take up of new technologies, materials and methods. Similarly, Harty *et al.* (2007) provided a helpful taxonomy of these 'issues and drivers' from previous studies, covering the period 1998–2005, and classified them as 'technological', 'environmental', 'human', 'economic', 'governance' and 'other' (Table 1.1).

More recently, the CITB (2015) study identified 10 drivers of long-term change in the construction industry (Table 1.2). These drivers also link quite closely with the five priority areas identified as being crucial to long-term success in the UK's Construction 2025 Vision (HM Government, 2015b):

- people: an industry that has a talented and diverse workforce
- smart: an industry that is efficient and technology advanced
- sustainable: an industry that leads in low carbon and green construction exports
- growth: an industry that drives economic growth
- leadership: an industry with strong leadership from the Construction Leadership Council.

5 See http://designingresilientcities.co.uk/.

Table 1.1 Key issues and drivers in UK futures studies in construction (1998–2005) (Harty *et al.*, 2007).

Group	Specific issues
Technological	Increased standardisation and offsite construction
	Increased use of common ICT and information-sharing platforms
	Increased automation and use of robotics
	Increased use of 3D technology (virtual reality, CAD)
	New/smart construction materials
Environmental	Increased importance of sustainability
	Climate change/global warming/extreme weather
	Resources/energy conservation
	Oil depletion/energy crisis
	Reduce waste and pollution/increased recycling
	Increased urbanisation
	Demographics changes
Human	Reduction of skilled trades/consolidation of professions
	Shift education and training requirements
	Improved health and safety, welfare and working conditions
	Flexible working
	Smaller households
	Changing healthcare needs and requirements
	Vulnerability and security
Economic	More profitable, efficient and competitive construction industry
	Increased foreign competition and globalisation
	Consolidation and de-fragmentation of construction industry
	Increased use of whole-life costing, PPP and PFI initiatives
	Increase gap between rich and poor
Governance	Changes in government policy
	Increased or alignment of legislation and regulation
Other	Wild cards
	Major shocks

ICT, information and communications technology; CAD, computer aided design; PPP, private and public partnership; PFI, private finance initiative.

The timelines of such studies also vary. Generally speaking, government and industry/professions-based studies have taken a view to 2020 or 2030. Occasionally 2050 has been the focus of study, for example the CIC (2014) study on Built Environment 2050 takes a long-term look to 2050 to examine construction's digital future. This work was partly driven by the BIM2050 group and focuses on education and skills, technology and process, and the culture of integration, and divided the timeline for digital futures into four waves corresponding to specific time horizons (Table 1.3). A longer-term perspective has also been seen in the work of academia in both the UK and Australia looking ahead to 2050 (see, for example, Dixon *et al.* (2014), McGrail and Gaziulusoy (2014) and Alford *et al.* (2014)).

Table 1.2 Drivers of long-term change in UK construction (CITB, 2015).

Driver	Comments
Economy	The construction industry is sensitive to the level of economic growth and is vulnerable to a cyclical economy. The rate of economic growth and its direction are key to demand within the different subsectors and will determine the demand for the number of trainees and the type of skill required.
Market sector conditions	The level of activity in each of the main market sectors of the industry – defined for this research as new housing, new building, infrastructure and repair and maintenance – will have a significant impact on training needs as each has its own requirements for skills.
Demography and migration	The population in Britain is growing and changing rapidly, causing demand for infrastructure, homes and public buildings. The population is becoming more diverse. Immigration has recently become important to the construction industry in supplying labour. Migration patterns could provide significant shocks to skills supply.
Sustainability	The issues of climate change and carbon mitigation and adaption are important as a source of work and employment. They will affect the legislation imposed on the industry and attitudes within it.
Technology and innovation	Changes in technology have the possibility of significantly changing the industry. They are primarily digital technology, notably BIM, and off-site construction processes
Relationship with government	Government is construction's largest customer and as a smart customer has the capability to help the industry develop and improve. A good relationship with government is necessary to ensure that regulation is supportive and appropriate.
Business model-direct employment	A significant change within the industry over the past decade has been the shift from direct employment to self-employment and sub-contracting. This has had an impact on training and implications for the relevance of government skills policy.
Business model supply chain	The British legal system and construction's adversarial contracts are considered to be a significant cause of the ills of the industry. Moves toward collaborative contracts have only been moderately successful. A change in the current model would stimulate change within the industry, improving innovation and margins, and demanding new skills.
External image	The external image of the industry is important in recruitment and in relationships with clients and government. The current image is poor, due to the lack of technology, poor quality, a poor health and safety record, and precarious employment terms.
Internal attitudes	While flexibility and problem solving abound in the industry, its resistance to change, macho image, confrontational attitudes up and down the supply chain, sexism and prejudice are recognised as being deterrents to efficiency, recruitment and diversity.

Some of these recent studies also link back to current UK government policy on construction. As far as UK government policy on construction is concerned, the Construction 2025 strategy should also be seen in the context of its links with the Business and Professional Services strategy, the Smart Cities strategy and the Information Economy strategy, all of which are brought together with the Digital Britain strategy

Table 1.3 Timelines for feedback wave cycles: digital future in construction (adapted from CIC (2014)).

Wave	Period	Characteristics
Wave 1: Analogue decisions	2010–2020	At key stages (Capex/Opex)
Wave 2: Digital decisions	2020–2030	Converging information Performance/operation
Wave 3: Predictive digital	2030–2040	Emerging information Social outcomes
Wave 4: Artificial intelligence	2040+	Adaptive and agile

(HM Government, 2015a). The Construction 2025 strategy (HM Government, 2015b) also summarises the work that the Government will undertake to achieve its overall ambitions, which are focused on (Rhodes, 2015; Hansford, 2014):

- a 33% reduction in both the initial cost of construction and the whole-life cost of assets (from 2010/09 levels)
- a 50% reduction in the overall time from inception to completion for new-build and refurbished assets (based on industry standards in 2013)
- a 50% reduction in greenhouse gas emissions in the built environment (compared to 1990)
- a 50% reduction in the trade gap between total exports and total imports for construction products and materials (from February 2013 deficit of £6 billion).

The recent *Government Construction Strategy 2016–20* report (Infrastructure Projects Authority, 2016) also focuses on more immediate, shorter-term steps, including improving government capability in construction 'clientship', the industry-wide adoption of BIM and the development of appropriate workforce capacity and skills.

1.3.2 A critique of future studies in construction

A major weakness of many of these futures studies is that they tend to extrapolate current trends rather than reimagine a radically transformed future (Harty *et al.*, 2007). Often the terms that are used are also not unpacked or defined, for example the many differing interpretations of 'sustainability' can impact and be perceived differently by different stakeholders in the built environment. Sustainability will also mean different things to different people in national contexts: what is sustainable in a developed world city (e.g. smart metering) may have no place in a developing world city struggling to provide basic utilities.

Moreover, the studies we have examined also often assume internal drivers and external drivers do not interact together, rather they operate independently. So, for example, demographic changes are assumed to configure and drive change in the sector without an examination of how this impacts and interacts on the organisation of the sector or the long-term skills requirements for the sector (Harty *et al.*, 2007). Moreover, these internal and external drivers can be seen as effects and causes of change, for example technology can be a driver pushing construction professionals towards greater reliance on ICT for design construction and management but also utilised as a response to cost reduction or the need to compete in a global market. Therefore, it is the interconnectivities and interrelationships between drivers that are important to understand, but they are often overlooked in construction futures studies.

Chan and Cooper (2011) also point to a great deal of convergence within futures studies in construction as they have tended to examine changes faced by society across social, economic, political and environmental dimensions during a particular time period of change (i.e. the last 20 years or so). However, as the nature of the main participant stakeholders changes over time, and as power relations shift, there may be a possible divergence of views which is important to capture. What might be true for one generation may not be true for the next. Furthermore, as was seen in the previous section, construction futures studies tend to take a short/medium term view of the future, looking 10–20 years ahead, at most. The advantage of a longer time frame to 2050 is that this opens up a 'possibility space', or freedom to think outside current constraints, and can help overcome the disconnection that exists between short-term planning horizons and longer-term environmental change (Eames *et al.*, 2013a,b).

There is also a tendency to see futures studies in construction as produced by 'committee' and so lacking a personalised view of the world (Chan *et al.*, 2005; Chan and Cooper, 2011). As Chan and Cooper (2011: 21) state:

> 'It is our suspicion that foresight reports are just simply crystal-balls for future gazing; it is probably difficult, and indeed a futile exercise, to figure out what real action exactly derives from which report. If foresight studies were to realise their intentions of engendering change in industry and society, there is a pressing need to personalise "futures thinking".'

Ultimately, we must also think about the context of futures studies, and what they mean for the construction industry (Harty *et al.*, 2007). First, defining what we mean by 'construction' is important, and who comprises the target audiences of the futures studies. Second, the futures set out in such studies have different implications for different stakeholders. A future based on a highly regulated and standardised sector, with a strong focus on environmentally sound buildings, not only needs to consider the important potential social impacts caused by employment shifts, but also the resultant aesthetics and design of such buildings. Finally, what will be the potential differential impact of particular scenarios on small firms and larger firms? Who will be the winners and who will be losers? We should not shy away from answering these sorts of questions.

Despite these criticisms, futures studies can help us develop a clearer understanding of the complexities of change in an uncertain world. Futures studies help us challenge our existing assumptions and explore ways in which the future might be different from the present. This implies that by understanding the future better, we can make 'better' decisions now, either by avoiding ones that are not future proof or at least bringing about better or improved futures (Coyle, 1997). This book is therefore an attempt to bring together thinking from leading academics and practitioners within a foresight framework to understand future changes in construction and development. Learning from the shortcomings of previous futures studies in construction, we take a long-term perspective to 2050 and adopt a multidisciplinary approach in exploring a range of related interdependent, and cross-cutting, themes.

1.4 Conceptual framework for the book

The starting point for our book is the built environment in 2050, focusing on a sustainable future. The date is important, not only because it is a mid-century point, but also because it represents a key date in the UK's national strategy to address greenhouse gas emissions, namely that by 2050, under the Climate Change Act (2011), there is a primary target to reduce national greenhouse gas emissions by 80% from their 1990 baseline levels. It also represents a longer-term view of construction and development than has been the case in the majority of futures studies.

This book is also founded on a foresight approach to thinking about the future. In this sense, we adopt the Miles and Keenan (2002:15) view of foresight as describing:

> '…a range of approaches to improving decision making…Foresight involves bringing together key agents of change and sources of knowledge in order to develop strategic visions and anticipatory intelligence. Of equal importance, foresight is often explicitly intended to establish networks of knowledgeable agents.'

Foresight techniques also include 'horizon-scanning', which aims to gather a wide range of evidence and information about upcoming trends, ideas and events (Habegger, 2009). This also underpins the rationale for compiling the chapters in this book, which are written by experts in each field and address developments that inform each particular subject area (cf. Dixon *et al.*, 2014). The chapters in this book were therefore commissioned on the basis of highlighting, where appropriate, for each topic:

- data and trends (including historical data and UK and international case studies)
- policies or government legislation/programmes related to the field
- the current state of understanding
- key challenges
- key advances (including disruptive and systemic technological innovations)
- change issues and critical uncertainties
- future visions and scenarios.

However, it should be noted that in some chapters a more discursive, critical approach is adopted to offer an academic counterpoint and critique of current thinking (see, for example, Chapters 15 and 16). Also, to build on this and to offer a 'practice-based' perspective, we have commissioned two chapters in Part 3 of the book which are practitioners' viewpoints, 'provocations about the future'. These are less formal in their approach to foresight and are designed to provide a provocative counterpoint to the more formal foresight chapters in the rest of the book.

In methodological terms, the authors were identified because they had substantive knowledge in the field and because of their ability to think in terms of the future (cf. Loveridge, 2009). The overall aim of the book therefore, within an integrated programme of foresight thinking to 2050, is to bring together leading thinking on:

- issues of new professional practice
- the future of a sustainable built environment.

The book focuses on both construction and development issues as key elements in the built environment. The majority of the chapters have a 'construction' focus but importantly some chapters also have a 'development' focus, for example around sustainable real estate, sustainable communities and planning.

In summary, the book focuses on how we can transition to a sustainable future by 2050, bringing together leading research and practice. The book examines how emerging socio-economic, technological and environmental trends will influence the built environment of the future, covering both the built environment (across the scales of buildings, communities and cities) and how professional practice will need to adapt to these trends. This broader context is underpinned by an analysis of emergent technologies, business models and shifting requirements for expert advice from clients within the relevant chapters.

1.5 Overview of book

The book is structured into four main parts as follows.

Part 1: Sustainability and the Built Environment

In the first part of the book, the chapters cover the interface between sustainability and the built environment.

In Chapter 2 Barlow, Li Shao and Smith examine the complexities of the relationship between climate change, resilience and the built environment. This chapter considers the current use of dynamic thermal simulation software, its fitness for purpose in predicting future building performance, and new approaches arising from the application of climate science.

In Chapter 3 van De Wetering examines sustainable buildings and looks at some of the important key trends and drivers and barriers influencing the take-up of sustainability, particularly in relation to commercial property markets.

In Chapter 4 Woodcraft and Baldwin examine sustainable communities. In the UK there is growing interest in measuring the social outcomes of regeneration and urban development from property developers and local government, and this chapter offers a critical perspective on how the 'sustainable community' is defined, operationalised and measured in planning policy and urban development.

Dixon looks at the emergence of smart and sustainable cities in Chapter 5. This chapter reviews the growth of the 'future cities' agenda in the UK and internationally, and examines the implications for the construction and development professions. The chapter also looks at how cities may evolve in the future if they are to be smart and sustainable, and what the challenges and opportunities will be looking ahead to 2050.

Tran *et al.* examine sustainable infrastructure in Chapter 6. As they point out, infrastructure systems (energy, transport, water and digital communications) are vital for modern economic activity, but are also major sources of carbon emissions and environmental impacts. The chapter reviews the state-of-the-art on infrastructure modelling and assessment for futures studies, and provides key insights for policy makers and practitioners for the analysis of sustainable infrastructure futures.

In Chapter 7 Farrelly examines sustainable design. In this chapter Farrelly offers examples of an approach to design which encourages new and reactive solutions to designing for the built environment of the future, and how design relates to its surrounding community. The chapter also touches on the nature of 'defuturing' in design.

Part 2: Changing Professional Practice

This part of the book examines the way in which professional practice in the built environment, in its widest sense, is changing as technology, new business models and interpretations of sustainability evolve now and into the future.

In Chapter 8 Parker and Doak review the concept of sustainable planning, exploring its roots in planning policy and practice, its emergence as an overarching discourse and its possible trajectories into the future. The chapter provides a critique of the concept of sustainability as deployed in planning theory and practice, drawing out its definitional flexibility, contested nature and core principles.

Green examines sustainable construction in Chapter 9 and offers a critical review of key concepts in the context of contested knowledge and the decline of professionalism. In this chapter, Green reviews definitions of 'sustainable construction', 'sustainability' and the notion of 'systems thinking' in a critical vein. The chapter shows how sustainability is ultimately about making difficult trade-offs. It further recognises that making meaningful progress despite transient and conflicting objectives is an inevitable part of the work of a professional.

Connaughton and Hughes look at sustainable procurement in Chapter 10. This chapter examines the role of procurement in sustainable construction and development in terms of both buyer and supplier responsibility and governance, and in the context of recently published standards and guidance. It focuses in particular on the construction supply chain and the challenges to more sustainable procurement raised by the contemporary practice of competitive buying/contracting through multiple tiers of suppliers. The chapter envisions a future for sustainable construction by 2050 in which procurement focuses more on understanding and meeting client requirements through innovation rather than through the provision of low-cost labour and materials.

Thompson examines the changing role of social media in construction and real estate in Chapter 11. As the chapter points out, if Facebook were a country, at the start of 2015 it would be the same size as China. This indicates that social media is no longer a fringe activity for any company in any sector, but few companies have an understanding of exactly how social media interacts with consumers to expand product and brand recognition, drive sales and profitability, and engender loyalty. This chapter therefore catalogues the contribution that the different threads of social media can make to a sustainable built environment now and in the future.

Part 3: Provocations about the Future: Practitioners' Viewpoints

In this part of the book practitioners set out their personal viewpoints on changing professional practice.

In Chapter 12 Ford and Gillich look at sustainable and collaborative working. The built environment established players are realising that the effective separation that has for so long served their needs may be at a tipping point. Up until now construction has delivered profit through a simple project focus, but new types of professional are required who are able to work across industries and established professions, translating and working together with a concentration on the customers' long-term experience. This chapter examines how collaboration is playing out in the design and construction professions, and the role of academia in facilitating sustainable change.

In Chapter 13 Healey examines the built environment professions and their relationship with the sustainability agenda. The chapter summarises why traditional economic, moralistic and information-based approaches can be inadequate to engage clients. The chapter draws upon literature from behavioural economics, judgement and decision making, green buildings and sustainability communication, as well as the author's experiences as an engineer and sustainable building practitioner to propose a broader range of communication tools for pitching sustainability initiatives to decision makers.

Part 4: Transformative Technologies and Innovation

Coker and Torriti examine energy and the built environment in Chapter 14. They suggest that the ways that we access, transport and use energy are changing dramatically in the face of technological advancement and the policy imperatives of affordability, security and decarbonisation, and that variable renewable energy sources will provide a significant share of cities' energy needs by 2050. Together, these trends bring many challenges for built environment professionals, who must be able to navigate this complexity.

Larsen looks at sustainable innovation in construction and development in Chapter 15. This chapter takes the stance that transitioning to a sustainable built environment by 2050 will require innovation and change within current materials, digital technologies, processes and working practices in the construction sector. Central to the chapter is the notion that firms are rarely innovative in isolation and that for the uptake of an innovation to be sustained, networks of stakeholders must work together, either knowingly or unknowingly. It is then essential to gain a greater understanding of how all associated stakeholders operate in a market network and the potential impact these have on the uptake of innovations.

In Chapter 16 Ewart looks at the importance of humanising digital practices in construction. The chapter first explores the process of social incorporation of new technologies, how they transfer from one community to another and the opportunities for innovation this presents. Second, the chapter focuses on the vast proliferation of data generated by digital technologies and the need to reframe this at a human scale to make it meaningful. In both cases Ewart suggests that the AEC sector can make a significant and optimistic contribution to our digital future.

Part 5: Conclusions and Common Themes

Finally, in Chapter 17 we draw together the main themes and findings of the book, and anchor these against an appraisal of foresight techniques and views on the future. The chapter covers three main themes:

- *Understanding the future*: explores the nature of technology disruption and convergence, and the interaction with 'megatrends' to 2050, with a particular focus on their impact on construction and development.
- *What lies ahead for the built environment?*: explores the emergent lessons from the chapters in this book.
- *Shaping the future: techniques, practice and policy*: examines the importance of futures-based techniques and 'black swans', and discusses the policy and practice implications of foresight in helping to shape the built environment of the future.

References

Alford, K., Cork, S., Finnigan, J., Grigg, N., Fulton, B. and Raupauch, M. (2014) The Challenges of Living Scenarios for Australia in 2050. *Journal of Futures Studies*, March, 18(3), 115–126.

Arup (2013) *It's Alive: Can you imagine the urban building of the future?* Arup, London.

Arup (2014) *Cities Alive: Rethinking Green Infrastructure*. Arup, London.

Arup (2015) *Green Construction Board Low Carbon Routemap for the Built Environment: 2015 Routemap Progress – Technical Report*. Arup, London.

Bok, B., Hayward, P., Roos, G. and Voros, J. (2012) *Construction 2030: A Roadmap of R&D Priorities for Australia's Built Environment*. Sustainable Built Environment National Research Centre, Brisbane. Available at: http://www.sbenrc.com.au/wp-content/uploads/2013/11/construction_2030_fullreport_4dec12.pdf (accessed March 2016).

Brundtland Commission (1987) *Our Common Future: Report of the 1987 World Commission on Environment and Development*. Oxford University Press, Oxford.

BIS (2010) *Estimating the Amount of CO_2 Emissions that the Construction Industry Can Influence: Supporting Material for the Low Carbon Construction IGT report*. Department for Business Innovation and Skills, London.

BIS (2013) *UK Construction: An Economic Analysis of the Sector*. Department for Business Innovation and Skills, London.

CABE/RIBA (2003) *The Professionals' Choice: The Future of the Built Environment Professions*. Commission for Architecture and the Built Environment/Royal Institute of British Architects, London.

Chan, P., Abbott, C., Cooper, R. and Aouad, G. (2005) 'Building future scenarios: a reflection for the research agenda', in Khosrowshahi, F (ed.), *21st Annual ARCOM Conference, 7–9 September, SOAS, University of London*. Association of Researchers in Construction Management, Vol. 2, pp. 709–19. SOAS, London.

Chan, P., and Cooper, R. (2011) *Constructing Futures: Industry Leaders and Futures Thinking in Construction*. Wiley-Blackwell, Oxford.

CIC (2014) *Built Environment 2050: A Report on Our Digital Future*. Construction Industry Council, London.

CITB (2015) *Construction 2030 and Beyond: The Future of Jobs and Skills in the UK Construction Sector*. Construction Industry Training Board, London.

Conway, M. (2014) *Foresight: An Introduction – A Thinking Futures Reference Guide*. Thinking Futures: Melbourne. Available at: http://thinkingfutures.net/wp-content/uploads/TFRefGuideForesight1.pdf (accessed March 2016).

Cook, D. (2015) RICS futures: turning disruption from technology to opportunity. *Journal of Property Investment & Finance*, 33 (5), 456–464.

Coyle, G. (1997) The nature and value of futures studies or do futures have a future?. *Futures*, 29 (1), 77–93.

Curry, A., Hodgson, T., Kelnar, R. and Wilson, A. (2006) *Intelligent Infrastructure Futures: The Scenarios – Towards 2055*. DTI, London.

DEFRA (2005) *Sustainable Development Strategy*. Department for Environment, Food and Rural Affairs, London.

DTI (2002) *Foresight Futures 2020 Revised Scenarios and Guidance*. Foresight/Department of Trade and Industry, London.

Dixon, T., Barlow, J., Grimmond, S. and Blower, J. (2015) *Smart and sustainable: Using Big Data to Improve Peoples' Lives in Cities*. Discussion Paper. University of Reading, Reading. ISSN 2058-975.

Dixon, T., Eames, M., Lannon, S. and Hunt, M. (eds) (2014) *Urban Retrofitting for Sustainability: Mapping the Transition to 2050*. Routledge, London.

Dodge Data and Analytics (2016) *World Green Building Trends*. Dodge Data and Analytics, Bedford, MA.

Eames, M., Dixon, T., May, T. and Hunt, M. (2013a) City futures: exploring urban retrofit and sustainable transitions. *Building Research and Information*, 41 (5), 504–516. ISSN 1466-4321.

Eames, M., Hunt, M., Dixon, T. and Britnell, J. (2013b) *Retrofit city futures: visions for urban sustainability*. Report. University of Cardiff, Cardiff.

Egan, J. (1998) *Rethinking Construction: Report of the Construction Taskforce*. Department of the Environment, Transport and the Regions, London.

Elkington, J. (1997) *Cannibals with Forks: the Triple Bottom Line of 21st Century Business*. Capstone, London.

Ellen Macarthur Foundation (2016) *Intelligent Assets*. Ellen Macarthur Foundation.

Ernst and Young (2015) *Megatrends 2015: Making Sense of a World in Motion*. Ernst and Young, London.

Fairclough, J. (2002) *A Review of Government Policies and Practices*. Department of Trade and Industry, London.

Farrell, T. (2014) *The Farrell Review of Architecture and the Built Environment*. Farrells, London. Available at: http://www.farrellreview.co.uk/.

Fernandez-Guell, J. and Gonzalez Lopez, J. (2014) Cities Futures: A Critical Assessment of How Future Studies are Applied to Cities, *5th International Conference on Future Oriented Technology Analysis (TFA – Engage Today to Shape Tomorrow)*, Brussels, 27–28 November.

Fernie, S., Leiringer, R. and Thorpe, T. (2006) Change in construction: a critical perspective. *Building Research and Information*, 34(2), 91–103.

GCP Global/Oxford Economics (2015) *Global Construction 2030: A Global Forecast for the Construction Industry to 2030*. GCP Global/Oxford Economics, London.

Godet, M. and Roubelat, F. (1996) Creating the future: The use and misuse of scenarios. *Long Range Planning*, 29(2), 164–171.

Goodier, C.I. (2013) The future(s) of construction: a sustainable built environment for now and the future, in Soutsos, M., Goodier, C., Le, T.T. and Van Nguyen, T. (eds) *The International Conference on Sustainable Built Environment for Now and the Future*, Hanoi, Vietnam, 26–27 March 2013, pp. 27–36.

Goodier, C.I., Soetanto, A., Austin, S. and Price, A. (2007) A competitive future for UK construction? *Construction Information Quarterly*, 9(4), 169–174.

Green, S.D. (2011) *Making Sense of Construction Improvement*. Wiley-Blackwell, Oxford.

Green Construction Board (2016) *Low Carbon Routemap for the Built Environment*. Green Construction Board, London. Available at: http://www.greenconstructionboard.org/index.php/resources/routemap (accessed March 2016).

Habegger, B. (2009) *Horizon Scanning in Government: Concept, Country Experiences and Models for Switzerland*. Center for Security Studies, Zurich.

Handy S.L., Boarnet M.G., Ewing R. and Killingsworth, R.E. (2002) How the built environment affects physical activity: views from urban planning. *American Journal of Preventive Medicine*, 23, 64–73.
Hansford, P. (2014) How Britain's construction industry will be transformed by 2025 – and the reasons why, *Civil Engineering*, 167(Feb), 9.
Harty, C., Goodier, C., Soetanto, R., Austin, S., Dainty, A. and Price, A.D.F. (2007) The futures of construction: A critical review of construction future studies. *Construction Management and Economics*, 25(5), 477–493.
Harvard, T. (2008) *Contemporary Property Development*. RIBA, London.
Health Canada (2002) *Natural and Built Environments*. Division of Childhood and Adolescence, Health Canada, Ottawa.
HM Government (1999) *A Better Quality of Life*. HM Government, London.
HM Government (2015a) *Digital Built Britain: Level 3 Building Information Modelling – Strategic Plan*. HM Government, London.
HM Government (2015b) *Construction 2025*. HM Government, London.
Infrastructure Projects Authority (2016) *Government Construction Strategy 2016–20*, March 2016. Infrastructure Projects Authority (Crown Copyright), London.
Jennings, M., Hirst, N. and Gambhir, A. (2011) *Reduction of Carbon Dioxide Emissions in the Global Building Sector to 2050 – Grantham Institute for Climate Change Report GR3*. Grantham Institute, London.
Jermey, D. (2015) Global markets: constructing a sustainable future worldwide, in *Building Better: Recommendations for a More Sustainable UK Construction Sector*. Westminster Sustainable Business Forum, London.
Kubeczko, K., Ravetz, J., van der Giessen, A. and Weber, M. (2011) *Screening Urban Foresights and Studies Supporting Forward Activities: What can we learn for a JPI-Urban Europe 2050+ Foresight*. European Foresight Platform, Brussels.
Latham, M. (1994) *Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry*. HMSO, London.
Loveridge, D. (2009) *Foresight: The Art and Science of Anticipating the Future*. Routledge, London.
McGrail, S. and Gaziulusoy, A.I. (2014) *Using futures inquiry to create low-carbon, resilient urban futures: a review of practice, theory and process options for the Visions and Pathways project*. Working paper for the Visions and Pathways project, March 2014. V & P 2040, Melbourne. Available at: http://www.visionsandpathways.com/wp-content/uploads/2014/06/McGrail_Gaziulusoy_Futures_RB.pdf (accessed March 2016).
Miles, I. and Keenan, M. (2002) *Practical Guide to Regional Foresight in the United Kingdom*. European Commission.
Morrell, P. (2015) *Collaboration for Change: The Edge Commission Report on the Future of Professionalism*. Ove Arup/The Edge, London.
ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007) Structure and explanatory notes*. Office for National Statistics, London.
Pearce, D. (2003) *The Social and Economic Value of Construction: The Construction Industry's Contribution to Sustainable Development. nCRISP*, London.
Poincare, H. (1913) *The Foundations of Science: Science and Hypothesis, The Value of Science, Science and Method (English translation)*. Science Press, London.
Rhodes, C. (2015) *Construction Industry: Statistics and Policy Briefing Paper Number 01432, 6 October*. House of Commons Library, London.

Rogers, C., Leach, J., Lombardi, D. and Cooper, R. (2012) The urban futures methodology applied to urban regeneration. *Proceedings of the Institution of Civil Engineers Engineering Sustainability,* 165(ES1), 5–20.

RICS (2015a) *Competency Framework and Real Estate Lifecycle*. Royal Institution of Chartered Surveyors, London.

RICS (2015b) *RICS Futures: Our Changing World – Let's Be Ready*. Royal Institution of Chartered Surveyors, London.

Sami Consulting/Experian (2008) *2020 Vision: The Future of Construction*. SAMI/Experian, St Andrews. Available at: http://www.cskills.org/uploads/2020VisionScenariosforconstructionskills_tcm17-11077.pdf (accessed March 2016).

Smart Cities Council (2015) *Smart Cities Readiness Guide*. Smart Cities Council, Redmon, WA.

Srinivasan, S., O'Fallon, L. and Deary, A. (2003) Creating healthy communities, healthy homes, healthy people: initiating a research agenda on the built environment and public health. *American Journal of Public Health*, 93(9), 1446–1450.

UN (2015) *World Urbanization Prospects: the 2014 Revision*. United Nations, New York.

Voros, J. (2003) A generic foresight process framework. *Foresight*, 5(1), 10–21.

Wilkinson, S. and Reed, R. (2008) *Property Development*. Routledge, London.

Wolstenholme, A. (2009) *Never Waste a Good Crisis: A Review of Progress since Rethinking Construction and Thoughts for Our Future*. Constructing Excellence, London.

WBCSD (2008) *Energy Efficiency in Buildings*. World Business Council for Sustainable Development, Geneva.