HELEN LINGARD | RON WAKEFIELD

INTEGRATING WORK HEALTH AND SAFETY INTO CONSTRUCTION PROJECT MANAGEMENT

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Preface

This book presents a synthesis of more than a decade of research conducted by a small, multidisciplinary team of researchers at RMIT University in Melbourne, Australia. The idea for the book grew from our reflections about lessons learned from the research and, in particular, the way our own thoughts about work health and safety (WHS) in the construction industry have developed and changed over time.

From the outset, our collaborative research activity was driven by a shared belief that something different needed to be done to prevent the relatively high incidence of work-related death, injury, and illness experienced by construction workers. Together with Professor Nick Blismas (a significant contributor to several chapters in this book), Helen Lingard and Ron Wakefield initiated a programme of research to better understand and directly address the barriers to improving WHS in the construction industry. Our earliest work, undertaken at the Tullamarine-Calder Interchange Alliance, was strongly supported by Pat Cashin, General Manager of Baulderstone Pty Ltd. This work grew into a multipronged programme, involving many different partner organizations and guided by an active Industry Advisory Group chaired by former National President of Engineers Australia, Peter Godfrey.

The backdrop to the programme of research presented in this book was a growing international focus on the role to be played by clients and designers in identifying and addressing WHS risks in their decision making. Prompted by the recognition that some WHS risks experienced by construction workers could be traced back to planning and design choices, the RMIT research team was engaged by the Cooperative Research Centre for Construction Innovation to develop a voluntary Guide to Best Practice for Safer Construction. The Guide was commissioned by Engineers Australia and its development was led by an industry task force consisting of peak bodies representing contractors, design consultants, and public and private sector construction clients. The Guide established a set of principles to drive collaboration and sharing of WHS responsibility between clients, designers, and constructors, and also suggested WHS management practices for each stage in the project lifecycle, from planning and design through to construction and completion.

However, the Guide did not reflect the social and technical complexity of construction projects. It treated WHS as something that could be managed through a mechanistic process of risk identification, assessment, and control within each project stage. The

Guide established simplistic roles and responsibilities for clients, designers, and constructors without acknowledging the heterogeneous nature of client organizations, or the complex web of designers and constructors involved in project delivery. Neither did the Guide adequately reflect the fact that construction project participants' actions and decisions are shaped by broader forces in regulatory, economic, and policy contexts.

Our understanding of the factors at play in shaping client behaviour and safety in design effectiveness became more nuanced as we considered the impact of organizational complexity, procurement policy, supply network fragmentation, and the segregation of product and process design. Our work also expanded into new areas. We investigated how aspects of an organizational culture impact WHS, and we considered how workers' health and wellbeing are shaped by the work practices and the quality of work in the construction industry.

In 2009, Helen was awarded an Australian Research Council Future Fellowship to undertake a four-year programme of work investigating the importance of integration to protecting construction workers' WHS. The Future Fellowship programme of work, titled 'Differentiation not disintegration: Integrating strategies to improve occupational health and safety in the construction industry' (ID number FT0990337), has provided a strong backbone for this book.

While each chapter of this book can be read as a standalone presentation of our work on a particular topic, we encourage readers to explore and reflect on the points of connection between the information contained in different chapters. For example, the issue of workers' health and wellbeing cannot be properly understood without considering the timelines established for delivering projects and the implications of tight project schedules for hours of work, the quality of work–family interactions, and wellness in the workforce.

In writing this book our overarching aim was to explore many topics in construction WHS through the theme of integration. We suggest WHS needs to be an integral part of managing construction organizations and projects, such that it constitutes a serious consideration in everything that is done.

We do not favour glib statements that WHS should be an organization's 'number one priority'. Indeed, such statements are cynically received when workers are fully aware that managers are rewarded for performance on multiple competing priorities. However, WHS does need to be firmly embedded in decisions made about all aspects of business and project management. WHS should not be treated as an afterthought, to be considered once important decisions have already been made. Unfortunately, managerial decisions with the potential to impact WHS are sometimes post-rationalized, with the result that the most effective forms of risk control are not realized.

It is also vital that we remain alert to the main aim of managing WHS, which is to protect the health and safety of workers. In this book we sought to provide insights gleaned from our research to suggest ways to more effectively integrate WHS into management decision making for the purpose of making workplaces and systems of work safer and healthier.

The book represents a team effort. Our colleagues have played a key role in working on specific topics or research projects. These team members have significantly contributed to the development of our thinking and, in this book, they are acknowledged as co-authors of chapters about topics they have worked on. We extend warm and very

grateful thanks to these colleagues, whose ideas, passion, and hard work have greatly enriched the collective research programme.

We also gratefully acknowledge the important groundwork provided by researchers whose formative contributions helped shape the research presented in the book, in particular, Tracy-Lee Cooke and David Jellie.

Last, but certainly not least, we acknowledge the support of organizations and agencies that have funded components of the research, including (in alphabetical order):

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Helen Lingard and
Ron Wakefield

1

The State of Work Health and Safety in Construction

1.1 The Construction Safety Problem

Most reports or articles about work health and safety (WHS) in construction begin with a statement about the industry's poor safety statistics. Irrespective of the part of the world in which a particular study has been conducted, it is common for authors to describe:

- high rates of injury and fatality in construction, relative to other industries, and
- disproportionate numbers of work-related injuries or deaths compared to the size of the construction workforce.

The construction WHS problem is a global one. Indeed, the International Labour Organization (ILO) estimates at least 60 000 fatal accidents occur in construction each year, representing one fatal accident every 10 minutes. The ILO estimates the construction sector typically employs between 6% and 10% of the workforce, but accounts for between 25% and 40% of work-related deaths.

The Center for the Protection of Workers' Rights Construction Chart Book (2013) provides information about the leading causes of work-related fatalities and non-fatal work injuries resulting in days away from work (DAFW) in the construction industry in the USA. Between 1992 and 2010, the highest ranked causes of fatalities in construction were:

- falls to a lower level (6678 deaths);
- highway incidents (2707 deaths);
- contact with electric current (2443 deaths); and
- being struck by an object (2054 deaths).

In contrast, there were 74 950 reported non-fatal injuries resulting in DAFW in the USA construction industry in 2010. Leading causes were:

- bodily reaction/exertion (33.6%);
- contact with objects (33.0%); and
- falls (24.2%).

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Helen Lingard and Ron Wakefield.

In Australia, an industry profile compiled in 2018 found the most common types of incidents resulting in serious claims for workers' compensation between 2012–2013 and 2015–2016 were:

- muscular stress while lifting, carrying, or putting down objects (16%);
- muscular stress while handling objects (14%);
- falls on the same level (13%);
- falls from height (11%);
- being hit by a moving, or flying object (8%);
- hitting moving objects (6%); and
- other mechanisms (32%) (Safe Work Australia 2018).

Of the construction fatalities that occurred in Australia between 2013 and 2016, the majority involved:

- falls from height (30%);
- being hit by falling objects (15%);
- vehicle incidents (15%);
- being hit by moving objects (11%);
- contact with electricity (10%);
- being trapped between stationary and moving objects (9%); and
- other mechanisms (11%) (Safe Work Australia 2018).

The largest number of fatalities involved construction and mining labourers (22% or 27% fatalities over the four-year period). Other occupations involved in fatalities were electricians (11% or 14% fatalities), bricklayers, carpenters, and joiners (8% or 10% fatalities), and mobile plant operators (8% or 10% fatalities) (Safe Work Australia 2018).

In the UK, there were 196 fatal injuries to workers in the construction sector between 2012–2013 and 2016–2017. Of these:

- 97 involved a fall from height;
- 19 involved someone being trapped by something collapsing or overturning;
- 19 involved someone being struck by a moving vehicle;
- 16 involved someone being struck by a moving, including flying, object;
- 14 involved contact with electricity or an electrical discharge; and
- 9 involved contact with moving machinery (Health and Safety Executive 2018a).

Non-fatal injuries to construction workers in the UK in 2016–2017 that resulted in more than seven days off work involved:

- lifting/handling (29%);
- slips, trips, or falls on the same level (21%);
- falls from height (10%);
- struck by moving, including flying, object (12%);
- contact with moving machinery (6%); and
- struck by moving vehicle (1%) (Health and Safety Executive 2018a).

The evidence suggests safety performance of construction industries in developing countries is considerably poorer than in developed countries. This may be because institutional and governance frameworks regulating industrial activities are relatively weak and have little impact (Kheni et al. 2008) and because the construction industry in developing countries relies on an unskilled, mobile workforce, often drawn from agricultural backgrounds (Priyadarshani et al. 2013). The economic environment in many developing countries also creates challenges for WHS as construction businesses operate in a competitive, relatively unregulated, environment. Delayed payments, and the failure of contractor assistance programmes, dramatically reduce resources available for investment in improving workers' health and safety (Kheni et al. 2010).

In the USA, Australia, and the UK, recent decades have seen a steady downward trend in rates of non-fatal injury in the construction industry. In contrast, projections for developing countries are for an increase in work-related injuries and deaths as work becomes more industrialized (Kheni et al. 2008). In the UK, Australia, and the USA the numbers of work-related fatalities in construction have also declined, although the rate of fatalities remains high relative to other industries. In the UK, the fatality rate of 1.62 per 100 000 workers per year is more than 3.5 times the average rate across all industries (0.46 per 100 000 workers) (Health and Safety Executive 2017). The Center for the Protection of Workers' Rights observes that reductions in fatalities have not occurred uniformly across all incident types. Thus, in the USA, fatalities due to contact with electric current decreased nearly 45% between 1995 and 2010, while the number of fatalities from falls to a lower level was similar at the two time points. Also, the total number of deaths due to highway incidents became the second leading cause of fatalities in construction over the period 1995–2010. Although deaths in some areas have reduced, in others they have remained fairly constant (CPWR 2013).

A detailed comparative analysis of international safety statistics is beyond the scope of this introductory chapter. However, the quick overview of statistics from the USA, Australia, and the UK reveals some important insights for preventing work-related injury and fatalities.

First, the ways in which construction workers are injured and killed (at least in industrialized countries) are remarkably similar and have changed little over recent years. The same injury mechanisms and incident classifications are prevalent, meaning construction workers are still being killed and injured in ways that are well-known and documented in national and international statistical reports.

Second, although work-related injuries have decreased in many countries, on average the construction industry's fatality rate remains relatively high, and some types of incident have been resistant to change.

Third, the type of incident that results in a non-fatal injury (albeit one that involves a workers' compensation claim) is generally quite different from the type of incident in which someone is killed.

The implications of these three observations will be considered briefly in turn.

The similarity between injuries and incident types, over time and across the globe, indicate that the kinds of activities and incidents that result in people being injured or killed are known and understood. Further, there is not a great deal of variation between these activities and incidents among construction industries (at least in industrialized countries). Fatal incidents are largely attributed to falls from height, contact with electricity, and being trapped or struck by a moving object. Body exertion, lifting/handling, falling, and being struck by an object were leading incident types resulting in non-fatal injury. The consistency with which these types of incidents/injuries impact on construction workers indicates that strategies targeting these specific areas could significantly reduce the burden of injury or death in the construction industry.

Data from the USA suggest some types of fatal incidents have been reduced through targeted collective industry efforts. Most notably, the number of fatal incidents involving workers coming into contact with electricity reduced in recent years. However, in other areas, including falls and highway incidents, fatalities have not reduced to the same extent. The persistence of certain types of fatal incident suggests greater efforts need to be targeted to reducing work-related deaths in these high-risk, high-consequence areas.

Finally, differences in the types of incident that produce low- versus high-consequence outcomes can have implications for where resources and effort are focused.

Some writers on WHS have suggested a false sense of invulnerability in high-risk organizational environments has resulted from the emphasis on lost time injury frequency rates, and consequent effort focused on preventing occupational injuries seen as being high in frequency but of low consequence. To evidence this argument, it is pointed out that serious incidents resulting in multiple fatalities, as well as extensive environmental damage and service disruption, have occurred in organizations believed to have good safety records, based on the measurement of occupational injury frequency rates. Two often-cited examples are an explosion at the Longford gas facility in Australia (Hopkins 2000), and the blow out, subsequent explosion, and uncontrollable fire at the Macondo (Deepwater Horizon) well in the Gulf of Mexico (Dekker 2014).

It is argued that effective control of occupational injury frequency rates at these sites – Dekker describes how the managers of the Deepwater Horizon well had prohibited carrying coffee in a cup without a lid – masked an underlying, gradual, and incremental drift towards failure danger as the production systems at Longford and Macondo edged closer to the edge of their safety 'envelope'. The argument has also been made that indicators of occupational safety performance are not good measures of how effectively process safety risks are being controlled (see, for example, Baker 2007). The point is often made by people studying high-risk production processes, such as those found in the oil and gas or nuclear energy industries, that unlike the majority of occupational safety risks, process safety risks have the potential to cause harm to workers and the general public on a very large scale. While these arguments have some validity, taking this thinking to its logical conclusion in an industry such as construction may not be helpful. Many work-related injuries and illnesses experienced by construction workers are very high in frequency, yet have non-fatal consequences (for example musculoskeletal disorders). These injuries and illnesses cause significant pain, disability, and hardship for workers. They need to be the focus of concerted prevention efforts (see also Chapter 8) at the same time as managing risks associated with high-consequence failures.

The question has also been raised about whether safety incidents producing outcomes with different degrees of severity share similar causes. The 'similar causation' argument stems from work undertaken by Heinrich (1931) who investigated several thousands of insurance claims for deaths and disabling injuries. Heinrich studied the history of activities being undertaken when these incidents occurred and collated statistics showing the relative frequency for these activities of serious/disabling injury, minor injury, and near-miss incidents. He found that for every serious/disabling injury, there were many more minor injuries and more near misses again. Hale (2002) describes how, as a result of Heinrich's analysis, it has become an 'urban myth' that incidents resulting in serious injury share the same causes as those resulting in minor injury

(Hale, 2002). Hale (2002) observes that Heinrich's analysis of causation was never made clear. Because not all minor incidents could have been major incidents, it is largely due to careless reasoning that safety practitioners have come to expect that preventing minor incidents (low consequence) will automatically lead to preventing major incidents resulting in death or permanent disability. The amount of damage that occurs is, according to Hale (2002), a factor of the amount of damaging energy that is released in a particular situation, and what it comes into contact with before it dissipates. High-energy activities and events will largely produce more damage, and more serious consequences, than low-energy activities and events (see also Hallowell et al. 2017).

Bellamy (2015) re-examined this argument, modelling the causes of 23 000 reportable fatal and non-fatal incidents occurring in the Netherlands between 1998 and 2003. This study revealed that incident causes were similar for fatal and non-fatal incidents, but only if looking within the same hazard category (or incident type). The analysis also reveals that, although incidents of a similar type share similar causes, these causes were not observed in the same proportions. Thus, causes relevant to fatal falls from height (roofs/platforms/floors) were:

- fall-arrest failure (48% of fatal incidents) and
- roof edge-protection failure (42% of fatal incidents).

Roof edge-protection failure was a factor in 45% of non-fatal falls from roofs/platforms or floors, but fall-arrest failure was a factor in only 28% of non-fatal incidents of this type (Bellamy 2015).

Bellamy (2015) observes a similar finding for falls from a scaffold. Edge-protection failure was a factor in 44% of fatal, and 31% of non-fatal, falls from a scaffold. Deficient anchoring or fixings was a factor in 30% of fatal, and 20% of non-fatal, falls from scaffolds. Loss of control of body balance was involved in proportionally more non-fatal falls from a scaffold (39%), compared to fatal falls from a scaffold (26%).

On the basis of these findings, Bellamy (2015) suggests the analysis of minor (non-fatal) occupational accidents can help to prevent major (fatal) ones, providing incidents of the same hazard or type are analysed together.

The international construction safety statistics support the assertion that different hazards or incident types have different degrees of lethality. Some types of hazard are far more likely to result in serious consequences (such as a fatality) than others. However, it is important not to lose sight of some of the high-frequency, low- (or lower-) consequence WHS issues that impact construction workers as these create considerable human cost and social and economic impact. Hale (2002) concludes: 'We should discriminate between the scenarios that can lead to major disaster and those which can never get further than minor inconvenience. If we tackle minor injury scenarios, it should be because minor injuries are painful and costly enough to prevent in their own right, not because we believe the actions might control major hazards' (p. 40).

Trade unions have also noted the importance of managing risks associated with frequent but relatively low-consequence incidents. In the UK, the Union of Construction, Allied Trades and Technicians stated that: 'Small injuries can mean significant loss of pay and significant psychological stress for the worker and their family. If we don't have zero tolerance in the work place, then standards will slip and the number of injuries will increase … Allowing workers to suffer small injuries, while focusing just on saving lives, is not good for building workers. Building workers need to stay completely and entirely safe – and avoid all injuries' (Warburton 2016).

1.2 The Neglect of Occupational Health

Another observation to make about construction WHS is that historically, a strong emphasis has been placed on safety. However, much less attention has been paid to problems relating to construction workers' health. This is in spite of the fact that work-related illness is a very significant problem in the construction industry, and workers are exposed to a multitude of serious occupational health hazards in their daily work.

Snashall (2005) reports that construction workers have a high overall mortality rate, independent of social class. Further, Snashall (2005) points out that, because of the diversity of construction jobs and activities, almost every occupational illness has been recorded among construction workers.

Silica is a particularly insidious occupational hazard in construction. Silica is found in sand, granite, quartz, and most stone. Fine, respirable particles of crystalline silica dust are created when these materials are chipped, cut, drilled, or ground. Exposure to silica dust causes silicosis, a disabling and often fatal disease similar to black lung experienced by coal miners (Lahiri et al. 2005).

Many construction activities involve exposure to silica dust, including:

- abrasive blasting with sand;
- jack hammering;
- rock/well drilling;
- concrete mixing;
- concrete drilling;
- brick and concrete block cutting and sawing;
- tuck pointing; and
- tunnelling operations (OSHA 2002).

Even very small amounts of silica dust can cause harm, and by the time symptoms become apparent the condition is often serious, leading to permanent disability or death. In the UK, it is estimated that every year more than 500 construction workers die from exposure to silica dust (Health and Safety Executive 2013).

Part of the problem may be in how WHS is conceptually framed. In the commonly used acronym 'WHS', workers' health and safety are typically referred to in the singular. Although this is a semantic point, it is also an important one because the evidence suggests occupational health hazards to which construction workers are exposed are being addressed less effectively than the safety hazards. Implicit in the interfusion of health and safety into a single concept is the implication that health and safety can both be managed in the same way by the same processes; that is, while focusing effort on improving workers' safety, their health will also somehow be magically improved. However, the high rates of serious work-related illness in the construction industry suggest this is not the case, and health needs to be better managed as a separate issue. Sherratt (2015) argues standard WHS risk management processes are not well suited to managing occupational health risks that require special attention and a different approach.

In the UK, the Health and Safety Executive reports that, in 2018, 82 000 construction workers suffered from a new or long-standing work-related illness. Of these:

- 62% were work-related musculoskeletal disorders (WMSDs);
- 25% were stress, depression, or anxiety; and

- 13% were other work-related illnesses.

In 2018, there were 51 000 cases of WMSDs (new or long standing) in the construction industry, with construction workers almost twice as likely to experience a WMSD compared to workers across all industries. The Health and Safety Executive also estimates that around 2.4 million working days (full-day equivalent) were lost each year between 2015/16 and 2017/18 due to workplace injury or work-related illness in the construction industry of Great Britain. Two million of these working days were lost as a result of work-related illness, while 0.4 million were lost as a result of workplace injury, indicating the magnitude of the impact of work-related poor health relative to injury in the construction industry (Health and Safety Executive 2018a).

1.3 The Evolution of Workplace Safety

Over the years, the emphasis on how workplace safety should be tackled has changed, as understanding of the contributory factors to work-related injury has evolved. Some writers suggest the approach taken to managing workers' safety has progressed through a number of discernible periods or ages.

Hale and Hovden (1998) summarize these ages as follows.

- *The 'technical' age*: spanning the nineteenth century until after the Second World War. In the technical age the focus was on technical measures for guarding machinery, stopping explosions, and preventing structures from collapsing.
- *The 'human factors' age*: spanning the 1960s and 1970s. The 'human factors' age considered the main source of accidents to be human error arising from interactions between human and technical factors. The merging of two fields that influenced safety – probabilistic risk analysis and ergonomics – saw the focus shift to human error and human recovery or prevention.
- *The 'safety culture' age*: from the 1980s onwards. The safety culture age developed as it became apparent that matching individuals to technology did not resolve all safety problems. The 1990s saw a growing emphasis on cultural determinants of safety. The main focus of safety development and research shifted to organizational and social factors.

The 'technical age' of safety responded to fundamental changes in agricultural, industrial, and manufacturing processes that began with the industrial revolution. The technical age was principally focused on the development of engineering and technological solutions to newly emerging workplace hazards. However, as shortcomings of focusing heavily on technology were identified, attention shifted to the interface between people and technology. Thus, the second age of safety, as Hale and Hovden designate it, is the 'human factors' age. Within this age, growing prominence was enjoyed by the discipline of ergonomics, a science that deals with designing and arranging things so people can use them easily and safely. Yet again, towards the end of the twentieth century, the focus changed as research revealed the critical role of management and organizational factors in shaping workplace health and safety outcomes. Thus, in the third age of safety, the 'safety culture' age, greater emphasis was placed on organizational and social factors.

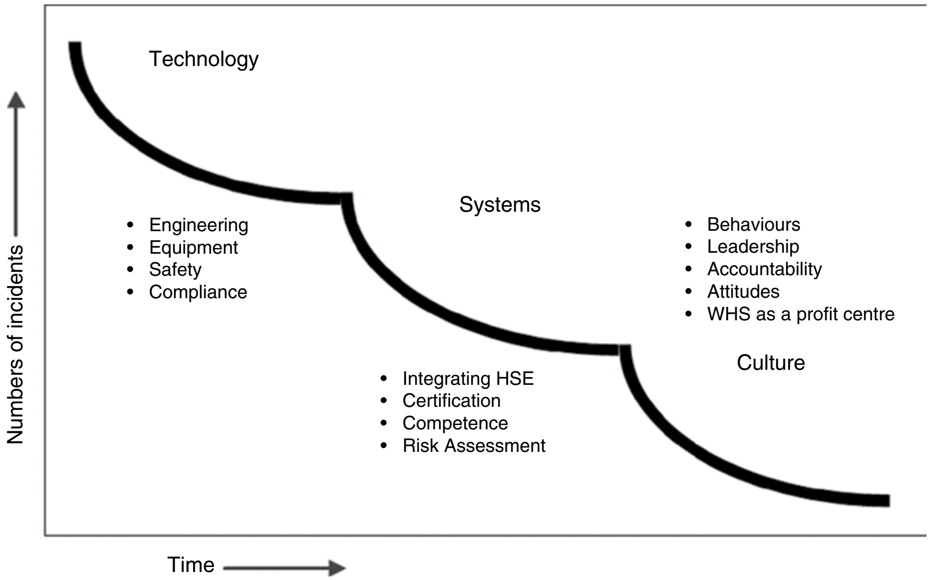

Figure 1.1 The progressive 'ages' of safety. *Source:* Hudson (2007).

Hudson (2007) proposed three slightly different stages in the evolution of safety thinking (see Figure 1.1). These were based on his observation that the focus of safety improvement efforts changes over time in large multinational organizations:

- first, there is an emphasis on technology and the opportunities it affords to reduce injuries and ill-health;
- second, there is an emphasis on implementing safety management systems; and
- third, organizations begin to place greater emphasis on cultural aspects of safety.

Hudson argued that technology and systems-based approaches to managing workplace safety produced significant reductions in incidents (and injuries), but these improvements eventually plateaued.

Thus, the focus on cultural aspects of workplace safety emerged from recognizing that the people within the organization were the missing component in workplace safety processes. A greater emphasis was placed on people and culture in an effort to engage organizational members' 'hearts and minds' in the workplace safety effort, whatever their role or level.

'Step change' models, such as those proposed by Hale and Hovden (1998) and Hudson (2007), reflect a relative change in emphasis in the way that workplace safety has been thought about and tackled over time. These models are focused more on safety rather than health. However, their inherent limitations also have relevance to the management of occupational health. Indeed, these models should not be interpreted too literally because they suggest the benefits to be gained from earlier approaches are already exhausted when a change of emphasis is made. Hopkins (2006b) argues that implicit in these models is the suggestion that the only opportunity to produce further improvement in workplace safety is to stop focusing attention on technologies and systems, and to focus exclusively on culture and behaviour (Hopkins 2006b). Given that technological means for controlling workplace safety (and also occupational health) risks (for example, elimination, substitution, and engineering) are preferable to behavioural means (for example, relying on administrative measures and using personal protective equipment), some of the most effective solutions to the construction industry's WHS problems may lie in better deployment of advanced technologies. Arguably, the best way to do this is to ensure systems and cultures enable technological enhancements and improvements for WHS risk control. There is also an increasing emphasis placed on reducing WHS hazards at source in the design stage of construction project work. Rollenhagen (2010) argued that placing too strong an emphasis on safety culture could potentially discourage technologists from designing better equipment, construction processes, or ways of working. Rollenhagen (2010) also identified the need to improve design organizations' management practices and cultures in relation to developing innovative ways of improving WHS.

In the construction industry, as in other sectors, the analysis of workplace injuries and deaths shows that the underlying causes of incidents include issues of equipment and work process design, the organization of work, and multiple layers of management decision making (Gibb et al. 2014). Even when workers fail to follow work procedures, procedural violations can often be traced back to factors in the organizational and physical work environment (Lingard et al. 2016). This is illustrated in Case Example 1.1.

Case Example 1.1 Multiple Factors in a Work-Related Death

John was in the final year of completing his apprenticeship as a plumber and gas fitter. This meant he was unlicensed and was required to be under a qualified plumber's supervision. The day prior to the incident, John's supervisor requested he (John) attend a caravan park to fit a new gas water heater in a mobile home permanently housed there. Later in the day, after works had commenced, John realized he did not have the equipment he required to complete the job. He returned the following day and began work in a hole that had been dug the previous day, connecting the new gas line to the town mains gas line. It was while undertaking this work that John damaged the mains gas supply and was overcome by gas. Efforts to revive him failed.

During the course of the investigation it was identified that the mobile home's owner had not advised the caravan park proprietor of any works. Further, the proprietor was unaware of the presence of any tradesman onsite, despite having security/access restrictions at the park entrance and a 'sign-in' process in place. This incident reveals a complex interaction between technological, managerial, and behavioural causes. A coronial inquiry found John was not using the correct equipment to allow for safe connection to the gas mains. He had not been trained properly in the work he was asked to undertake, and consequently he failed to recognize what equipment was required to carry out the work safely. At the site, a hole had been dug around the mains pipe and to access this pipe John had to lie on his stomach on the ground and place his head, arms, and the top part of his body into the hole. John was not wearing any protective equipment and did not use the gas detection meter he had been given. Despite being an apprentice, John was not being supervised at the time of the incident and he did not possess sufficient skill or knowledge to carry out this work. The caravan park proprietor did not control access to the site and was unaware that the work was being undertaken. There was no documentation of the work and the owner of the pipeline was not identified or contacted by John or his supervisor.

(*Source:* adapted from Cooke and Lingard 2011)

In designing safe (and healthy) systems of work, it is important to understand and address the interactions between people, equipment, structural components of buildings and other aspects of the built environment, including underground services, and the processes of construction. A systematic approach to managing WHS is critical to ensuring things are not left to chance and all hazards are identified, analysed, and properly addressed. Glendon et al. (2006) argue the challenge lies in better understanding how technology, systems, and culture can be simultaneously considered, thereby creating the possibility of a more integrated approach to improving workers' health and safety. Glendon et al. (2006) refer to this as 'the integration age' of WHS.

1.4 An Integrated Approach to WHS in Construction

The construction industry is a particularly difficult environment in which to apply an integrated, interdisciplinary approach to WHS. Reasons for this are:

- the industry's fragmented supply arrangements, including high levels of specialization and division of labour;
- use of flexible labour processes that increasingly rely on precarious forms of employment (for example, subcontracting and labour hire); and
- cultural characteristics of the industry that are often driven by client demands and militate against WHS improvements.

Each of these reasons is explored below.

1.4.1 Fragmented Supply Arrangements

Construction industry supply arrangements are highly differentiated and sometimes fragmented, making an integrated approach to managing WHS difficult to achieve. Construction project teams have been described as 'temporary, multidisciplinary and network-based organizations' (den Otter and Emmitt 2008, p. 122) in which multiple specialists work together in a 'web' of interorganizational relationships (Pietroforte 1995, 1997; Nicolini et al. 2001).

Project organizations are vertically segregated as people involved in the initiation, design, production, use, and maintenance of facilities are engaged under separate contracts. Depending on the particular project procurement or project delivery model selected, these groups may have limited opportunity to communicate or engage in joint problem solving (Atkinson and Westall 2010). This is a problem because decisions made in the early project phases of planning and design are known to have a significant impact on construction workers' health and safety (Hare et al. 2006). Integrating WHS into project planning, procurement, and design activities is discussed further in Chapters 2 and 3.

The traditional separation between design and construction functions in delivering construction projects can impede the development of shared project goals (Baiden and Price 2011) and can negatively impact on project outcomes (Love et al. 1998). Traditional procurement methods militate against the proper consideration of construction WHS issues during the pre-construction planning and design stages, as critical knowledge about construction processes (and their WHS implications) is often not available to decision makers in these early project stages (Yates and Battersby 2003). This is supported by a review of WHS in the UK construction industry that identified the separation of, and poor communication between, design and construction functions as causal factors in construction fatalities (Donaghy 2009).

The acknowledged problems inherent in vertical segregation between contributors engaged to deliver construction projects have contributed to growth in collaborative or integrated forms of project delivery. Integrated project delivery is defined as 'a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction' (American Institute of Architects 2007). Such integrated project delivery methods are believed to improve buildability and, by implication, also have the potential to improve WHS (Bresnen and Marshall 2000; Kent and Becerik-Gerber 2010). Technologies such as building information modelling (BIM) have also enabled construction project delivery to become more integrated as information is collected and easily shared between project contributors and across project lifecycle stages (Azhar 2011; Succar 2009).

However, integrated project delivery does not guarantee WHS success (Ankrah et al. 2009). Instead, actual WHS improvements are likely to occur as a result of increased communication and information exchange among project participants afforded by the integrated delivery method. An Australian analysis of the impact of commercial frameworks on construction project WHS performance affirmed this, with one senior industry figure interviewed explaining: 'You can make a huge impact on safety no matter what the commercial framework is. Because it's people generally who are the solution to how we get better at things.'

This quote illustrates the important role played by people and their relationships in driving WHS performance. The distributed nature of project teams can create challenges for a coordinated approach to managing WHS. Distributed teams are those in which some individuals may be co-located, but others are clustered in other locations, preventing regular or routine face-to-face interaction (Stagl et al. 2007). Participants in these distributed teams can make or influence decisions with the potential to impact WHS – sometimes with little or no knowledge of these impacts. In distributed teams there are fewer opportunities to monitor team members' behaviour and provide feedback. Fewer opportunities to observe non-verbal cues can also create ambiguity and reduced situation awareness in members (Fiore et al. 2003). Added to this, construction work is inherently stressful because it is often undertaken under conditions of time pressure, with severe financial penalties for time overruns (Leung et al. 2008; Bowen et al. 2013a,b). Stress can cause people to lose the team perspective and become narrowly focused on the performance of their own individual tasks (Driskell et al. 1999). Further, while working in the temporary construction project environment, participants must also balance the interests of the project with their own individual professional or business interests. All these factors make it difficult to achieve a common purpose and an integrated approach to managing WHS risk.

Establishing shared mental models has been examined as a means of enabling improved team coordination and performance (Salas et al. 2005; Banks and Millward 2007). Mental models are defined as 'mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system functioning and observed system states and predictions of future system states' (Rouse and Morris 1986, p. 351). Shared mental models within a team refer to an organized understanding or mental representation of knowledge shared by team members (Cannon-Bowers et al. 1993). In teams with strong shared mental models, members implicitly coordinate their efforts to focus on achieving team goals (Fisher et al. 2012), and teams are most effective when members are able to anticipate and predict other members' needs, identify changes in the task or team, and adjust their strategy as needed. The existence of shared mental models in work teams has been linked to safety performance (see, for example, Smith-Jentsch et al. 2005), but differences between managers and workers' WHS mental models have been observed (Prussia et al. 2003). A study by Lingard et al. (2015d) also revealed that construction project participants (including architects, engineers, and construction and WHS managers) had significantly different WHS mental models. These differences are attributed to variation in experience, education, and professional focus.

1.4.2 Flexible Labour Processes and Precarious Employment

Flexible labour hire practices benefit construction contractors in helping them to cope with changing market conditions and a competitive tendering environment. These practices (including multiple levels of subcontracting and, increasingly, the use of labour hire) have been linked to reduced levels of WHS performance (Mayhew and Quinlan 1997). Quinlan (2011) suggests WHS problems arise in supply and production networks as a result of three factors.

1. Economic and reward pressures that become successively greater towards the bottom of supply chains.
2. Disorganization due to the engagement of many different (often small) businesses.
3. Workers, whose employment is often precarious, working within complex and fragmented production arrangements.

Subcontractors are engaged by principal contractors to undertake a substantial proportion of construction work. In some sectors, principal contractors effectively take on the role of managing contractor and subcontract out all physical construction activity. Subcontractors are positioned at the lower end of the hierarchical structure of contracting and have the highest exposure to hazards and risks (Lingard and Holmes 2001). The low profit margins that result from a competitive tendering system mean subcontractors may be reluctant to invest in WHS.

Many subcontracted workers do not believe legislative requirements adequately address their particular safety concerns, including manual handling injuries and repetitive movement injuries (Wadick 2010). Further, subcontracting often operates on a payment-by-results basis; that is, payment is based on the amount of work completed rather than the time spent on work (Mayhew and Quinlan 1997; Wadick 2010). This arrangement can drive subcontractors to work excessively long hours and take WHS 'shortcuts'. Depending on their employment arrangements, some subcontracted workers in construction may have limited compensation, holiday, sick leave, or superannuation entitlements (Mayhew and Quinlan 1997; Mayhew et al. 1997). Difficult access to compensation, and financial pressures, may cause them to continue working after injury instead of seeking medical treatment. Thus, chronic injuries are common among subcontracted workers, and research indicates many workers take early retirement due to disability caused by injury sustained at work (Mayhew and Quinlan 1997).

Communication between subcontractors engaged to work at a construction site can sometimes be poor and it is the job of a principal contractor to ensure work is properly coordinated so that the activities of one subcontractor do not increase dangers to others. The fragmentation of trade-based subcontractors can also create ambiguity about the boundaries of WHS responsibility (Mayhew and Quinlan 1997). Wadick (2010) reports that subcontractors in the construction industry's residential sector perceive WHS management systems imposed by principal contractors as being heavily paper-based, irrelevant, costly, and ineffective. In some cases, subcontractors distrust these systems, believing them to be driven by the principal contractors' desire to protect themselves from possible criticism or legal liability, rather than a genuine interest in protecting workers' WHS (Wadick 2010).

1.4.3 Cultural Characteristics of the Construction Industry

Christensen and Gordon (1999) explain cultural differences between industry sectors in terms of broader industry imperatives. Gordon (1991) argues that organizational culture is deeply influenced by the characteristics of the industry in which the company operates. Companies in the same industry usually share some common cultural values and practices that are essential for survival in the industry. This is because industry-driven assumptions create industry-wide value systems, which lead companies to develop strategies, structures, and processes consistent with – and not 'antagonistic' towards – the prevailing industry culture.

The construction industry is well known as a male-dominated industry with a strongly masculine culture (Gale and Cartwright 1995; Loosemore and Galea 2008). Mearns and Yule (2009) report that industries characterized by a male-dominated, 'macho', 'can do' culture tend to attract, accept, and retain workers who are inclined to take greater risks. The construction industry follows traditional work patterns and is characterized by a culture of long hours and weekend work, especially for site-based workers. Lingard and Francis (2004) report that, on average, site-based employees in direct construction activity work 63 hours a week, employees in site offices work 56 hours, and employees in the head offices of construction companies work 49 hours. In addition, the project-based nature of construction work, and the uncertainty associated with competitive tendering systems, lead to many workers experiencing a lack of job security, or suffering from frequent relocation as a means of ensuring continuity of employment (Lingard and Francis 2004).

This demanding work environment impacts construction workers' WHS and non-work life in a negative way. Lingard and Francis (2004) found that project-based construction workers experience high levels of work–family conflict and emotional exhaustion as a result of excessive job demands, including long and irregular work hours. In another study, Lingard et al. (2010a) reported Australian construction employees showed higher mean scores for time-based, strain-based, and behaviour-based work-interference with family (WIF) compared with scores reported in other international studies. They found those who work onsite in direct construction activity had higher levels of time-based and strain-based WIF than salaried workers who work predominantly in office-based roles. Long work hours and high work pressure interfere with construction workers' ability to fulfil family responsibilities, and have a detrimental effect on their health and wellbeing.

Dainty and Lingard (2006) report that the need to comply with male-oriented work practices, such as the expectation that workers will work long hours and work in disparate geographical locations, is an impediment to women's career advancement in the construction industry. The under-representation of women in the construction industry means their behaviour is subject to even greater 'time scrutiny' than their male counterparts, increasing the pressures upon women to be available for work at all times. Indeed, in an industry culture that 'glorifies' workers who work as though they have no personal life, it is extremely difficult for workers (male or female) with primary responsibility for caring for children or other family members to manage the demands on their time.

Social and cultural aspects of work are also reported to impact negatively the health and work ability of male, manual/non-managerial workers. Kolmet et al. (2006) interviewed Australian male, manual/non-managerial workers and found a tension between cultural constructs of masculinity (for example, the need to feel 'in control') and low levels of control they have in their work situations. Low levels of job security associated with project-based work and precarious employment arrangements created a sense of disempowerment and resignation to the likelihood of diminished life expectancy. Du Plessis et al. (2013) also describe how 'hyper-masculine' subcultures develop in male, manual/non-managerial work environments. In these subcultures, unhealthy lifestyle behaviours are often inadvertently promoted and workers who seek help with health problems are regarded as 'weak' (Iacuone 2005).

Despite structural and cultural challenges associated with achieving an integrated approach to managing WHS in the construction industry, the potential improvements that could be made by doing so are substantial. Integration is the central theme of this book.

1.5 Structure of the Book

This book describes research undertaken over a 10 year period in the Centre for Construction Work Health and Safety Research at RMIT University. At the time the work commenced, in 2005, Australia was implementing legislative changes that allocated responsibility for construction workers' health and safety to designers. There was growing industry and academic interest in defining 'best practice' in terms of WHS and in exploring the role played by organizational, project, and workgroup culture in shaping construction industry WHS. Each chapter in this book incorporates data collected in collaboration with construction industry partners.

The following chapters examine the underlying need to address, in a more integrated way, the construction industry's relatively poor health and safety performance.

Chapter 2 describes the role clients can play in establishing clear objectives for WHS from the commencement of a construction project, and how they can drive WHS performance through their procurement and project management activities. A Model Client Framework is presented. This framework establishes actions for clients across the project lifecycle that can create conditions within which WHS is integrated into