

Centre for
**Construction Work Health
and Safety Research**

Ten Years

A look at the work of the
Centre for Construction
Work Health and Safety
Research since 2005

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About the Centre for Construction Work Health and Safety Research

The Centre for Construction Work Health and Safety Research provides leading-edge, applied research to the construction and property industries. Our members are able to work with organisations to analyse health and safety (H&S) performance and identify opportunities for improvement. We can develop and evaluate innovative solutions, provide specialised H&S programs or undertake other research-based consulting activities. Our work addresses real-world H&S challenges and our strong international linkages provide a global perspective to our research.

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Foreword



I vividly recall, as a young engineer working on road sites, close encounters with construction plant that likely would have severely injured, if not killed me if circumstances had been ever so slightly different. Sadly, others in the companies for which I have worked have not been so fortunate. Some have been badly hurt and, in the most tragic instances, left family members mourning their loss. In 2004, Bill Wild, an icon in construction, was honoured with the Civil Engineer of the Year award and his acceptance speech was a “call to arms” for action to address the dreadful accident toll in the industry. As the then chair of the Civil College Board of Engineers Australia and shaped by my own safety encounters, I was proud to champion the formation of the Safer Construction Taskforce, under Bill’s leadership.

The Taskforce comprised key representatives from clients, designers, constructors, government, and importantly, a group of academic safety experts from several different universities, including RMIT. The research undertaken by these academics, in collaboration with industry, was crucial to the development of *The Guide to Best Practice for Safer Construction*. Moreover, Taskforce members, Ron Wakefield and Helen Lingard then went on to grow RMIT’s own area of expertise into what is now the Centre for Construction Work Health and Safety Research.

Under Ron’s direction and foresight, an Industry Advisory Group was established in 2009 to provide guidance and feedback to RMIT’s research group. It has been my privilege and honour to chair this group since its inception. The Centre’s model whereby clients, industry, government, professional bodies and other key stakeholders work collaboratively with expert academics has been a powerful force. It has helped direct priority research efforts and has been a vehicle for promulgating findings back to industry, ultimately improving the wellbeing and safety of construction workers.

Over the past decade, RMIT’s Centre for Construction Work Health and Safety Research has conducted and disseminated research that has been ground-breaking. It has engaged with other leading international academic bodies in the construction safety field and developed an enviable global reputation. As evidence of the importance of the Centre’s work and the influence that it is having on improving safety and wellbeing in the construction industry, RMIT’s construction safety research group has produced numerous papers and developed many practical applications to assist industry. This is important work that has real safety benefits for real people. I believe that the research being undertaken by RMIT is improving the construction industry’s safety culture and it is delivering practical and influential tools that help those at the forefront to deliver far safer outcomes.

I commend the work done by the Centre for Construction Work Health and Safety Research over the past ten years and wish everyone involved even greater success for the next phase of the Centre’s journey.

Peter Godfrey

*HonFIEAust, CPEng, EngExec, FAICD Chair,
Industry Advisory Group, RMIT Centre for
Construction Work Health and Safety Research
Past National President, Engineers Australia*

Introduction

The Centre for Construction Work Health and Safety Research (CCWHSR) developed from a strong and productive research collaboration between three Professors in the School of Property, Construction and Project Management at RMIT University.

Professor Ron Wakefield had been one of the founding principal investigators of the Center for Innovation in Construction Safety and Health at Virginia Polytechnic Institute and State University (Virginia Tech, USA). He moved to RMIT University in 2005 and was appointed Head of RMIT's School of Property, Construction and Project Management.

At RMIT, Ron continued his research in construction work health and safety (WHS), collaborating with colleague, Professor Nick Blismas, who had come to RMIT from Loughborough University in the UK.

In 2006, Ron and Nick were joined by Professor Helen Lingard, who had been working in industry at the time. Helen was drawn to RMIT because of Ron's vision for the School and his commitment to undertaking robust research that industry practitioners would find useful and could easily apply in practice.

This original workgroup was formed with these common values, and a shared belief in the importance of conducting industry-relevant research to improve the WHS of construction workers. From the beginning, the team worked well together as each team member brought a different set of skills to the research projects. The fact that each of us had industry experience was important. It meant that we could properly understand, and thus appropriately respond to, industry challenges.

Coming from a range of disciplinary backgrounds (civil engineering, social science and construction project management), our

team was also equipped to investigate the complex problems faced in construction WHS from different perspectives.

Over a ten year period, Ron, Helen and Nick were joined by other like-minded researchers who also shared a passion for WHS research and improving the working lives of construction workers.

In 2009, we established an Industry Advisory Group (IAG). This group included key stakeholders and end users of our research, including construction industry employers, unions, regulators, professional associations and peak industry bodies. Since its formation, the IAG has been chaired by Peter Godfrey, a past National President of Engineers Australia. The group has played a key role in informing our research activity and helped to translate our research findings into industry practice and policy. A full list of IAG members and supporting organisations is provided in the Appendix.

Our volume of research activity (in terms of funding, industry partnerships and Ph.D. student numbers) has continued to grow over time and, in 2012, the group was formally recognised as a Research Centre within the RMIT University Research Structures Policy.

The Centre for Construction Work Health and Safety Research takes a life-cycle approach to research. We consider all facets of WHS and involve a range of stakeholders, including government agencies, unions, design firms, professional bodies and clients. Our research is based on a cycle of translation in which projects are developed in response to the difficulties experienced by industry (practice to research) and translated into outcomes that can easily be implemented by industry (research to practice).

Our ability to engage industry has been one of our greatest achievements. The close relationship we have with our industry partners distinguishes us from our peers, who tend to have an arms-length relationship with the end users of research.

This booklet describes and celebrates the first ten years of our research. In putting it together, we gratefully acknowledge the help and

support of all our industry partners, funders and Industry Advisory Group members over the ten year period.

We have pursued a number of diverse areas of research over the past ten years—some strategic, others evolving—as our understanding of issues has grown. For ease of reading, this work is presented thematically rather than chronologically.

Supporting Evidence-Based Policy

Safe Work Australia (SWA) develops evidence-informed national work health and safety and workers' compensation policy. Because of the high numbers and rates of injuries and fatalities, the construction industry is a national priority under the Australian Work Health and Safety Strategy 2012-2022 (Australian Strategy). One of the seven strategic outcomes is for evidence-informed policy, programs and practice.

The Centre for Construction Work Health and Safety Research (RMIT University) is making a major contribution to the achievement of this strategic outcome. The theoretical and applied work of the Centre helps inform both targeted national and local prevention activities.

SWA is watching with particular interest the Centre's research in WHS in design, supply chains, workplace cultures and metrics. We also acknowledge the important work the Centre is undertaking to build and maintain work health and safety research and evaluation infrastructure and capacity through their undergraduate and postgraduate programs.

A key national activity under the Australian Strategy is for evidence to be translated and then effectively disseminated. We were therefore delighted Professor Helen Lingard agreed to participate in the 2015 Virtual Seminar Series, bringing her considerable academic kudos to the panel discussion on applying good work design in construction's complex supply chains. This has proved to be a highly popular session and is an example of how academic institutions such as RMIT can partner with policy agencies to reach a large and non-traditional audience. We look forward to continuing to collaborate with RMIT to provide the evidence to help achieve our vision of healthier, safer and more productive working lives.

Dr Peta Miller

Special Advisor Policy and Engagement, Safe Work Australia



Shaping the International Research Agenda

The goals, achievements, and innovative thinking of the Centre for Construction Work Health and Safety Research are embodied by the opening sentence of Professor Helen Lingard's 2013 Editorial in *Construction Management and Economics*. Helen motivated the global construction community, writing, "The expectation that workers be able to work productively without suffering harm as a result of wealth-generating activities is the sign of a mature, responsible and equitable industry." As Coordinator of CIB W099, I have the opportunity to examine and evaluate construction health and safety research from all parts of the globe. Over the past ten years, RMIT University has consistently produced impactful and useful construction health and safety research. The Centre's strong ties with industry have always been impressive and are a testament to their pragmatic and applied research outputs. This was most evident when they hosted the 2009 CIB W099 conference. It was without a doubt the highest industry-attended W099 conference in recent history. Our conference planning committee uses the conference as a benchmark and goal for industry involvement. In 2014, I was honoured to be selected as a Visiting Research Fellow to RMIT and the Centre. Once again, industry involvement and interest was overwhelming with over 100 registrants for our seminar. Professors Wakefield, Blismas, and Lingard have been incredible academic leaders and mentors. Their team of researchers and Ph.D. students over the past ten years have been very impressive; the RMIT legacy is strong with new researchers who understand the value of establishing valid and reliable methodologies, which is so challenging in field-based health and safety research. RMIT's Centre for Construction Work Health and Safety Research is the most impactful academic-based construction health and safety research unit in the world, and I am anticipating increased prominence over the next ten years.

Dr Michael Behm

Professor of Occupational Safety, East Carolina University

Coordinator, International Council for Research and Innovation in Building and Construction (CIB),

Working Commission on Safety and Health in Construction (W099)

Client WHS Leadership

There is growing recognition among industry practitioners that construction industry clients can use their purchasing power to play a significant role in improving WHS in construction projects.

During Helen's time working in the Hong Kong construction industry, she observed significant improvements being made in the health and safety performance of large government-funded construction projects, including the construction of the Hong Kong International Airport at Chek Lap Kok. In particular, government clients had driven down accident rates on publicly funded construction projects to well below the accident rates seen in privately funded projects.

At the time, the role of construction industry clients in WHS had not received a great deal of attention from the research community. Our team believed this to be a significant knowledge gap and impediment to improvement.

In 2006-2007, the Centre 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 overseen by a high-level industry task force consisting of peak bodies representing 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 engaged in the delivery of construction projects. Practices were identified that would embed WHS across the project life cycle, from planning and design through to construction and completion. The Guide has had a substantial international impact and has been downloaded more than 4,000 times across 99 different countries. It has also been implemented by large client organisations, including the Port of Melbourne Corporation at the \$1.6 billion Port Capacity Project.

Concurrent with this work, Centre researchers were commissioned by the Office of the Federal Safety Commissioner (OFSC) to undertake a review of model client WHS activities. This review documented best work health and safety practices for construction industry clients and described the potential for Australian Government agencies to significantly improve construction workers' WHS in their procurement and project management practices. In 2007, the OFSC commissioned our Centre to develop a Model Client Framework, a set of five booklets describing the actions that clients could undertake in the procurement and management stages of construction projects that could help to improve WHS.

The Model Client Framework received international attention, being cited as an example of the translation of research-to-practice in the US Centers for Disease Control National Occupational Research Agenda (NORA) for the construction industry.

In the intervening period, Safe Work Australia released the Australian Work Health and Safety Strategy 2012-2022. The Strategy emphasises the need to ensure that commercial relationships within supply chains and networks are used to improve WHS and it identifies government agencies as being major purchasers of products and services. The Strategy suggests that, by:

“incorporating WHS and safe design requirements into government investment, procurement arrangements and contracts, governments can actively encourage suppliers to improve products and their health and safety practices and performance.”

Also in 2012, the *Getting Home Safely* report was published in the Australian Capital Territory (ACT). This report documents the findings of an inquiry that investigated the ACT construction industry's level of compliance with WHS

requirements. The report provides several recommendations about how government, a major client with significant purchasing power, can have a 'pull' effect on the construction sector, by using its procurement and project management systems to leverage improved WHS through judicious procurement and contractor management activities.

However, despite the groundswell of policy development, there was still little by way of evidence that client actions could make a difference. The Model Client Framework was based on desk research, undertaken five years prior to these policy developments. During this development there had been little opportunity to identify, through empirical evidence, which client practices had the biggest impact on project WHS. Our team believed that further research was needed to investigate and identify those client actions that yield the greatest WHS benefit.

In 2012, Ron, Nick and Helen were awarded an Australian Research Council (ARC) Linkage Project Grant for a project titled "Safe and healthy construction: The influence of clients in driving improvement through construction procurement and project management practices."

They were later joined in this research by Dr Ehsan Gharaie, a Ph.D. graduate and now Senior Lecturer in RMIT's School of Property, Construction and Project Management. This grant was awarded in partnership with Major Projects Victoria, The Port of Melbourne Corporation and Metro Trains Melbourne. The aim of the research, which is ongoing, is to measure client WHS activity across a number of active construction projects and identify links between client actions and WHS performance over the life of these projects. The ARC project will produce the evidence base required to support enhanced and effective client leadership in construction WHS. Thus, the ARC research will provide important evidence to help Australian Government agencies to meet the expectations of the Australian Work Health and Safety Strategy 2012-2022.

One way for us to understand organisational influences on WHS is to examine cultural characteristics through the measurement of the prevailing organisational safety climate. Our research addressing these issues is described in Part 4 of this booklet.

Working Closely with Industry Partners

The Australian Constructors Association (ACA) is pleased to have RMIT as an advisor in the development of practical tools and information to assist the Australian building and construction industry to improve its safety culture and safety performance. The RMIT Centre for Construction Work Health and Safety Research provides industry leading experience, capability and responsiveness critical to facilitating positive improvements in the field of workplace health and safety.

Lindsay LeCompte

Executive Director, Australian Constructors Association



Industry Publications

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Tim Fleming, Helen Lingard & Ron Wakefield. (2007) *Guide to best practice for safer construction: principles*, CRC For Construction Innovation, Icon Net Pty Ltd, Brisbane: ISBN: 978-0-9803503-6-4.

Tim Fleming, Helen Lingard & Ron Wakefield. (2007) *Guide to best practice for safer construction: tasks*, CRC For Construction Innovation, Icon Net Pty Ltd, Brisbane: ISBN: 978-0-9803503-5-7.

Nick Blismas, Tracy Cooke, Helen Lingard & Ron Wakefield. (2006) *Model clients: promoting safe construction: a framework to develop 'model construction clients' in Australian Government agencies*. (Report prepared for and submitted to the Office of the Federal Safety Commissioner, Canberra.)

Academic Publications

Helen Lingard, Nick Blismas, Tracy Cooke & Helen Cooper. (2009) 'The model client framework: resources to help Australian Government agencies to promote safe construction', in *International Journal of Managing Projects in Business*, vol. 2, pp. 131-140.

Safety Climate/ Organisational Culture

Safety culture emerged as a concept following some major disasters in the 1980s. Many researchers would be quick to identify the Chernobyl nuclear disaster of 1986 as one of the more prominent events tied to the concept's origin, however, safety culture has also been discussed in the context of rail, aviation and oil sector disasters. Safety culture has been defined as "those aspects of the organisational culture which will impact on attitudes and behaviours related to increasing or decreasing risk" (Guldenmund, 2000, p.251). However, cultural influences on WHS are complex and multi-layered.

Culture is shaped by those basic assumptions underlying the operation of an organisation that influence all aspects of the organisation's activities, including H&S. While these assumptions are not directly observable and are difficult to uncover, workers' attitudes and perceptions about what is important in their organisational environment can provide us some clues as to the state of the culture at a given point in time. Safety climate tools have been developed to measure workers' perceptions of management's commitment to health and safety, and the relative priority placed on H&S in relation to other organisational objectives. These tools have become widely used as an indicator of the state of an organisation's culture (relating to WHS) at a particular point in time.

The concepts of culture and climate have come to dominate WHS practice and the WHS profession, and have inevitably had a major influence on the construction industry. However, the concepts have needed clarification and analysis in practice. Our work in the area started when Helen and Ron were invited to measure safety climate as an indicator of workers' perceptions of the state of safety at the Tullamarine Calder Interchange (TCI) Alliance in 2005.

This project involved the upgrade of a crucial freeway interchange on Melbourne's Tullamarine and Calder Freeways, a major thoroughfare to the Tullamarine Airport. The project was established as an alliance between VicRoads, Baulderstone Hornibrook Pty Ltd and Parsons Brinckerhoff Pty Ltd.

Prior to joining RMIT, Helen had conducted a quarterly safety climate survey for the project and reported the results to the Alliance Leadership Team (ALT). During these surveys, Helen met Ron, who had assisted the ALT to develop a safety index that combined positive performance measures with traditional lagging indicators designed to monitor the project's safety performance. Helen and Ron noted that there were relationships between the positive performance indicators, quarterly climate scores and outcome measures. This type of measurement, which has now become a standard operation, was innovative in 2005. The Federal Safety Commission website features a best practice case study of the TCI safety index indicating the innovation and contribution of this early work.

Then General Manager of Baulderstone Hornibrook Pty Ltd (Victoria), Pat Cashin, also commented on the impact of this early work, stating that:

"...the tool has been fundamental in helping promote positive safety behaviours and accountabilities within our business...the Safety Index has continued to provide an excellent barometer, combining critical lag and lead behavioural elements. It has been central in providing genuine impetus for improvement..."

Our subsequent work was influenced by Professor Dov Zohar's writing. Zohar identified that safety climate could vary within organisations as workgroups developed their

own unique safety climates, often driven by supervisor behaviour. Zohar defined safety climate as:

“.....a summary of molar perceptions that employees share about their work environments...a frame of reference for guiding appropriate and adaptive task behaviours.”

The concept of safety climate is important insofar as it predicts WHS performance within organisations. Researchers have empirically investigated the relationship between safety climate and various aspects of safety-related performance. The results have generally (but not always) supported a link between safety climate and performance. Generally speaking, the more positive the safety climate, the better the safety performance.

Ron and Helen wondered how group-level climates might be more pronounced in the construction context, in which work is undertaken in semi-autonomous sub-contracted work groups. Until then, safety climate studies in construction had assumed that climate only arises at the organisational level. Micro-climates within workgroups were not well understood. In 2006, Helen, Ron and Nick were awarded a competitive ARC Linkage Project Grant to investigate supervisors' influences on group level safety climate in construction. Soon afterwards, Helen moved from the Queensland University of Technology, where she held an adjunct position, to RMIT University.

Our partners in this early ARC grant were Boulderstone Hornibrook and the New South Wales Roads and Traffic Authority (now Roads and Maritime Services). The data demonstrated, for the first time, that construction workers' perceptions of safety climate at the organisational level may differ from their perceptions of safety climates at the group level. It also showed that safety climate perceptions among subcontractors varied significantly, and that workgroups in which the safety climate is strong and positive have lower injury rates. Our research expanded the safety climate concept to include a multi-level safety climate measurement in the construction industry. This approach

is now widely accepted as being appropriate in construction, due to the hierarchical arrangements of contracting and subcontracting.

We also examined the role of supervisors as the conduit through which principal contractors convey messages about the importance of safety. Our analysis statistically demonstrated that supervisors play a key mediating role in shaping safety climates within construction projects.

Another new area of investigation introduced in our early research was the measurement of co-workers' safety responses as a component of safety climate. The majority of safety climate surveys had focused exclusively on the actions of people in formal leadership positions, such as managers and supervisors. Our work also considered peer group influences and social norms that can develop between co-workers. The results of this work have since been cited by international researchers investigating the formation of workgroup safety climates.

This early research advanced the understanding of how safety climates develop in construction project organisations. We demonstrated that group-level safety climates can and do develop, and that these group-level climates are also more directly related to group-level safety outcomes than organisational safety climates. We demonstrated the significant role that supervisors play in shaping safety climates in construction projects, and we considered the role of co-workers as being important in establishing a shared understanding among workgroup members about the importance of working safely.

Fonterra – New Zealand

This research led to us being engaged by the Fonterra Cooperative Group in 2012. Having read about the work we had conducted for the TCI Alliance, Fonterra's Risk Manager approached us about undertaking some measurement of the safety climate on construction projects within Fonterra's capital works program. Dr Rita Zhang joined the Centre in 2012 and was instrumental in adapting the multi-level safety climate tool (previously used by

Helen, Ron and Nick) for Fonterra's purposes. She extended the use of the tool to include a measure of workers' perceptions of the relative priority placed on safety by the client of a construction project. Some of the findings from this project aligned with those of the Model Client Framework, in which clients' actions were found to have significant potential to shape how safety is managed in construction projects.

By 2016, the Centre had measured safety climate at regular intervals for five completed Fonterra construction projects in New Zealand, and data collection had commenced for two additional projects. This system of regular measurement and reporting has proven to be useful to the project management teams who use this information to understand the differences between contractors and subcontractors, the impact of project events, and changes over the life of the projects.

The similarities in WHS law between Australia and New Zealand have always been strong. Following a Royal Commission into the Pike River coal mine disaster, the New Zealand Government undertook a complete review of its WHS laws and the operation of its WHS regulator. As a result, New Zealand used the most recent and perhaps applicable set of workplace safety laws from Australia—the Model Work Health and Safety laws—as a framework for its own safety legislation and guidelines. The revised Act will be operational in April 2016.

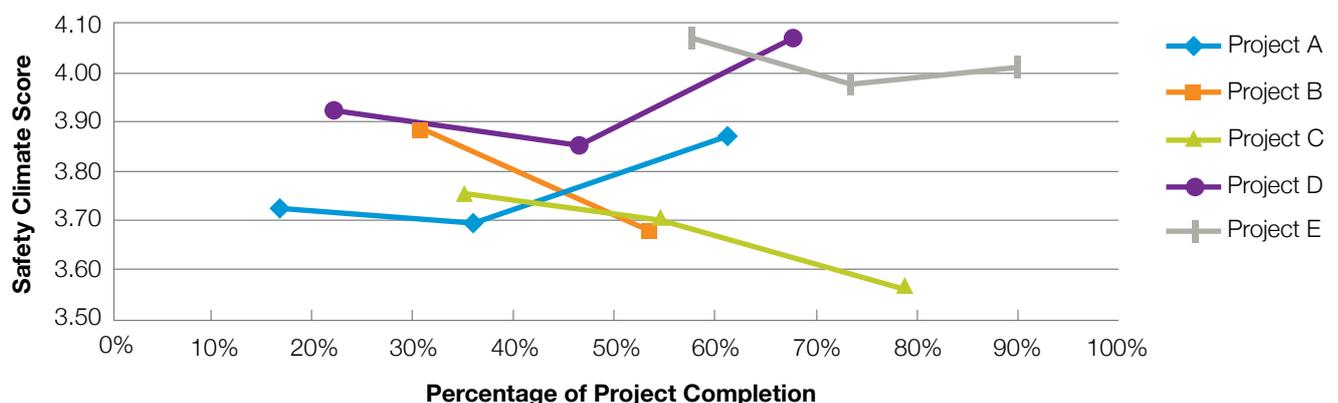
This process has strengthened the operational and theoretical safety links in the region, increasing the relevance of the Centre's safety climate research and ensuring its broad relevance and applicability beyond Fonterra's capital works program.

The measurement of safety climate over time has enabled us to develop benchmark data for safety climate at different points of project operations and to understand dynamic changes in safety climate over the life of construction projects. The longitudinal measurement of safety climate is unusual because most research relies on cross-sectional measures which cannot capture changes over time. This 'snapshot' approach is of limited use in dynamic construction project environments where management priorities can change quickly due to unexpected project events such as program slippages.

Our longitudinal measurement of safety climate can also be used to evaluate the impact of safety initiatives on construction projects. Figure 1 below shows how, at project D, a targeted safety program implemented in response to the climate survey at 47% completion was followed by a significant improvement in safety climate when measured at 68% completion.

Our multi-level safety climate instrument has been tested and validated and is now being used by researchers in both the USA and UK. It has become an internationally accepted instrument.

Figure 1: Safety climate changes as construction activity progresses



Undertaking Research that is Useful to Industry

Rita and Helen have been very supportive with the prompt development of the project-specific survey tools and interpretations of results. Often they provided balance to our thoughts – moving our thinking from large-scale changes to “fine tuning” and leveraging opportunities. Additionally, they have provided an external perspective of scores achieved outside of Fonterra projects and how we may compare. The involved Construction Management Teams (CMT) are starting to develop a strong capability to have robust discussions/debates around the results in their debriefs – originally Helen and Rita were involved with these but there is a feeling there is less need for this – thanks to their mentoring in the earlier debrief sessions.

The intent of the Climate Survey activity was to provide a mirror to our Construction Management Teams about their performance and ‘message sending’ to their project workforce – e.g. Are the right messages being sent? Are they being correctly received by the work teams?

Undertaking three surveys during the length of a project has enabled benchmarking of performance. It has provided the opportunity for the CMTs to reflect on the influence they have on the workforce and contributed to the personal maturity of our leaders. The survey results have also been used to benchmark between projects and set a level of expectation of achievement i.e. If the effort is put into good project planning at commencement we should expect to achieve positive scores in the initial survey, and so on.

Steve Nevin

Risk Manager, Assets and Capital Projects, Fonterra Cooperative Group Ltd

Australian Constructors’ Association

In 2014, the Australian Constructors’ Association (ACA) engaged our Centre to undertake a comprehensive review of the safety culture literature and to develop a safety culture framework and related tool. Rita joined the research team in this work.

Significantly, the ACA report argues that safety culture is an outmoded and unhelpful term. Based on our review of the literature, we argue that safety should be regarded as an outcome rather than a subset of the organisational culture. Framing safety culture as something an organisation either has or does not have suggests that a safety culture can be somehow easily ‘bolted on’ to an organisation. In the report, we argue for a more nuanced approach to understanding how the characteristics of broader organisational cultures can shape the way health and safety is prioritised and applied.

The ACA report identifies nine core components of organisational cultures that can affect health and safety:

- leadership,
- organisational goals and values,
- trust,
- learning,
- resilience,
- responsibility and accountability,
- engagement,
- the provision of a supportive environment, and
- communication.

The report describes the prevailing confusion surrounding the term safety culture and argues that the primary differences between culture and climate relate to their depth, stability over time and the methods of inquiry used to understand them. Some critics of safety

climate measurement argue that climate surveys can never reveal the deep and complex characteristics of organisational cultures that can only be understood through qualitative ethnographic investigations. We agree with this statement, but we argue that safety climate is still a useful concept as workers are highly sensitive 'barometers' who sense changes in managerial emphasis on safety that can sometimes be very subtle and not easily observed. If understood by managers, these changes can be acted upon and addressed.

The ACA report also contains an organisational culture maturity continuum, which plots the progressive development of cultural maturity

across each of the nine components, as well as a multi-faceted climate assessment tool. The maturity continuum has been well-received by industry and is being used to understand the progressive development of organisational cultures that support health and safety in the Australian construction industry. Our Centre is engaged in ongoing work with the ACA to validate the new safety climate tool.

A supportive work climate is an important factor in ensuring the health and wellbeing of an organisation's workforce. Our research into work-life balance, health and wellbeing is described in Part 5 of this booklet.

Industry Publications

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Health and Wellbeing

An interest in health, wellbeing and work/life balance was sparked when Helen had her first child and began wondering how difficult it would be to juggle her job and family while working in the construction industry. At the time, the subject of work and family life had received little or no attention in the construction literature, and the topic was absent from the leading textbooks concerning the management of people in construction.

This prompted Helen to begin reading about the interaction between work and family life. Her thinking was heavily influenced by the work of Rosabeth Moss Kanter who challenged “the myth of separate worlds” and argued that our work and family lives are inextricably intertwined.

Early research looking into the work and family experiences of construction workers revealed alarming results. The levels of work-family conflict experienced by construction industry workers in Australia were extremely high. Also, the relationship between work and family was not symmetrical; work had a far greater disruptive effect on family life than family life did on work.

Our team’s early research in this area was funded by the Construction Industry Institute of Australia and supported by the Queensland Department of Main Roads, Baulderstone Pty Ltd and Leighton Contractors Pty Ltd. The significance of the preliminary findings lay in the international research that clearly and consistently linked work-family conflict to a whole range of negative outcomes for workers, families and organisations, including:

- increased stress and anxiety,
- depression,
- lower job satisfaction,
- heart disease,
- strained family relationships,
- absenteeism,
- burnout, and
- increased turnover.

Further, the research revealed that construction industry workers with family responsibilities used coping mechanisms to deal with work-family conflict and that significantly disadvantaged female workers. Female workers with family responsibilities would take career breaks or scale back their work commitments, which resulted in them being overlooked for career development opportunities or promotion to project management roles. Male workers with family responsibilities were rarely the lead carers within their families, instead relying heavily on stay-at-home partners to take care of children and undertake domestic work.

Having established the magnitude of the work-family problem in the construction sector, the focus of the research then shifted to understanding the factors that create work-family conflict, and those which potentially support workers in better managing the work-family interface. In 2007, in collaboration with Dr Valerie Francis, Helen won an ARC grant to investigate how construction workers experience work-family interaction throughout the life of a construction project. This research was supported by Baulderstone Hornibrook Pty Ltd, Contexx Pty Ltd and Workforce Victoria.

Dr Michelle Turner was engaged as a researcher in this project, while developing her own Ph.D. research focusing on work-life fit in the construction industry. Michelle completed her Ph.D. in the Centre for Construction Work

Health and Safety Research in 2013 and is now a successful researcher in her own right. She continues to engage in research in the Centre, focusing on workers' health and wellbeing and resilience.

Having an Impact Through Research Training

I undertook a Master of Project Management (MPM) at RMIT. As part of the program I completed research in work-life balance and was supervised by Professor Helen Lingard. I had the opportunity to participate in a research project being conducted by the Centre and was invited to undertake a Ph.D. following completion of the research.

Construction is a high risk environment for poor work-life balance, and mental and physical health disorders. I used an innovative Q methodology approach to map the demands and resources experienced by construction workers in different family, life-stages and age brackets. I examined the ways that these configurations created levels of work-life fit (or mis-fit) and the ways these configurations impacted workers' health and wellbeing.

I was able to identify the way in which demands and resources interact in complex ways across a worker's life to shape the health of the construction workforce. In examining the interactions between work, family and community demands and resources, my research reflected the fact that work and non-work lives are inextricably linked.

Workers' health is best understood using a social ecological framework in which job quality and demands experienced at work interact with family and community demands and resources in order to produce work-life fit and good health or work-life misfit and poor health.

Members of the Centre are experienced researchers who provided excellent guidance and support throughout my candidature. I enjoyed undertaking my Ph.D. and gained a great deal of satisfaction.

The Centre's work is innovative and the researchers have a wide variety of experience which enables ongoing learning. The research is well regarded by industry as it relates to real world problems experienced by workers of the construction industry.

I enjoy working with industry stakeholders to explore a problem and work through possible solutions which can be practically implemented.

Dr Michelle Turner

Former Ph.D. student and Senior Lecturer in the School of Property, Construction and Project Management, RMIT University

The ARC project data was collected at live construction projects, including the West Gate Freeway Alliance project. Quantitative and qualitative data was collected using a combination of surveys, interviews and focus groups, but an innovative feature of data collection was the use of workers' diaries. The diaries allowed researchers to collect data over time to understand how workers' experiences of work and family life unfolded and changed in relation to project events.

The research confirmed very high levels of time-based and strain-based work-to-family conflict at participating sites. Hours of work were long and workers routinely worked non-standard hours. Regular weekend work and low levels of job schedule autonomy were also significantly related to work-family conflict.

The research also revealed a strong link between project events, work hours and the quality of work-family interaction. Stress and conflict peaked as major project milestones approached.

Our ARC research coincided with an emerging interest in the international literature in the positive interaction between work and family life, i.e., the possibility of mutual benefits flowing between work and family. International researchers were moving away from a sole focus on work-family conflict and were beginning to examine broader concepts, such as facilitation, enrichment and positive spillover. These concepts had never been examined in the construction context. Our research revealed that having a supportive supervisor, work schedule flexibility and being able to exercise some autonomy or control over one's work time enabled workers to achieve a more satisfactory work-life fit and was significantly linked to higher levels of work-family enrichment.

The results of this research produced valuable new knowledge that informed the development of organisational work-life policies and programs in our partner organisations and also informed policy through the Working Families Council: Strategic Action Plan 2010-2013.

Our Centre's researchers continued to work with the Victorian Government Department

of Business and Innovation, delivering a collaborative research project with Professor Sara Charlesworth exploring work-family experiences in small to medium sized enterprises (SMEs) in the construction sector. Sara had previously undertaken a large cross-sectional representative survey of workers in regional and metropolitan areas of Victoria, in which she applied Barbara Pocock's Australian Work and Life Interference Index (AWALI) to measure work-life experiences. Building on this work, Helen and Sara interviewed workers in construction SMEs. The interview data revealed that workers in medium sized organisations were often engaged in larger construction projects, sometimes as subcontractors to larger firms, and felt increased time pressures in their work. While workers in smaller firms worked closely with the business owner and could often request informal supports to manage work-family clashes, workers in medium sized organisations did not enjoy this close personal relationship with the business owner, but neither were they protected by the types of formal human resource policies and procedures that are in place in larger organisations. These findings provide evidence for the need to tackle work-life interface using different approaches in organisations of different sizes.

Job Design

Originally, the work-life balance and WHS streams of research activity in the Centre were treated as being unrelated. However, the growing recognition that job quality and the way work is organised have a significant impact on workers' health and wellbeing became apparent in research undertaken on behalf of the Queensland Government's Department of Justice and Attorney General (DJAG).

In 2013, the Queensland DJAG engaged the Centre to undertake research to design, implement and evaluate health promotion interventions in the Queensland construction industry. Unlike much of the previous work of the Centre, this research focused exclusively on site-based manual, non-managerial construction workers. The research was undertaken as part of the Healthier, Happier,

Workplaces Initiative, and was supported by the Lendlease Foundation.

The research brief required the use of a participatory action research approach to address five health-related behaviours or factors, namely:

- smoking,
- nutrition,
- alcohol consumption,
- physical exercise, and
- overweight/obesity.

Targeted health improvement strategies were implemented at participating construction sites for each of the five factors. However, diary data collected from workers revealed no sustained improvement in health-related behaviours and data collected during evaluation workshops and follow-up interviews revealed significant environmental impediments to the adoption

of healthy lifestyle behaviours. In particular, excessive hours of work, often combined with long commute times, concerns relating to job security, and tensions between work and family life were cited as reasons why workers did not change their behaviours. The workers identified that having a work environment that is supportive of healthy behaviour is critical to them being able to change their health-related behaviours.

These research results highlighted the need for an integrated approach to workers' health and work-family interaction. Indeed, the factors that negatively affect work-family relationships are also impediments to engaging in healthy lifestyle behaviours.

Lendlease continues to work with the Centre to identify more effective ways to design work that promotes and improves workers' health, wellbeing and work-life interaction.

Translating Research into Industry Practice

The 'Work health in the construction industry' project proved to be a valuable and productive relationship for WHSQ. The research team were able to take their thorough knowledge and expertise of the construction setting and apply it to better understanding the health and wellbeing of construction workers, an emerging area of interest for work health and safety regulators. The findings gave WHSQ and the participating workplaces an insight into what factors really impact on the health and wellbeing of construction workers and gives a clear direction on what good practice looks like.

The research outputs of the Centre so far have been an important step in helping industry become more evidence-based, by translating research findings to industry practice in areas such as health and wellbeing, safety climate/culture, safety in design and supply chain engagement.

The Centre's ability to deliver research that is meaningful and practical provides a great opportunity to get knowledge to the people in industry that need it most, promote new and innovative practices and contribute to better health, safety and wellbeing outcomes in the Australian construction industry.

Elliot Parkinson

*Principal Advisor, Construction Strategy Unit,
Workplace Health and Safety Queensland (WHSQ)*

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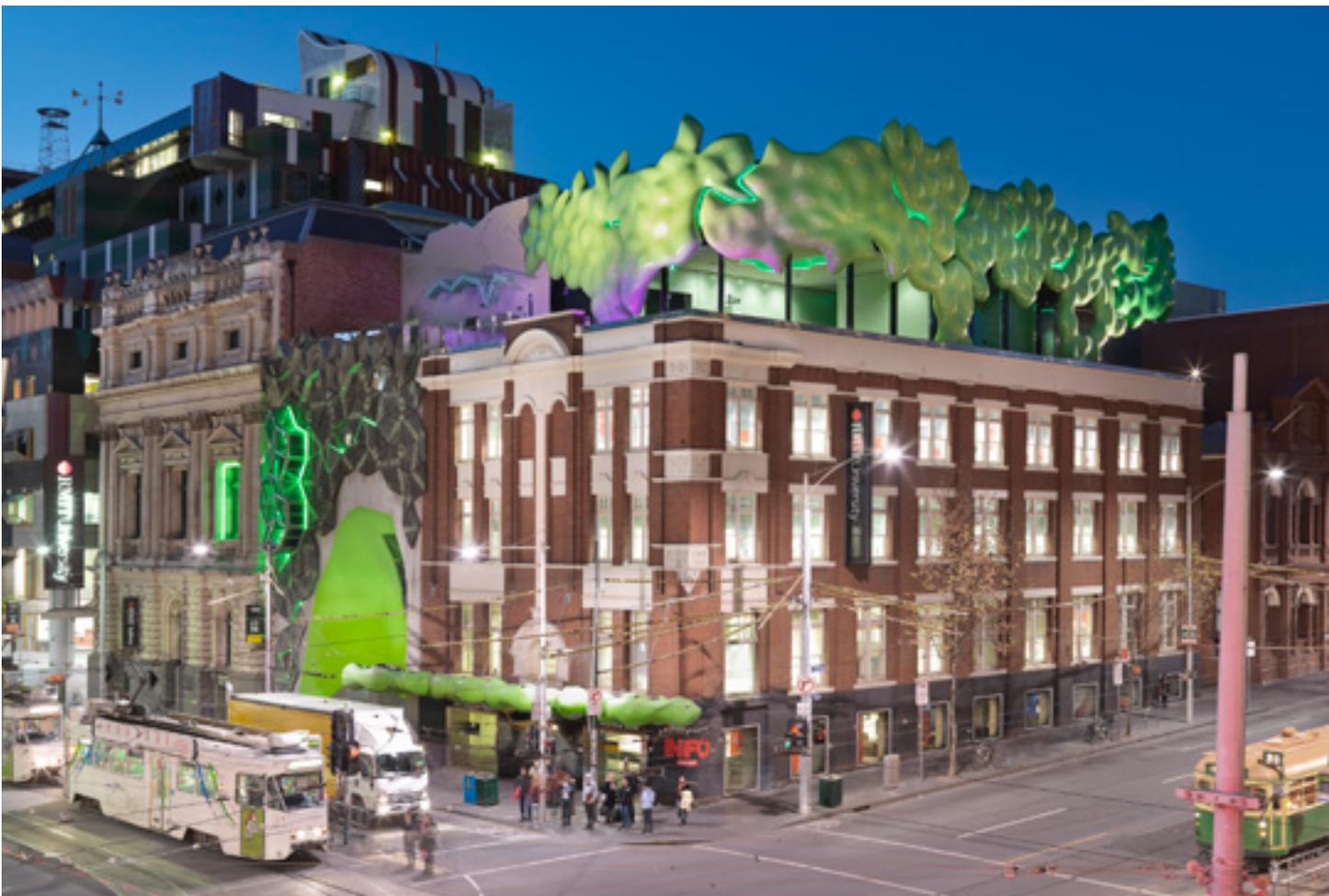
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Safety in Design

Nick joined RMIT after having worked with Professor Alistair Gibb at Loughborough University in the UK. At Loughborough, Nick had worked on developing tools and resources to support the implementation of safety in design in the UK construction industry, following the introduction of the Construction (Design and Management) Regulations.

A review of the Victorian Occupational Health and Safety Act (1985) had been undertaken by Chris Maxwell QC and published in 2004. The Maxwell Review recommended that specific responsibilities for the designers of buildings and structures be included in the occupational health and safety legislation in Victoria by 2005. Around this time, when our research team was in its infancy, a significant policy debate about the regulation of safety in design was taking place. In 2006, Victoria became one of the first Australian jurisdictions to include safety in design requirements in its principal Occupational Health and Safety Act. Questions about how this would work in practice were very prominent.

Today, safety in design is a core element of government policy and is a 'key action area' in the Australian Work Health and Safety Strategy 2012-2022. However, when safety in design responsibilities were first introduced into the Victorian occupational health and safety legislation, concerns were raised about the extent to which designers should be responsible for people who interact with structures during their use, operation and maintenance. Causing even greater concern was the suggestion that designers should consider the health and safety of people who construct, erect or install components of a building or structure.

Our very early research into safety in design sought to identify ways in which designers could be provided with detailed knowledge about the implications of their design decisions, so that

they may be better equipped to improve the safety of people interacting with the buildings/structures at various stages in the life cycle.

In 2006, leveraging off Nick's safety in design research experience in the UK, we were awarded a grant by the Department of Communication, Information Technology and the Arts under the Information Technology On-line Scheme. This funding was awarded to develop a web-based knowledge-management tool to deliver OHS decision support to building/construction designers. RMIT researchers teamed up with Associate Professor Andrew Stranieri from the Centre of Informatics and Applied Optimisation at Ballarat University (now Federation University).

Andrew had developed experience in producing models to represent ways in which knowledge is used in discretionary decision-making in the legal and medical fields. Drawing upon Andrew's expertise, we developed an argumentation-based method for assessing the extent to which different decisions made in the design of the roof of a building were associated with risk to the health and safety of maintenance workers. First, we worked with a multi-stakeholder group of industry experts. This group included safety professionals, engineers, facilities managers and construction personnel. We asked them about the different features of roof design, such as pitch, surface material, layout and accessibility, and explored in great detail the safety implications of the different options for each feature. We then considered how the relative risk of these design options could be impacted by other building or environment features, such as height or wind loading. We compiled this information into multiple interactive weighted decision trees that represented all of the different options in combination and produced a determination, based on the experts' evidence, as to the extent to which a particular roof design would present a high, medium or

low risk of a maintenance worker falling from height. This knowledge was embedded into a prototype online decision support tool, known as ToolSHeD (Tool for Safety and Health in Design). ToolSHeD could be used by designers to assess their design, and to review and change their design as needed, to produce the desired level of risk.

The ToolSHeD concept was well received by design professionals as the information it contained was presented in a way that could be easily understood and applied to practical design decisions. However, the knowledge base underpinning it was large and cumbersome, and there were some unresolved challenges about how such a knowledge base could be kept up to date to reflect new technologies and safety in design solutions.

The ToolSHeD experiment raised interesting questions about how knowledge about work processes and health and safety could be made available to designers to enable improved design decision-making in the interest of workers' health and safety. It was increasingly apparent that the expectation that safety in design could easily be managed using a simple linear risk management process of progressively more detailed safety in design risk reviews was not realistic.

In 2008, together with architecture researchers from The University of Melbourne, Helen and Nick were awarded an ARC Discovery Grant to explore the way in which professional responsibility for safety in design could realistically be applied in the construction industry. This work involved undertaking a detailed analysis of the way in which design decisions 'unfold' in the dynamic and iterative process of building design. It was identified that the social and material complexity of design work led to frequent changes, and that a negotiation of trade-offs took place as new information came to light and as stakeholders' interests evolved. The emergent nature of design, and the way in which decisions were shaped through complex processes of negotiation and interactions between technology, materials and project participants,

revealed that the application of a series of risk management workshops at various stages of design development was inherently limited because design is a much more fluid activity than these processes imply. The case studies also revealed serious challenges inherent in attributing responsibility for safety in design to a single actor (i.e. "the designer") because design work is a socially complex process. Indeed, some decisions that significantly impacted on safety outcomes were made by external stakeholders who were not contractually involved in our case study projects. Issues, such as the selection of project delivery method and structures of project governance were also important client decisions that impacted the way safety in design could be practically implemented.

Our writing about the problem of attributing professional responsibility for safety in design received international recognition. In 2011, an internationally refereed conference paper titled "Who is 'the designer' in construction occupational health and safety?" by authors Helen Lingard, Tracy Cooke and Nick Blismas was awarded The Chartered Institute of Building (CIOB) Prize for Best Research Paper at the 27th Annual Association of Researchers in Construction Management (ARCOM) Conference, Bristol, 5-7th September 2011.

The Discovery Grant research raised more questions than it answered, but it did highlight that safety in design in the construction industry is a concept more difficult to implement than the legislation and standard risk management methods would suggest.

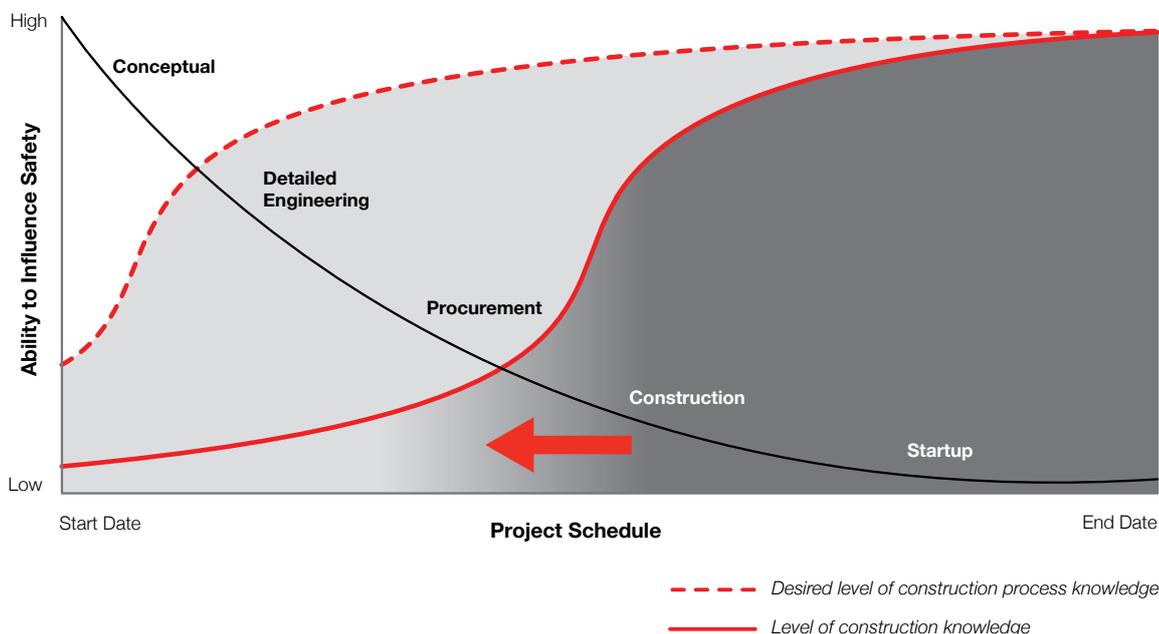
In 2009, our Centre was awarded a five-year international benchmarking research project funded by the US Government Centers for Disease Control/National Institute for Occupational Safety and Health (CDC/NIOSH). We were awarded this work under a subcontract arrangement with the Center for Innovation in Construction Occupational Safety and Health at Virginia Tech. The benchmarking study examined ways to develop a whole of industry approach to managing WHS through the construction supply chain.

This research had a number of component parts. First, we undertook a detailed social network analysis of the ways in which construction project participants interacted and communicated information during different stages of project activity, e.g. the planning, design and construction stages. We analysed the ways in which decisions were being made in multiple case study construction projects and used the hierarchy of control (HOC) to objectively score the WHS risk control outcomes that were ultimately achieved in these projects. Higher scores reflected the adoption of technological solutions to identified WHS hazards, while lower scores reflected a reliance on less effective administrative or behavioural controls. The resulting analysis revealed that significantly higher HOC scores were achieved when:

- WHS hazards were identified and addressed early in the process (i.e. before construction work commenced), and/or
- people with construction process knowledge (i.e. the constructors and subcontractors) were central to decision-making in the pre-construction stages of a project.

Through this research we clearly and statistically demonstrated the benefit of thinking about construction workers' WHS early in the life of a construction project and the importance of engaging people with construction process knowledge early in project decision-making (Figure 2). Problematically, this is not always possible in some project delivery situations since detailed construction process knowledge may reside with specialist subcontractors who may not be engaged during the design stage, even in more integrated design and construct procurement approaches.

Figure 2: Forward knowledge about construction decision-making



Nonetheless, the research provides, for the first time, tangible evidence based upon empirical social network metrics of the importance of early constructor engagement and the potential WHS benefits to be gained from feeding forward knowledge about construction processes

into pre-construction project decision-making (as represented in Figure 2).

A Research-to-Practice report was developed as an output from this research and provided to Virginia Tech and CDC/NIOSH. The report contains practical tools that organisations

can use to identify, understand and manage stakeholders' influences on WHS in construction projects and assess their effectiveness in undertaking safety in design activities.

This work has also received international recognition. In 2014, an internationally refereed conference paper titled "Construction hazard prevention: the need to integrate process knowledge into product design," by authors Ron Wakefield, Helen Lingard, Nick Blismas, Payam Pirzadeh, Brian Kleiner, Thom Mills,

Andrew McCoy and Lance Saunders, received the award for the "Best Research Paper" at the *International Council for Building: Achieving Sustainable Construction Health and Safety Conference* in Lund, Sweden.

Mr Payam Pirzadeh played a key role in analysing the data collected in the NIOSH research and he is extending his use of social network analysis in project teams in his own doctoral research project. He is currently undertaking his Ph.D. in the Centre.

Building Successful International Partnerships

Virginia Tech has held a long-standing relationship with RMIT's School of Property, Construction and Project Management, and the Centre for Construction Work Health and Safety. A prime example of the nature of this partnership can be illustrated by a five-year research grant funded by the US National Institute for Occupational Safety and Health. This particular project provided a benchmark for international collaboration. With three faculty at RMIT, and three faculty at Virginia Tech (and respective students), the collaboration was balanced, productive, effective, and impactful. A disproportionate number of scholarly outputs resulted (compared to similarly sized grants), but more importantly, information was gleaned that translates into worker health and safety. RMIT was particularly valuable in the translation phase, given their close relationship with industry partners. While the project has formally ended, the partnership thrives through new proposals, publications and more.

Dr Brian M Kleiner

School Director, Myers-Lawson School of Construction, and NIOSH project Principal Investigator, Virginia Tech, USA

In 2012, again in collaboration with Andrew Stranieri, the Centre was awarded an ARC Linkage Grant to continue working on the knowledge capture and transfer methods first developed in the ToolSHed project. In particular, this Linkage project, which was awarded in partnership with Hyder Consulting Pty Ltd (now Arcadis), aimed to use an experimental design to evaluate whether providing WHS knowledge to designers in different forms improved the quality of safety in design decision-making. During this project, different ways of presenting WHS information to designers were evaluated. Of particular note, safety in design infographics were developed, depicting common construction technologies and erection processes deployed

in the installation of building façade systems. These infographics combined visual prompts with textual WHS information and annotations explaining the links between façade design features and WHS risk. The infographics were well received by designers who participated in the evaluation workshops. Participants found the graphical-textual combination easier to use and interpret than written information, such as that presented in tree diagrams or structured checklists. An evaluation of designers' ability to identify WHS hazards inherent in a façade design revealed that the infographics extended and broadened designers' ability to recognise and understand the WHS hazards that could arise during the processes of delivery, erection and installation.

In 2014, our Centre was engaged by the Australian Constructors' Association to undertake a comprehensive review of safety in design literature, policy and practice. The resulting research report formulated eight recommendations relating to: the effective organisation and management of safety in design reviews; the engagement of relevant stakeholders in safety in design activities; communicating health and safety risk

information; and ensuring appropriate design change management methods are in place to cope with emergent hazards.

As a flow-on from the use of infographics to communicate WHS information within design teams, our researchers have developed a keen interest in understanding visual tools to understand and improve WHS in construction projects. This work is described in Part 7 of this booklet.

Delivering International Research Training in Construction WHS

Upon completion of a Master of Civil Engineering in Malaysia, I decided to pursue my Ph.D. in the field of construction management, focusing on Industrialised Building Systems (IBS) and work health and safety. I was granted a scholarship by the Ministry of Higher Education (Malaysia) and I chose to pursue my Ph.D. at the School of Property, Construction and Project Management (specifically under the Centre) due to its well-known reputation in the field of health and safety (H&S) and its highly knowledgeable staff. I was supervised by Professors Nick Blismas and Helen Lingard.

My Ph.D. thesis, titled "Development of a Knowledge-Based Energy Damage Model for Evaluating IBS OHS Risk", provides a comparative evaluation of the H&S risk presented by different construction approaches, namely IBS and traditional methods. The evaluation involved developing a model based on the concept of 'argumentation theory', which helps construction designers integrate the management of H&S risk into the design process. In addition, an 'energy damage model' was used as an underpinning framework.

In order to develop the model, I collected data on the activities of different construction processes and their associated H&S risks through field observation and interviews in five different case studies. I also studied H&S guidance materials, industrial standards and codes to gather additional 'knowledge'. Using a combination of these data, I developed a model which represents a reasoning template helping designers when making judgments about their designs. I also undertook a model validation process with the help of an expert panel, in which their opinions and judgments were used to revise and amend the developed model.

My research revealed that different approaches/methods of construction carried different levels of damaging energy, depending on how the activities were carried out. This showed how risks change during the construction process, and that there is a difference in the profile of H&S risk between IBS construction and traditional methods. Outcomes from this study provide a way for construction designers to integrate process knowledge and awareness of H&S risk variables into design to eliminate hazards or reduce risks in construction.

I really enjoyed undertaking my Ph.D. in the Centre. Members of the Centre were very helpful and provided continuous support, guidance, advice, suggestions and constructive criticism. They provided encouragement throughout my research period. Overall, the Centre offers a platform to excel in H&S research and I am proud to have been part of it.

Dr Nor Haslinda Abas

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Industry Publications

Helen Lingard, Nick Blismas, Rita Zhang, Payam Pirzadeh, Kevin Jones, James Harley & Ron Wakefield. (2015) *Engaging stakeholders in improving the quality of OSH decision-making in construction projects*, Centre for Construction Work Health and Safety Research, RMIT University, Melbourne (67 pages).

Helen Lingard, Payam Pirzadeh, James Harley, Nick Blismas & Ron Wakefield. (2014) *Safety in design*, Australian Constructors Association/RMIT University, Sydney. (96 pages).

Academic Publications

Dong Zhao, Andrew McCoy, Brian Kleiner, Thom Mills, & Helen Lingard. (2016) 'Stakeholder perceptions of risk in construction', in *Safety Science*, Elsevier BV, Netherlands, vol. 82, pp. 111-119.

Lance Saunders, Brian Kleiner, Andrew McCoy, Helen Lingard, Tom Mills, Nick Blismas & Ron Wakefield. (2015) 'The effect of early supplier engagement on social sustainability outcomes in project-based supply chains', in *Journal of Purchasing and Supply Management*, Pergamon Press, United Kingdom, pp. 1-11.

Helen Lingard, Rita Zhang, Nick Blismas, Ron Wakefield & Brian Kleiner. (2015) 'Are we on the same page? Exploring construction professionals' mental models of occupational health and safety', in *Construction Management and Economics*, Routledge, United Kingdom, vol. 33, no. 1, pp. 73-84.

Helen Lingard, Payam Pirzadeh, Nick Blismas, Lance Saunders, Brian Kleiner & Ron Wakefield. (2015) 'The relationship between pre-construction decision-making and the quality of risk control: testing the time-safety influence curve', in *Engineering, Construction and Architectural Management*, Emerald Group, United Kingdom, vol. 22, no. 1, pp. 108-124.

Rita Zhang, Helen Lingard, Nick Blismas, Ron Wakefield & Brian Kleiner. (2015) 'Exploring the work health and safety risk perceptions of construction industry stakeholders using photograph-based Q-methodology', in *Journal of Construction Engineering and Management*, vol. 141, pp. 1-13.

Ruwini Edirisinghe, Andrew Stranieri, Nick Blismas & James Harley. (2015) 'Perceptions of façade risks: a preliminary analysis towards presentation of knowledge graphically', in *Proceedings of CIB W099 International Health and Safety Conference: Benefitting Workers and Society through Inherently Safe(r) Construction (CIB W099)*, Mike Behm, Ciaran McAleenan (ed.), CIB, Rotterdam, Netherlands, pp. 373-382 (CIB W099: Safety and Health in Construction)

Payam Pirzadeh, Helen Lingard, Nick Blismas, Thom Mills & Brian Kleiner. (2015) 'Proactive evaluation of occupational health and safety performance in construction projects using the hierarchy of controls concept', in *Proceedings of CIB W099 International Health and Safety Conference: Benefitting Workers and Society through Inherently Safe(r) Construction (CIB W099)*, Mike Behm, Ciaran McAleenan (ed.), CIB, Rotterdam, Netherlands, pp. 438-448 (CIB W099: Safety and Health in Construction)

Helen Lingard, Payam Pirzadeh, Nick Blismas, Lance Saunders, Ron Wakefield & Brian Kleiner. (2014) 'Exploring the link between early constructor involvement in project decision-making and the efficacy of health and safety risk control', in *Construction Management and Economics*, vol. 32, no. 9, pp. 918-931.

Ron Wakefield, Helen Lingard, Nick Blismas, Payam Pirzadeh, Brian Kleiner, Thom Mills, Andrew McCoy & Lance Saunders. (2014) 'Construction hazard prevention: the need to integrate process knowledge into product design', in *Proceedings of CIB W099: International Conference on Achieving Sustainable Construction Health and Safety*, R. Aulin, A.Ek (ed.), Lund University, Lund, Sweden, pp. 425-437 (CIB W099)

Rita Zhang, Helen Lingard, Nick Blismas, Ron Wakefield & Brian Kleiner. (2014) 'Analysis of difference/similarity between construction project participants work health and safety (WHS) risk perceptions', in *Proceedings of the CIB W099 Conference, Achieving Sustainable Construction Health and Safety*, R. Aulin & A.Ek (ed.), Lund University, Sweden, pp. 468-480 (CIB W099 2014)

Academic Publications *continued*

Helen Lingard & Ron Wakefield. (2013) 'A voluntary approach to designing for safer construction', in *Proceedings of Institution of Civil Engineers: Management, Procurement and Law*, ICE Publishing, United Kingdom, vol. 166, no. 5, pp. 249-259.

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Nor Haslinda Abas, Nick Blismas and Helen Lingard. (2013) 'Knowledge-based energy damage model for evaluating Occupational Health and Safety (OHS) construction risks in Malaysia', in *HKU-HKHA International Conference 2013 - Construction and Housing in the 21st Century*, Liu, A.M. M., Rowlinson, S., Ng, T.S.T., Lu, W.W.S. and Chan, I. Y. S. (ed.), University of Hong Kong, Hong Kong, China, pp. 408-415 (HKU-HKHA International Conference 2013)

Helen Lingard, Tracy Cooke & Nick Blismas. (2012) 'Designing for construction workers' occupational health and safety: a case study of socio-material complexity', in *Construction Management and Economics*, Routledge, United Kingdom, vol. 30, no. 5, pp. 367-382.

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Helen Lingard, Tracy Cooke, Nick Blismas & Brian Kleiner. (2011) 'A socio-technical systems analysis of OSH decision-making in the early stages of construction projects', in *Proceedings of CIB W099, Prevention: Means to the End of Construction Injuries, Illnesses, and Fatalities*, Jack Davis (ed.), Virginia Tech, Washington DC, USA, pp. 1-16 (CIB W099)

Nor Haslinda Abas, Nick Blismas & Helen Lingard. (2011) 'Development of a knowledge-based energy damage model to assess occupational health and safety (OHS) construction risks in Malaysia', in *Prevention: Means to the End of Construction Injuries, illnesses, and Fatalities*, Jack Davis (ed.), Virginia Tech, Washington, United States, pp. 1-16 (CIBW099 Prevention: Means to the End of Construction Injuries, illnesses, and Fatalities)

Helen Lingard, Tracy Cooke & Nick Blismas. (2011) 'Who is 'The Designer' in construction occupational health and safety?', in *Proceedings of the ARCOM Twenty-seventh Annual Conference*, Charles Egbu and Eric Choen Weng Lou (ed.), Association of Researchers in Construction Management (ARCOM), University of Reading, Reading UK, pp. 299-308 (ARCOM Twenty-seventh Annual Conference)

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Rafiq Choudhry, Helen Lingard & Nick Blismas. (2009) 'Designing for safety: perspectives from the European Union, United Kingdom, Australia and United States pertaining to safety and health in construction', in *Proceedings of the CIB W99 International Conference: Working Together: Planning, Designing and Building a Healthy and Safe Construction Industry*. Eds H. Lingard, T. Cooke & M. Turber, Melbourne, Australia.

Tracy Cooke, Helen Lingard & Nick Blismas. (2009) 'Construction hazards prevention through design (CHPtD): a comparison of different mechanisms for regulation', in *Proceedings of the Australian Building Codes Board 'Building Australia's Future' International Conference*, Dr George Zillante, Nicholas Chilseshe, Stephen Pullen, Jian Zuo (ed.), Australian Building Codes Board (ABCB), ACT, Australia, pp. 1-13 (Australian Building Codes Board 'Building Australia's Future' International Conference)

Academic Publications *continued*

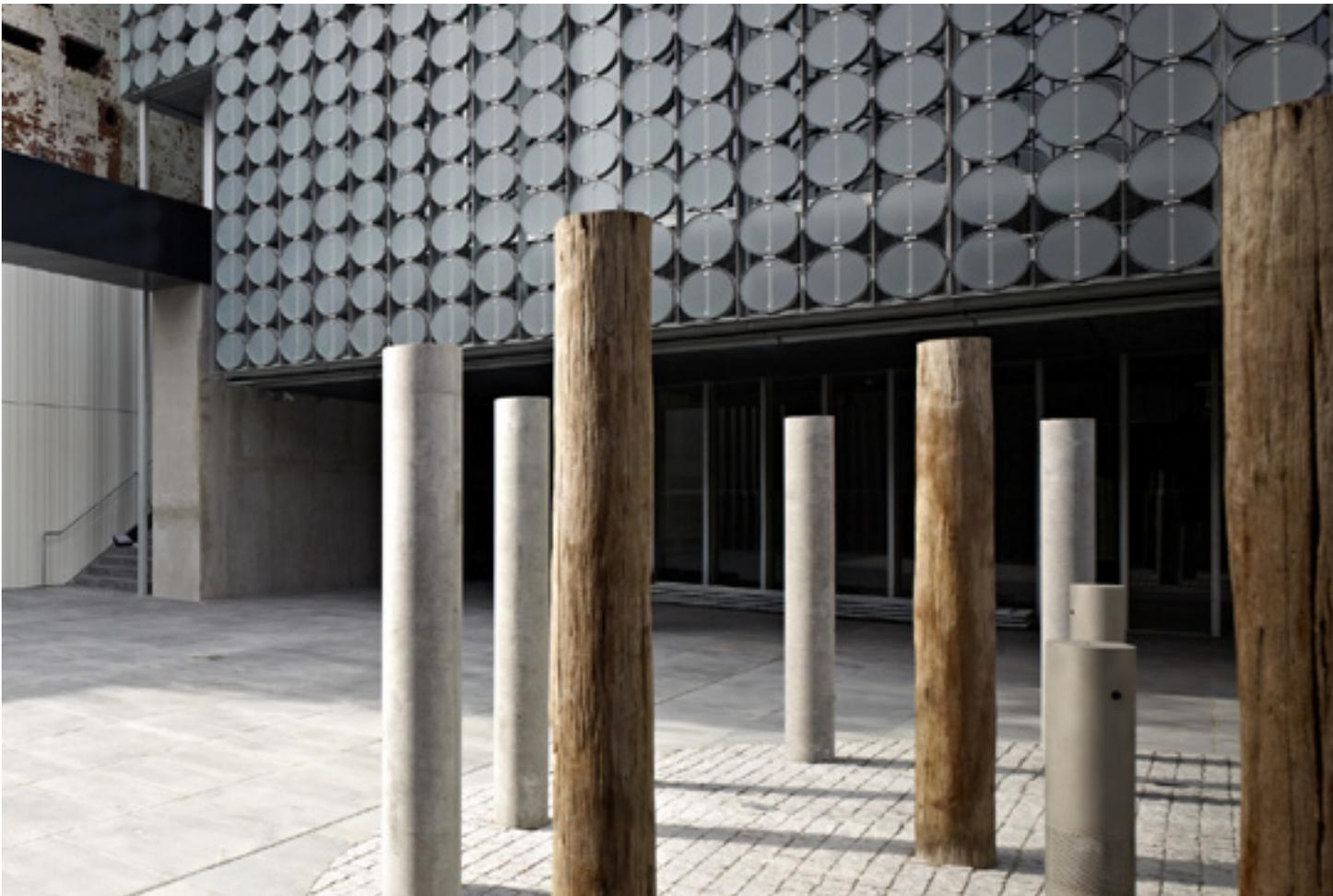
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Tracy Cooke, Helen Lingard, & Nick Blismas. (2007) 'On-line OH&S risk assessment for construction designers: The ToolSHeD prototype', in *Proceedings of the 23rd Annual ARCOM Conference*, Belfast, UK, September 3-5, 2007.

Helen Lingard, Paolo Tombesi, Nick Blismas & Blair Gardiner. (2007) 'Guilty in theory or responsible in practice? Architects and the decisions affecting occupational health and safety in construction design', in *Take 5: Looking ahead: defining the terms of a sustainable architectural profession*, Royal Australian Institute of Architects, Canberra, ACT, Australia, pp. 49-60.

Helen Lingard, Andrew Stranieri & Nick Blismas. (2006) 'Supporting the design OHS process: a knowledge-based system for risk management', in *Proceedings for the Cooperative Research Centre (CRC) for Construction Innovation's Second International Conference – Clients Driving Innovation: Moving Ideas into Practice.*, John McCarthy (ed.), Icon.Net Pty Ltd, Australia, pp. 225-234 (Cooperative Research Centre (CRC) for Construction Innovation's Second International Conference – Clients Driving Innovation: Moving Ideas into Practice.)

Helen Lingard, Andrew Stranieri & Nick Blismas. (2006) 'Supporting the design OHS process: a knowledge-based system for risk management', in *Proceedings of the Cooperative Research Centre (CRC) for Construction Innovation Third International Conference, Clients Driving Innovation: Benefiting from Innovation*, March 12-14, 2006, Brisbane. Published on CD-Rom, no pagination.



Visual Methods

A recent development for the Centre has been the use of visual methods to explore WHS issues and communicate WHS information; an approach that is not widely used in construction or WHS research. Many construction workers have relatively low levels of literacy and an increasing number of workers come from non-English speaking backgrounds, yet written forms of WHS information still dominate communication. The Centre for Construction Work Health and Safety Research has pioneered the use of images and other visual tools to explore people's understanding of WHS and their perceptions of risk.

In a pioneering project in 2013, Ron teamed up with Associate Professor Stefan Greuter, Director of the RMIT Centre for Game Design Research, Dr Frank Boukamp and Associate Professor Susanne Tepe. Together, they developed a game about the hazards encountered on construction sites. This game, called 'Trouble Tower,' was designed to provide information replicating WHS induction training, in a user-friendly and engaging format. An evaluation revealed that students found the game to be fun, engaging and useful. Trouble Tower is now deployed as a learning tool in the RMIT WHS curriculum.

The value in using images was further reinforced when our team conducted a multi-disciplinary collaborative research project. During the preliminary stages, one of the Centre's researchers, Tracy Cooke, photographed a number of building features that she believed presented a clear hazard to workers who would have to undergo routine maintenance work. She brought these photos to a research team meeting. At this meeting there was fierce disagreement about the extent to which these building features presented a danger to maintenance workers. Some team members perceived the danger to be unacceptably high and could readily imagine an incident. Other team members saw no inherent danger in the buildings. We discussed this as a research team

and decided there would be benefit in using photographs as stimuli in a study to explore differences and similarities in stakeholders' perceptions of WHS danger implicit in the use of common building technologies or methods.

We collected photographs depicting different designs and installations of façade systems, roof systems, building structures and building services. We then asked participants from different professional backgrounds in the construction industry to sort the photos according to their own perceptions of WHS danger to construction workers. Participants were then interviewed individually to explore the reasons behind their sorting patterns. The results revealed considerable variation between participants showing extreme differences. Participants' responses seemed to relate to their experience and involvement in projects in which the different technologies had been used. This research provided a much better understanding of the inherent danger and potential WHS issues associated with the different building systems or technologies. It also highlighted the need to understand safety from different perspectives.

As a result of this work, the Centre developed a tool, termed "Do you see what I see?" This tool provides an image-based protocol to develop shared mental models of WHS in diverse construction project teams.

As an extension of this image-based approach, the Centre joined with a small start-up firm called CodeSafe Solutions to understand how video could be used to capture and represent WHS knowledge and communicate information to construction workers using digital/mobile technologies.

Dr James Harley spent time onsite in Canberra and Melbourne, observing CodeSafe's participatory video process. Workers and managers who had participated in the video-making process were also interviewed. Our team observed that the process of engaging

workers in the scripting and development of films about the way they work revealed significant differences in the way that work was planned (i.e. the way that work was described in documented operating procedures) versus the way that work was done. These differences sometimes related to problems inherent in the physical work environment or equipment provided to workers. In some instances, the differences related to workers making adjustments to work tasks to make them more efficient or, indeed, safer. Sometimes, as a direct result of the participatory video process, workers, safety specialists and managers collaboratively re-designed work processes and re-wrote scripts as they co-created safer and healthier ways of working.

Managers reported how the participatory video process produced high levels of trust and unprecedented levels of worker engagement with organisational WHS activities. Workers

enjoyed the participatory video process and appreciated that their input and WHS knowledge was being taken seriously by their employers.

Importantly, workers unanimously indicated a strong preference for visual learning about work and WHS. They all commented that written documents were overly long, complicated and difficult for them to understand. In contrast, videos were easy to understand and could be watched on mobile devices as and when they were needed. They described video as being particularly helpful in communicating “know how,” rather than “know what.”

The Centre's work in exploring unspoken ways of knowing about WHS and the use of digital and mobile technologies is ongoing and we have partnered with Professor Sarah Pink, Director of RMIT's Digital Ethnography Research Centre, to develop this research further in the future.

Working Closely with Industry Partners

Through our research collaboration with the Centre for Construction Work Health and Safety Research, we have gained a far better understanding of how CodeSafe Solutions can benefit the construction industry. We have discovered ways in which we can improve and enhance the service we offer to our clients through what was learnt and explored during the research project. As a relatively young company, our credibility has been dramatically boosted in the eyes of our clients and potential clients as they have engaged with the published research findings. This has, in turn, opened doors to new opportunities as well as prompted us to invest in new product development.

Working with Helen and James made what we initially thought was going to be a complicated, time-consuming and possibly overwhelming research project, a seamless, enjoyable experience. They had a deep respect for our time and understood how valuable it was to our growing business. Because of their understanding and experience, their research activities had minimal disruption to our workflows and the workflows of our clients, creating a positive experience for all involved.

The research that we have done with RMIT to date has triggered so many more avenues to explore that we see an inevitable, ongoing, mutual exploration of concepts between the Centre and CodeSafe. With the construction industry being not only one of the most rapidly changing working environments in the world, but also one of the most dangerous, we predict a constant need for our company to engage with RMIT researchers in discovering, understanding and developing innovative solutions that will engagingly communicate critical information across an ever-increasingly complex supply chain.

Jacqui Broadhurst

Founder and Creative Coach, CodeSafe Solutions

Industry Publications

Helen Lingard, Ruwini Edirisinghe & James Harley. (2015) *Using digital technology to share health and safety knowledge*, Centre for Construction Work Health and Safety Research, RMIT University, Melbourne.

Academic Publications

Helen Lingard, Sarah Pink, James Harley & Ruwini Edirisinghe. (2015) 'Looking and learning: using participatory video to improve health and safety in the construction industry', in *Construction Management and Economics*, Routledge, United Kingdom, pp. 1-12.

Helen Lingard, Rita Zhang, Nick Blismas, Ron Wakefield & Brian Kleiner. (2015) 'Are we on the same page? Exploring construction professionals' mental models of occupational health and safety', in *Construction Management and Economics*, Routledge, United Kingdom, vol. 33, no. 1, pp. 73-84.

Rita Zhang, Helen Lingard, Nick Blismas, Ron Wakefield & Brian Kleiner. (2015) 'Exploring the work health and safety risk perceptions of construction industry stakeholders using photograph-based Q-methodology', in *Journal of Construction Engineering and Management*, vol. 141, pp. 1-13.

Rita Zhang, Helen Lingard, Nick Blismas, Ron Wakefield & Brian Kleiner. (2015) 'An image-based tool for work health and safety (WHS) risk perception communication', in *Proceedings of CIB W099 International Health and Safety Conference: Benefitting Workers and Society through Inherently Safe(r) Construction (CIB W099)*, Mike Behm, Ciaran McAleenan (ed.), CIB, Rotterdam, Netherlands, pp. 133-141 (CIB W099: Safety and Health in Construction)

Stefan Greuter, Susanne Tepe, Frank Boukamp & Ron Wakefield. (2013) 'Trouble Tower game demo', in *Proceedings of IE 2103, the 9th Australasian Conference on Interactive Entertainment*, Melbourne, Australia.

Stefan Greuter, Susanne Tepe, Fiona Peterson, Frank Boukamp, Kim D'Amazing, Kalponica Quigly, Rhys Van Der Waerden, Thomas Harris, Tom Goschnick & Ron Wakefield. (2012) 'Designing a game for occupational health and safety in the construction industry', in *Proceedings of the 8th Australasian Conference on Interactive Entertainment: Playing the System*, Auckland, New Zealand.

Susanne Tepe, Stefan Greuter, Frank Boukamp & Fiona Peterson. (2012) 'Playing 4 safety – designing an engaging hazard recognition game for construction safety induction', in *Proceedings of the CIB W099 International Conference on Construction Health and Safety*, Dr I Krisiani Tjandra, Professor George Ofori, Dr Evelyn Ai-Lin Teo (Eds), Singapore.

The Future

The Centre's projects, activities and membership continue to grow. This creates opportunities for us to engage researchers with different backgrounds and skills in construction WHS research. Particularly exciting new developments include innovative information and communication technology (ICT) applications including remote-sensing, mobile computing and building information modelling.

In 2015, the Centre was joined by a group of researchers working in the Cooperative Research Centre for Energy Pipelines. Under the leadership of Associate Professor Jan Hayes, this group is delivering a research program focused on 'Public Safety and Security of Supply.' The focus of Jan and her team on energy pipelines provides the opportunity to build on existing work underway in the Centre examining health and safety in other linear infrastructure projects, for example, in the road and rail sectors. As sociologists, Jan and her team also bring a new perspective in the analysis of organisational safety to the Centre.

We believe this is important because, while large-scale research projects by scholars from engineering and built environment disciplines have made some inroads into solving these problems, they have not managed to deliver the much-needed step-change in construction WHS. For this reason, the Centre is increasingly working in multi-disciplinary teams, drawing together world-leading Australian and international researchers with expertise in:

- construction project management,
- architecture and design,
- WHS, ergonomics and industrial psychology,
- industrial systems complemented by sociology/anthropology,
- health informatics,
- media and communications,
- virtual reality and gaming,
- work-life balance, health and aging, and
- advanced functional materials and clothing design.

We expect that these relationships will provide opportunities to grow and extend our research program in exciting new directions into the future and we are preparing to submit an application to become an Australian Research Council Centre of Excellence in 2017.

Our partnerships with leading international research institutions and academics engaged in construction WHS research include:

- Loughborough University, United Kingdom
- Virginia Tech., USA
- Hong Kong Polytechnic University, Hong Kong
- The University of Cape Town, South Africa
- Glasgow Caledonian University, United Kingdom
- East Carolina University, USA
- The University of Colorado at Boulder, USA, and
- The University of Hong Kong, Hong Kong.

These international partnerships help to ensure that our research is globally connected and has international impact.

The Centre's aspiration in the coming years is to create a new integrated model for undertaking applied research that crosses multiple disciplines and international boundaries. We anticipate our future program of research will give serious consideration to social trends in digital/mobile media use and opportunities to apply big data analytics to solve complex problems and positively improve construction WHS.

We aim to:

- contribute to a critical knowledge base for the global construction industry, enabling it to be better informed about ways to effectively and significantly reduce the incidence of work-related death, injury and ill-health experienced by construction workers, and
- have a measurable impact on WHS in the construction industry through the conduct of applied research with an emphasis on translating research to practice.

We would like to thank the many people who have actively supported or participated in our construction WHS research program over the past ten years. We value the contributions that you have made to our research successes and we look forward to continuing to serve the construction industry and our discipline in the future.

Collaborative, Multi-Disciplinary Working

I work at the Federation University in Ballarat and have been modeling reasoning and decision making with a particular focus on the legal sector. Many years ago I met Helen and began talking about how building designers make decisions and assess the safety of their designs.

One of the attractions of the work of this Centre is that the nature of the research area is multidisciplinary and relies on collaboration. This cross-disciplinary work is not very common and some find it quite threatening.

The research has shown that we need to go much deeper and beyond quantitative to qualitative analysis to assess the context of the entire industry and the different roles that people have to play. The reasoning models I had been using were the starting point for trying to understand the designers' decisions that make the best contribution to safety.

Nick and Helen are successfully trying to understand the construction industry at the social, psychological and economic levels. Information Technology can help integrate safety in this task.

Dr Andrew Stranieri

Associate Professor School of Engineering and Information, Faculty of Science and Technology, Federation University

Appendix

9.1 Industry Advisory Group Members, Partner Organisations and Research Collaborators

Industry Advisory Group Members

Peter Godfrey (Chair)

Glen Ahsam, Office of the Federal Safety Commissioner

Dr Gerry Ayers, Construction, Forestry, Mining and Energy Union

William Barlow, BILt Environment Consulting

Allan Beacom, WorkSafe Victoria

Amanda Benson, Alex Fraser Group and Safety Institute of Australia, formerly of Qanstruct

David Broadhurst, CodeSafe Solutions

Jonathan Cartledge, Consult Australia

David Cronin, Incolink

John Darcy, Master Builders Association Victoria

Nelson De Sousa, Consult Australia

David Dilisio, SMEC

Anthony Donald, Port of Melbourne Corporation

Murray Duckworth, VicRoads

Dr Karin DuPlessis, Incolink

James Evans, Department of Economic Development, Jobs, Transport and Resources (Victoria)

Taryn Fitzpatrick, Lendlease

Tamara Frigot, Arcadis, formerly of Hyder Consulting

Gary Grant, Evans and Peck

David Gyaw, Port of Melbourne Corporation

Kelvin Genn, Sinclair Knight Merz

Alan Kassas, formerly of Hyder Consulting

Graeme Kaye, Major Projects Victoria

Bruce Kemp, Metro Trains Melbourne

Tony Marino, Probuild Construction

Michael McInerney, Lendlease

Alan Meager, Arup

Peter Morrison, Port of Melbourne Corporation

Tony Page, Laing O'Rourke (formerly of Boulderstone Pty Ltd and Lendlease)

George Papadopoulos, Master Builders Association, Victoria

Nicole Prince, Department of Treasury and Finance

Scott Reid, LU Simon

Robin Schuck, Consult Australia

David Syme, CCF

Hetty Van Der Zwet, Office of Federal Safety Commissioner

Ali Ukur, Aurecon/BHP

Alvin Vink, Aurecon

Chris White, Civil Contractors Federation

Zak Zisopoulos, Aurecon

Partner Organisations

Australian Constructors Association

Boulderstone Pty Ltd

Chartered Institute of Building (Australasia)

CodeSafe Solutions

Construction Industry Institute of Australia

Contexx Pty Ltd

Cooperative Research Centre for Construction Innovation

Department of Justice and Attorney General (Queensland)

Department of Main Roads (Queensland)

Department of State Development Business and Innovation (Victoria)

Engineering Education Australia

The Fonterra Cooperative Group

Hyder Consulting

John Holland Pty Ltd

Leighton Contractors Pty Ltd

Lendlease Group

Metro Trains Melbourne

Office of the Federal Safety Commissioner

The Port of Melbourne Corporation

Roads and Traffic Authority (New South Wales)

West Gate Freeway Alliance

9.2 Other Research from the Centre

Apart from the themes presented in the preceding eight parts, members of the Centre have published on a broad range of health and safety-related topics. Sometimes this has been to address a specific policy debate, or to explore new areas of research. At other times, new methodologies were published to inform the academic community of innovative research approaches to conducting health and safety research. The variety of topics written about have included:

- accident causality,
- corporate social responsibility, particularly around health and safety,
- how to translate research to practice for the industry,
- research methodology, and
- HIV/AIDS in construction.

Significant Publications

Ehsan Gharai, Helen Lingard & Tracy Cooke. (2015) 'Causes of fatal accidents involving cranes in the Australian construction industry', in *Construction Economics and Building*, vol. 15, no. 2, pp. 1-12.

Alex Albert, Matthew Hallowell, Helen Lingard & Brian Kleiner. (2015) 'Multiple baseline testing: an experimental method for drawing causal inferences in construction engineering and management research', in *Journal of Construction Engineering and Management*, 04015012-1 – 04015012-13.

Paul Bowen, Yvette Allen, Peter Edwards, Keith Cattell & Leickness Simbayi. (2014) 'Guidelines for effective workplace HIV/AIDS intervention management by construction firms', in *Construction Management and Economics*, Routledge, United Kingdom, vol. 32, no. 4, pp.362-381.

Paul Bowen, Rajen Govender, Peter Edwards & Keith Cattell. (2014) 'An integrated model of HIV/AIDS testing behaviour in the construction industry', in *Construction Management and Economics*, Routledge, United Kingdom, vol. 32, no. 11, pp. 1106-1129.

Mike Behm, Helen Lingard & Jeffrey Bruening. (2014) 'Validity and reliability of dependent variables: considerations for construction safety researchers', in *Proceedings of the CIB W099 Conference, Achieving Sustainable Construction Health and Safety*, R. Aulin, A. Ek (ed.), Lund University, Lund, Sweden, pp. 609-617 (CIB W099 2014)

Sijie Zhang, Frank Boukamp & Jochen Teizer. (2014) 'Ontology-based semantic modeling of safety management knowledge', in *Proceedings of the 2014 International Conference on Computing in Civil and Building Engineering (ICCBCE)*, Hosted by ASCE, ISCCBE and CIB W078, Wyndham Grand Orlando Resort, Walt Disney World, Orlando, Florida, USA June 23-25, 2014.

Alistair Gibb, Helen Lingard, Mike Behm & Tracy Cooke. (2014) 'Construction accident causality: learning from different countries and differing consequences', in *Construction Management and Economics*, vol. 32, no. 5, pp. 446-459.

Ruwini Edirisinghe, Helen Lingard, Nick Blismas, Dileeka Dias & Ron Wakefield. (2014) 'Device-free detection to improve construction work health and safety', in *Proceedings of 2014 International Conference on Computing in Civil and Building Engineering*, R. I. Issa and I. Flood (ed.), American Society of Civil Engineers, United States, pp. 1078-1085 (Computing in Civil and Building Engineering)

Ruwini Edirisinghe, Helen Lingard, Nick Blismas & Ron Wakefield. (2014) 'Would the time-delay of safety data matter? Real-time active safety system (RASS) for construction industry', in *Proceedings of CIB W099 International Conference Achieving Sustainable Construction Health and Safety*, R. Aulin and A. Ek (ed.), Lund University, Sweden, pp. 564-574 (CIB W099 International Conference Achieving Sustainable Construction Health and Safety)

Helen Lingard, Tracy Cooke & Ehsan Gharai. (2013) 'A case study analysis of fatal incidents involving excavators in the Australian construction industry', in *Engineering, Construction and Architectural Management*, Emerald Group Publishing, United Kingdom, vol. 20, no. 5, pp. 488-504.

Significant Publications *continued*

Helen Lingard, Tracy Cooke & Ehsan Gharai. (2013) 'The how and why of plant-related fatalities in Australia', in *Engineering, Construction and Architectural Management*, vol. 20, no. 4, pp. 365-380.

Rita Zhang, Helen Lingard, Nick Blismas, Ron Wakefield & Brian Kleiner. (2013) 'Application of Q-methodology in studying construction stakeholders' perceptions of OSH risks – an introduction to the preliminary stage', in *Proceedings of the 19th CIB World Building Congress*, Brisbane 2013: Construction and Society. Eds Kajewski, S., Manley, K. and Hampson, K. 5th -9th May 2013.

Andrew McCoy, Lance Saunders, Brian Kleiner & Nick Blismas. (2012) 'Application of safety project interview data to a cyclical research model of translation', in *International Journal of Construction Education and Research*, vol. 8, no. 4, pp. 260–280.

Andrew McCoy, Lilly, J., Helen Lingard & Nick Blismas. (2011) 'Application of safety project interview data to a cyclical research model of translation', in *Prevention: Means to the End of Construction Injuries, illnesses, and Fatalities*, Jack Davis (ed.), Virginia Tech, Washington, United States, pp. 1-21.

Nick Blismas, Andrew McCoy & Helen Lingard. (2009) 'Academic arrogance or industry intransigence: innovation inertia in the construction industry', in *Proceedings of the Global Innovation in Construction Conference*, John McCarthy (chairman) (ed.), University of Loughborough, United Kingdom, pp. 481-491 (Global Innovation in Construction Conference 2009)

Rafiq Choudhry, Helen Lingard & Nick Blismas. (2009) 'Policy, practice, education and research issues in designing for safety', in *Proceedings of the 5th International Conference on Construction in the 21st Century (CITC-V)*, 20-22 May 2009 in Istanbul, Turkey.

Helen Lingard, Tracy Cooke & Michelle Turner. (2009) 'Working together: planning, designing and building a healthy and safe construction industry', in *Proceedings of the CIB W099 Conference*, Melbourne, Australia (21st-23rd October) – Rydges Hotel.

Helen Lingard, Nick Blismas & Peter Stewart. (2009) 'Corporate social responsibility in the Australian construction industry', in *Corporate Social Responsibility in the Construction Industry*, eds. M. Murray and A. Dainty, Spon Press, London, pp. 351-380.

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