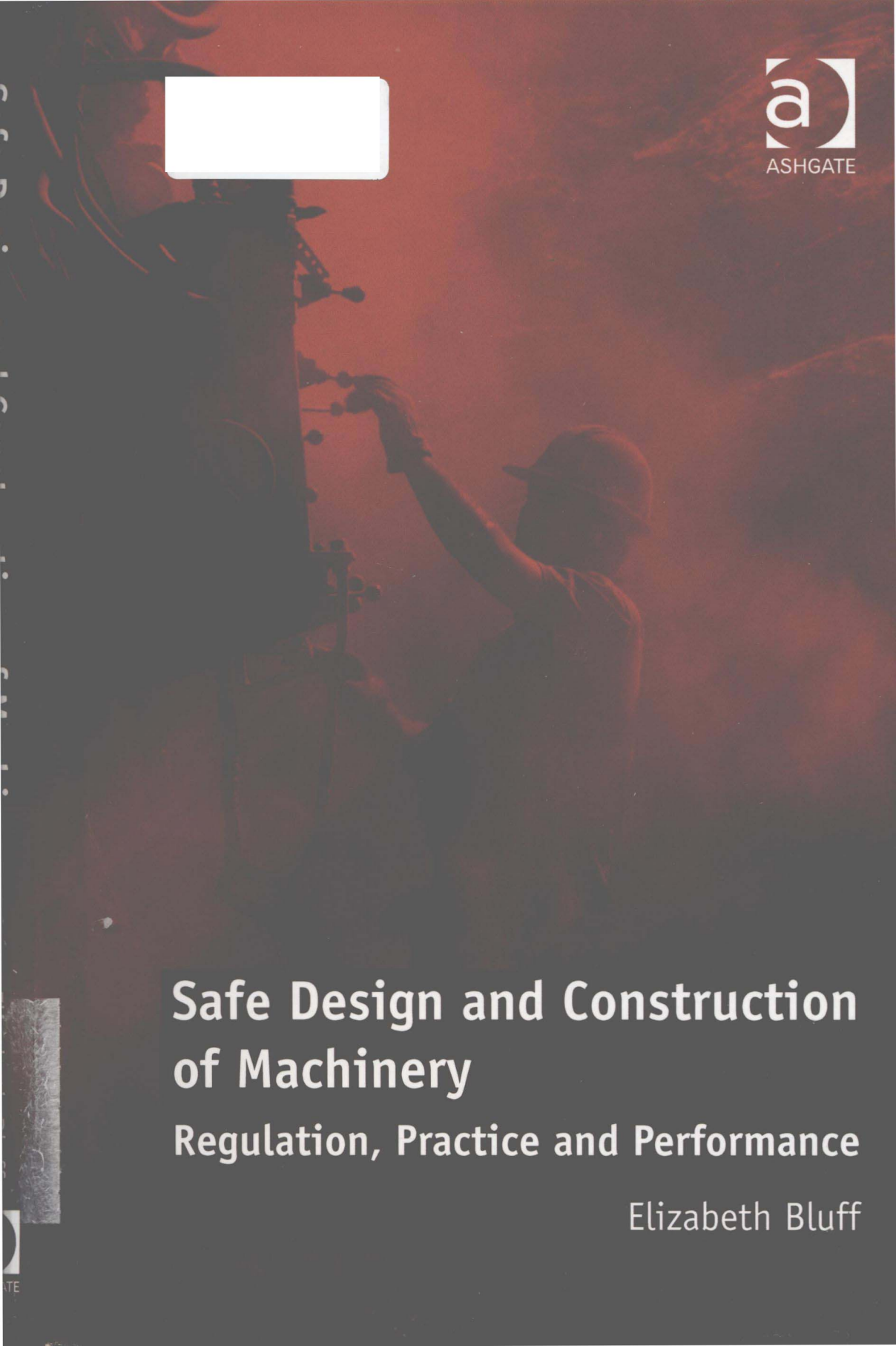

ASHGATE

Safe Design and Construction of Machinery

Regulation, Practice and Performance

Elizabeth Bluff

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SAFE DESIGN AND CONSTRUCTION OF MACHINERY

About the Author

Elizabeth Bluff has 30 years' experience in occupational health and safety (OHS) and risk management. She is a Director of the National Research Centre for OHS Regulation in the Regulatory Institutions Network, at The Australian National University where she also holds an appointment as a Research Fellow. She has a Bachelor of Science (Hons) from the University of Adelaide, a Masters of Applied Science (OHS) from the University of Ballarat and a PhD in OHS regulation from Griffith University, Queensland.

List of Abbreviations

ABS	Australian Bureau of Statistics
ANSI	American National Standards Institute.
ASCC	Australian Safety and Compensation Council
ASSE	American Society of Safety Engineers
AWCBC	Association of Workers' Compensation Boards of Canada
BSI	British Standards Institution
CE	Certification Europe
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CSA	Canadian Standards Association
DIISRTE	Department of Industry, Innovation, Science, Research and Tertiary Education (Australia)
DTI	Department of Trade and Industry (UK)
EC	European Community
FEM	Federation of European Materials Handling
HSE	Health and Safety Executive (UK)
HWSA	Heads of Workplace Safety Authorities (Australia)
ILO	International Labour Organization
IRC	Industrial Relations Commission
ISO	International Organization for Standardization
KAN	Kommission Arbeitsschutz und Normung (Germany)
NIOSH	National Institute for Occupational Safety and Health (US)
NOHSC	National Occupational Health and Safety Commission (Australia)
OSHA	Occupational Safety and Health Administration (US)
OHS	Occupational health and safety
PPE	Personal protective equipment
SAA	Standards Association of Australia
SWEA	Swedish Working Environment Authority
UK	United Kingdom
US	United States
VTHC	Victorian Trades Hall Council
WRMC	Workplace Relations Ministers' Council (Australia)

Preface

This book deals with the inter-related themes of risk, regulation, business practice and performance, based on an in-depth study of safety in the design and construction of machinery. Why machinery – because globally it takes a heavy toll in work-related deaths and injuries. Why design and construction – because removing hazards and integrating control measures at the source is one of the most cost-effective ways to manage risks. This is well recognized in the growing number of public policy and regulatory initiatives addressing health and safety problems 'upstream', including the Australian and European regulatory regimes for machinery safety in focus in this research.

The book is, however, much more than an account of business performance and responses to regulation in a particular context. It takes a fresh look at capacity and motivation as central elements shaping business conduct, and their highly contextualized nature. It offers insights into the impact of state regulation alongside the influence of non-state actors in firms' supply chains and networks.

This means that the book will appeal to an international audience from diverse backgrounds – those interested in human factors and safety engineering, work and product safety, risk management, regulation and socio-legal studies, sociology of work, standard setting and enforcement, and professional or vocational education. And, across these multiple fields, readers may come to the book as researchers, specialists or practitioners, regulators and policy makers, educators or students.

The book itself is multidisciplinary. I hope that by integrating literature and theory from different disciplines with empirical findings about safety in machinery design and construction, the book will help build bridges between specialist, regulatory and practitioner bodies of knowledge and communities of practice. It is my belief that only by applying a multidisciplinary perspective to understanding how and why health and safety problems arise, can we hope to develop and implement effective solutions.

While conducting the research and writing this book I have been working at the National Research Centre for OHS Regulation (NRCOHSR), which is part of the Regulatory Institutions Network (RegNet) at the Australian National University. The manuscript undoubtedly benefitted from discussions with my NRCOHSR and RegNet colleagues, and members of our wider networks. I would like to thank especially four people who read and provided very welcome and constructive feedback on the manuscript at different stages of its development. They are: Professor Richard Johnstone at the Australian Centre for Health Law Research, Queensland University of Technology; Professor Bridget Hutter at the Centre for Analysis of Risk and Regulation, London School of Economics; John Braithwaite,

Distinguished Professor and founder of RegNet; and my work health and safety colleague and very good friend Dr Clare Gallagher.

I am also indebted to the 66 manufacturing firms and the 32 staff of the occupational health and safety (OHS) regulators that participated in the research, and gave their time generously to contribute their understandings and experiences of safety in machinery design and construction, regulation and compliance. Finally I would like to thank my partner Des for his continuing encouragement and invaluable insights into the realities of industrial working life, which have also helped to shape my understanding of health and safety, and its implementation in practice.

Elizabeth Bluff
Canberra

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Introduction

What shapes business performance for social goals such as safety? Why are some firms' products inherently safe while others endanger safety? How do state imposed legal obligations and enforcement influence business conduct, and how does their influence compare with that of non-state actors in global markets and supply chains? What role do knowledge and motivational factors play in shaping firms' actions and performance for safety, and how are they constituted? Are specialist bodies of knowledge, such as those for human factors and safety engineering, applied in practice? What are the implications of all of this for safety policy and practice?

These are some of the significant social issues discussed in this book. They are topics that span the interests of researchers, regulators and policy makers, specialists, practitioners, educators and students across multiple fields in safe design, human factors and safety engineering, work and product safety, risk management, regulation and socio-legal studies, sociology of work, standard setting, and professional and vocational education, among others. The book offers readers from these diverse perspectives fresh insights into business responses to public policy, regulatory and professional imperatives, through an in-depth study of risk management in machinery design and construction. The research blends different literatures and theoretical approaches with empirical investigations to enrich understanding of how, to be effective in regulating and managing risks, we need to pay greater attention to the real nature of work and corporate life, and appreciate the complex contextual influences that shape business conduct.

The rationale for examining safety in machinery design and construction stems from the heavy toll that machinery takes globally in work deaths and injuries. Statistical data are not directly comparable between countries but as a broad indication, each year in the European Union machinery is a contributing factor in more than 300,000 injuries, which is 11 per cent of all injuries involving more than three days off work (European Commission, 2008), while machinery is an even more prominent cause of work injuries in China where 30 per cent of injuries treated in hospital emergency departments are machinery-related (Fitzharris, et al., 2011). Annually there are at least 65,000 injuries involving days away from work in the United States (Harris and Current, 2012), 15,000 injuries involving time off work in Canada (AWCBC, 2012), and around 3,500 hospitalizations from machinery-related injuries in Australia (Safe Work Australia, 2009; 2011; 2013a).

From hand-held power tools to complex production systems, machinery may pose genuine and serious risks to health and safety. Most well recognized are mechanical hazards as the following, not uncommon, examples illustrate:

> A machine operator was fatally crushed in a machine. He had entered the service area of a production line to clear an obstruction, triggering an automatic safety device, which stopped the machine. The machine was turned on again by an operator who sat at a console, in a position from which he could not see the operator in the service area.
>
> A farm worker suffered fatal injuries when his jacket caught on the auger of a drilling rig, pulling him into the machine. There was no caging around the drill, interlock or dead-man control on the operating panel. (Examples from NOHSC, 2000, pp. xiii, 86).

As well as the inadequately guarded danger zones and poorly positioned controls that these examples highlight, machinery may be hazardous through weak structures that collapse or break apart, hazardous chemical emissions and leaks, noise and vibration, the ergonomic problems of awkward postures or repetitive movements in machinery operation, and complex human–technology interfaces that give risk to mental strain, human error and hazardous incidents (Al-Tuwaijri, et al., 2008; Backstrom and Döös, 1997; 2000; Brauer 1994; 2006; Gardner, et al., 1999). There is also compelling evidence that a high proportion of machinery-related deaths and injuries are attributable to its poor design and construction in the first instance (Driscoll, et al., 2005; 2008; NIOSH, 2013; Safe Work Australia, 2009, p. 15).

The importance of inherently safe design has been recognized in a series of public policy and professional initiatives in the United States, Europe and Australia, based on the premise that one of the most effective ways to prevent work-related deaths and injuries is to design out hazards and integrate risk control measures at the source (ASSE, 2011; European Commission, 2008, pp. 209–10; Kletz, 1998a; 1998b; Manuele, 1999a; 2008; NOHSC, 2002; Safe Work Australia, 2012a,b; Swuste, 1997; Schulte, et al., 2008). There is also a substantial specialist body of knowledge, originating in the disciplines of human factors and safety engineering, to support the structured analysis and resolution of safety problems from early in the life cycle of machinery (for example Brauer, 1994; 2006; Corlett and Clark; 1995; Green and Jordan, 1999; Karwowski, 2005; Karwowski and Marras, 1999; Morris, Wilson and Koukoulaki, 2004; Stanton and Young, 1999; Stanton, et al., 2005).

On the legal side, the pre-eminent regulatory regime requiring the safe design and construction of machinery is the law of member states in the European Union giving effect to the *Machinery Directive* (European Commission, 1998a; 2006). Australian occupational health and safety (OHS) law also has a well-developed framework of legal obligations for machinery designers and manufacturers (Bluff, 2004; Johnstone, 1997, pp. 260–3; 2004a, pp. 275–80). In other countries the OHS legal obligations of employers may be the impetus for machinery producers to conform to safety standards, as with the American National Standards Institute