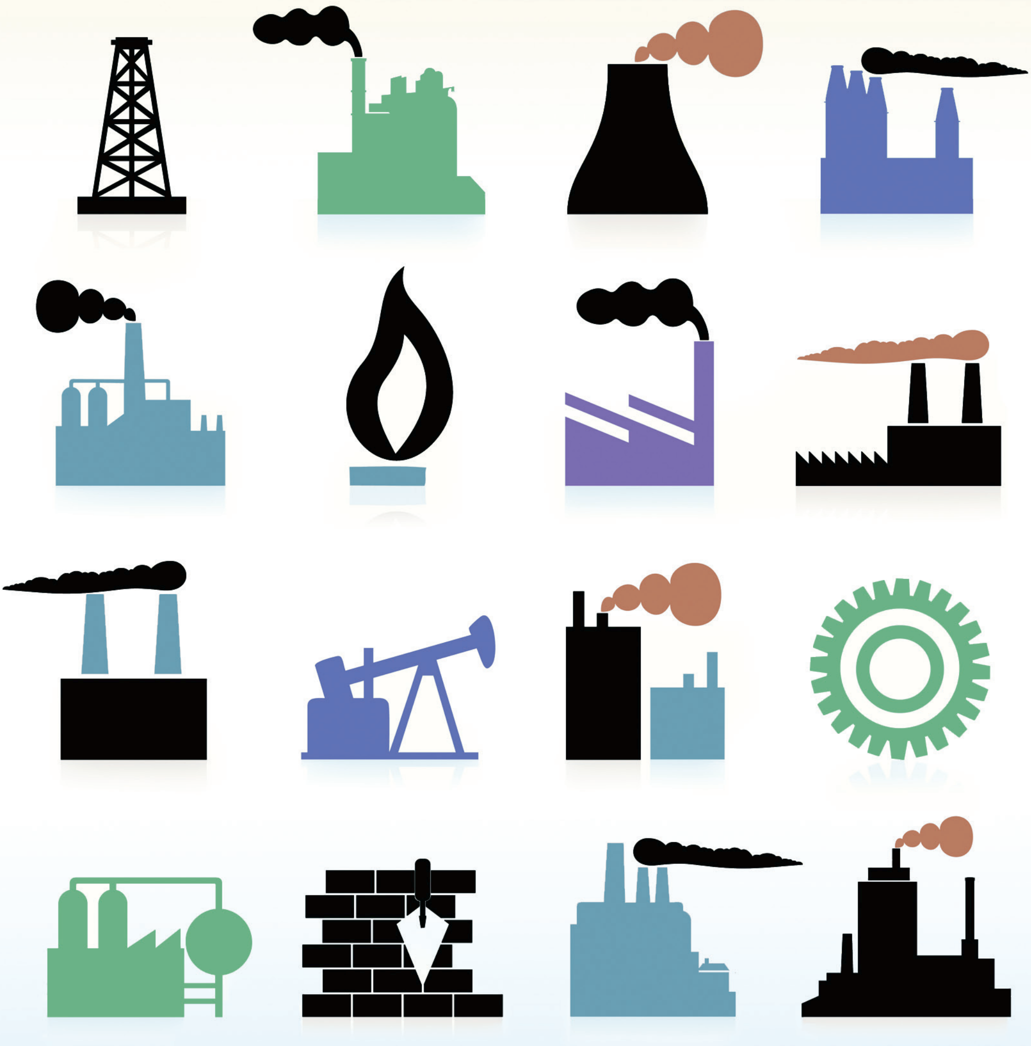
Introduction to Risk and Failures

Tools and Methodologies



D.H. Stamatis

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To

Jeanna

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Acronyms

Acronym	**Meaning**
ACOP	Approved Code of Practice
ACTS	Advisory Committee on Toxic Substances
ALARA	As Low as Reasonably Achievable
ALARP	As Low as Reasonably Practicable
CBA	Cost Benefit Analysis
CD	Consultative Document
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CLAW	Control of Lead at Work Regulations
COSHH	Control of Substances Hazardous to Health Regulations
CPF	Cost of Preventing a Fatality
CSF	Critical Safety Function
EC	European Communities
E/E/PE	Electrical, Electronic or Programmable Electronic
EU	European Union
FMRI	Final Mishap Risk Index
HSC	Health and Safety Commission
HSE	Health and Safety Executive
the HSW	The Health and Safety at Work, etc. Act
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
IMRI	Initial Mishap Risk Index
ISO	International Organization for Standardization
MEL	Maximum Exposure Limit
MHSWR	Management of Health and Safety at Work Regulations
NOAEL	No Observed Adverse Effect Level
OEL	Occupational Exposure Limit
OES	Occupational Exposure Standard
PHA	Process Hazard Analysis
PHL	Preliminary Hazard List
P&ID	Process and Instrumentation Diagrams *Note*: In the chemical industry sometimes this acronym means Pipe and Instrumentation Diagrams)
PPE	Personal Protective Equipment
QRA	Quantitative Risk Assessment
RBMK	Reactor Bolshoi Mozjnoct Kanali
SFAIRP	So Far As Is Reasonably Practicable
SSR	System Safety Requirement
TLM	Top Level Mishap
TOR	Tolerability of Risk
VPF	Value for Preventing a Fatality
WATCH	Working Group on the Assessment of Toxic Chemicals

Preface

It has been said many times by many individuals that risk is everywhere. We can never avoid it. It is present in whatever we do. Obviously, we must try to understand the risks we face and minimize them if possible. This book is in fact an extension of my first edition published in 1995 and a second in 2003 on failure mode and effects analysis (FMEA) in which I discussed the benefits of prevention based on an up-front analysis of failures.

As time passed, I noticed that, whereas FMEA is a powerful tool to forecast failures of designs and processes, a missing link involving safety issues, catastrophic events, and their consequences had to be covered. The second edition briefly mentioned HAZOP analysis but did not expand on the methodology. In this book, I focus on risk and HAZOP as they relate to major catastrophic events and safety issues. Specifically, I address processes and implementation and explain the fundamentals of using risk methodology in any organization to evaluate major safety and/or catastrophic problems. A classical and typical view of risk is shown in Figure P.1.

The significance of Figure P.1 is that the risk is emphasized and indeed becomes more serious as both individual and societal risks become evident. In fact, the hidden and untold significance is that implicitly the figure also represents a level of uncertainty as shown in Figure P.2. Both risk and uncertainty in the final analysis may be viewed and analyzed from the following five perspectives (Callaghan and Walker 2001). In some cases, one factor may be predominant, but combinations of factors often must be identified and evaluated. The five perspectives are as follows:

Individual concerns—how individuals see the risk from a particular hazard affecting them, their families, and the things they value. While they may be prepared to engage voluntarily in activities that often involve high risks, as a rule they are far less tolerant of risks imposed on them and over which they have little control unless they see the risks as negligible. Moreover, while they may be willing to live with a risk that they do not regard as negligible that secures them or society certain benefits, they would want the risk levels low and clearly controlled.

Societal concerns—the risks or threats from hazards that impact society and, if realized, may produce adverse repercussions for the institutions responsible for putting in place the provisions and arrangements for protecting people through legislation. These concerns are often associated with hazards that give rise to risks that, if materialized, could provoke a socio-political response, for example, events causing widespread or large-scale consequences or multiple fatalities. Typical examples relate to nuclear power generation, transportation accidents, or the genetic modification of organisms. Societal concerns arising from multiple fatalities in a single

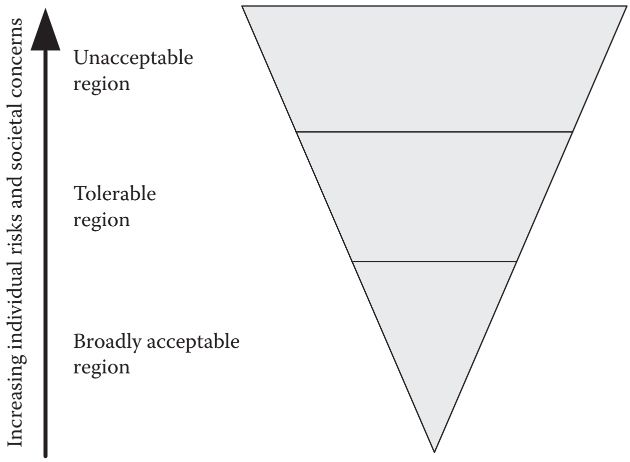

FIGURE P.1
Typical view of risk. (*Source:* www.HSE.gov.uk and public sector information published by the U.K. Health and Safety Executive and licensed under Open Government Licence v1. 0)

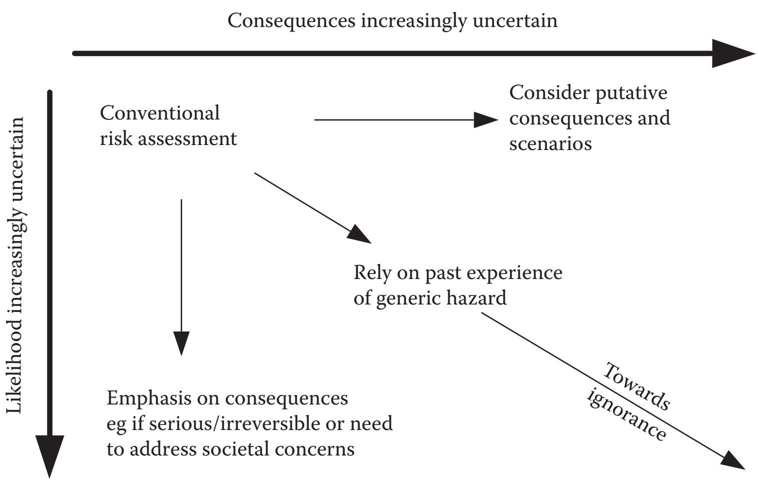

FIGURE P.2
Relationship between risk and uncertainty. (*Source:* www.HSE.gov.uk and public sector information published by the U.K. Health and Safety Executive and licensed under the Open Government Licence v1. 0)

event are known as *societal risks*. Societal risk is therefore a subset of societal concern.

Complexity in government regulations—regulations that affect and effect intra- and inter-state commerce and international commerce as well. Throughout the long history of legislation introduced to eliminate or minimize risks, the first areas to be regulated have always been the most obvious, often requiring little scientific insight for identifying problems and possible solutions. For example, it was not difficult to realize that controlling airborne dust would reduce the risk of silicosis in miners and that making it mandatory to guard moving parts of machinery would prevent workers from being killed or maimed. In short, dramatic progress toward tackling such problems could be (and was) made without unduly taxing existing scientific knowledge or the state of available technology. However, as the most obvious risks have been tackled, new and less visible hazards have emerged and gained prominence. Typical examples include hazards arising from biotechnology and processes that emit gases that contribute to global warming.

Patterns of employment defined by changing demographics present some challenges. The regulatory environment must cope with the increasing trend of industries to outsource work (and the attendant risks), resulting in changes in patterns of employment and in the fragmentation of large companies into autonomous organizations working closely together. Dramatic increases in self-employment and home working have been noted; small and medium size firms are now major forces in creating jobs. Moreover, many monolithic organizations have split into separate companies, for example, railways now operate as separate companies responsible for operating the tracks, rolling stock, and networks.

Polarization of approaches between large and small firms as a result of the patterns of employment. Some of these changes have blurred legal responsibilities for occupational health and safety, traditionally placed on those who created the risks and were best situated to control them. In certain industries, it has become difficult to determine who may be in that position. While case law clarified some situations, the fact remains that in many sectors it is very difficult to coordinate the adoption of measures to control risks. Many more players are involved, and some have little access to expertise.

Chapter 1 of this book serves as an introduction to risk and provides several definitions relevant to a number of industries. A distinction is also made between risk and uncertainty. Chapter 2 discusses approaches to risk and the zero mind-set philosophy. In conjunction with the concept of zero mind-set, the ALARP principle for determining what risk is and what its effects is also discussed. This chapter also addresses the major, serious, and minor categories of risks. Chapter 3 covers 18 risk methodologies dealing with analysis, failures, safety, and hazards.

Chapter 4 is about preliminary hazard analysis and explains how to evaluate a hazard in the early stages of a design. Chapter 5 covers hazard and operability (HAZOP) studies. It begins with an overview of HAZOP and provides key definitions. It also provides a detailed discussion of the study process, its effectiveness, and the team required to perform the study. It concludes with a full description of the process and report preparation. Chapter 6 focuses on fault tree analysis (FTA) and discusses the general rules of construction and the need for a top-to-bottom approach for defining failures and how they relate to HAZOP. Chapter 7 provides 14 additional risk analysis methodologies for handling HAZOP.

Chapter 8 is titled "Teams and Team Mechanics" and provides a rationale for utilizing teams in performing HAZOP analyses. It also defines what is necessary for a team to be effective, qualifications of team members, consensus, team process checks, problem solving, and logistical issues concerning meetings.

Chapter 9 discusses job hazard analysis and OSHA regulations and how they effect and affect risks in work environments. Chapter 10 is titled "Hazard Communication Based on CFR 910.1200" and covers a typical automotive hazard communication program. Specifically, it addresses the individuals involved, their responsibilities, appropriate training, and the importance of safe use instructions, chemical materials lists, and material safety data sheets.

Appendix A provides sample checklists for devising a safety plan and a facility location plan and guidelines of the Australian Health Administration. Appendix B details a HAZOP project.

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No single individual is ever capable enough to undertake any topic and develop it into a book form so that others may benefit. Everyone depends on many individuals who either have contributed to that topic before commencement of the work or during the writing. This work is no different.

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