

Contents

Preface.....	xiii
Author	xxi
Chapter 1 The 1900s and Onward: Beginnings.....	1
<i>Drew Rae and Sidney Dekker</i>	
1.1 Introduction	1
1.2 Safety and Risk: Divine or Human?.....	2
1.3 Modernity and Humankind's Control of Nature	5
1.4 Modernity and Safety Engineering	6
1.5 The Rise of Safety Institutions	8
1.5.1 The Politics of Safety	8
1.5.2 Inspectors and Investigators	10
1.5.3 Standards and Professional Associations	12
1.5.4 Insurers, the State, and Workers' Compensation	13
1.6 Safety Science and the Role of the Human	18
Study Questions.....	18
References and Further Reading	19
Chapter 2 The 1910s and Onward: Taylor and Proceduralization.....	23
2.1 Introduction	24
2.2 The Intersection of Science, Management, and Safety	24
2.2.1 Foundations of Procedures and Safety	24
2.2.2 Taylor and Time Studies.....	25
2.2.3 The Gilbreths and Motion Studies	27
2.2.4 Differences and Similarities between Time and Motion Studies	28
2.2.5 Implications for Safety Science.....	30
2.3 Procedures, Safety Rules, and "Violations"	32
2.3.1 The Relationship between Safety and Rules	32
2.3.2 Model 1 and the Scientific Management Legacy	34
2.3.3 "Violations" as a Preoccupation of Model 1	37
2.4 Model 2: Applying Procedures as Substantive Cognitive Activity	43
2.4.1 Procedures and the Complexity of Work	43
2.4.2 Procedures as Resources for Action.....	47
2.4.3 Work-as-Imagined Versus Work-as-Done	50
2.5 Model 2 and Safety.....	52
2.5.1 The Limits of Prespecified Guidance	52
2.5.2 Failing to Adapt or Adaptations That Fail	53

	2.5.3	Closing the Gap or Understanding It?.....	54
2.6		Scientific Management in Safety Today	54
	2.6.1	Workers Are Dumb, Managers Are Smart.....	54
	2.6.2	Taylor and Linear, Closed, Predictable Work	56
	2.6.3	Methodological Individualism	57
		Study Questions.....	58
		References and Further Reading	59
Chapter 3		The 1920s and Onward: Accident Prone.....	63
	3.1	Introduction	63
	3.2	The Discovery (or Construction) of Accident-Proneness	64
		3.2.1 Accident-Prone Workers.....	64
		3.2.2 German Origins of Accident-Proneness	65
		3.2.3 English Origins of Accident-Proneness	67
		3.2.4 French Origins of Accident-Proneness.....	69
	3.3	The Social Conditions of Possibility	70
		3.3.1 Modernization, Measurement, and Statistics	70
		3.3.2 Individual Differences and Eugenics	72
		3.3.3 Idiots, Imbeciles, and Morons.....	73
	3.4	Accident-Proneness Today	74
		3.4.1 The Growth of Dissent	74
		3.4.2 Recent Studies of Accident-Proneness	76
		3.4.3 Accident-Proneness Versus Systems Thinking.....	78
	3.5	Expertise and Accident-Proneness	79
		3.5.1 Are Experts More Accident Prone?	79
		3.5.2 Expertise and Organizational Vulnerability to Accidents	81
		Study Questions.....	83
		References and Further Reading	83
Chapter 4		The 1930s and Onward: Heinrich and Behavior-Based Safety	87
	4.1	Introduction	88
	4.2	A 'Scientific' Examination of Accident Causation	89
		4.2.1 Heinrich's Study	89
		4.2.2 Bird and 'Damage Control'	90
	4.3	Three Pillars of Heinrich's Theory	94
		4.3.1 Injuries Are the Result of Linear, Single Causation... 94	
		4.3.2 The Ratio between Occurrences, Minor Injuries and Major Injuries	97
		4.3.3 Worker Unsafe Acts.....	98
	4.4	Behaviorism and BBS.....	99
		4.4.1 Behaviorism, Industrialization, and Progress	105
		4.4.2 Behaviorism and Industrial Psychology	106
		4.4.3 Productivity Measures as Safety Measures.....	107

4.5	BBS	112
4.5.1	Impact across the Decades	112
4.5.2	Does BBS Work?	116
4.6	Critiques of Heinrich, Behaviorism and BBS	119
4.6.1	The Primacy of 'Human Error'	119
4.6.2	The Triangle (or Pyramid)	121
4.6.3	Chain-Of-Events Thinking and Decomposition Assumptions	131
	Study Questions	133
	References and Further Reading	134
Chapter 5	The 1940s and Onward: Human Factors and Cognitive Systems Engineering	137
5.1	Introduction	138
5.1.1	The Place of Human Factors in the 20th Century....	138
5.1.2	Human Factors Change Behavior, But Not by Targeting Behavior	139
5.1.3	The Emergence of 'Human Factors'	140
5.1.4	Work Inside and Outside the Research Laboratory	144
5.2	Human Factors and Changes in Psychology	146
5.2.1	Behaviorism: Changing the Legacy	146
5.2.2	The First Cognitive Revolution: Information Processing	147
5.2.3	Losing Situation Awareness	152
5.2.4	The Second Cognitive Revolution	156
5.3	Cognitive Systems Engineering	158
5.3.1	Human Error (Again)	158
5.3.2	Jens Rasmussen's Foundational Work	159
5.3.3	Two Stories of Error	162
5.3.4	Increased Socio-Technological Complexity	164
5.3.5	Joint Cognitive Systems	166
5.3.6	Patterns in Cognitive Systems Engineering	174
	Study Questions	183
	References and Further Reading	184
Chapter 6	The 1950s, 1960s, and Onward: System Safety	189
	<i>Drew Rae and Sidney Dekker</i>	
6.1	Introduction	189
6.2	Historical Background	192
6.2.1	Fly-Fix-Fly	192
6.2.2	Missiles, Nuclear, and Aerospace	193
6.2.3	Complexity, Culture, and Computers	196
6.3	Formal Concepts of System Safety	197
6.3.1	Hazards	197

	6.3.2	Risk Assessment.....	200
	6.3.3	Safety Cases	203
	6.3.4	Reliability and Safety	204
	6.3.5	System Safety and Understanding Complex System Breakdowns	207
	6.4	System Safety as the Absence of Negative Events?.....	214
		Study Questions.....	215
		References and Further Reading	216
Chapter 7		The 1970s and Onward: Man-Made Disasters.....	219
	7.1	Man-Made Disaster Theory	219
	7.1.1	Safety and Social Science	220
	7.1.2	Disasters Do not Come Out of the Blue	221
	7.2	The Incubation Period	222
	7.2.1	Stages of Incubation	223
	7.2.2	Failures of Foresight.....	227
	7.2.3	The Creation of Local Rationality	229
	7.2.4	Studying the 'Information Environment'	233
	7.2.5	Data Overload.....	239
	7.2.6	Groupthink	240
	7.2.7	Addressing the Barriers: Safety Imagination.....	243
	7.3	Models of Drift and Disaster Incubation after Turner.....	245
	7.3.1	Normalization of Deviance	247
		7.3.1.1 Continued Belief in Safe Operations	248
		7.3.1.2 Goal Interactions and Normalization of Deviance	249
	7.3.2	Practical Drift.....	251
	7.3.3	Drift into Failure	254
	7.3.4	Similarities and Overlap in Drift Models	258
	7.3.5	Drift into Failure and Incident Reporting	259
	7.4	Man-Made Disaster Theory and Societal Emancipation	260
		Study Questions.....	262
		References and Further Reading	263
Chapter 8		The 1980s and Onward: Normal Accidents and High Reliability Organizations	267
		<i>Verena Schochlow and Sidney Dekker</i>	
	8.1	Normal Accident Theory.....	267
	8.1.1	Linear versus Complex Interactions.....	272
	8.1.2	Loose versus Tight Coupling.....	274
	8.1.3	The Paradox of Centralized Decentralization.....	276
	8.2	High Reliability Organizations.....	281
	8.2.1	The Beginnings of HRO: La Porte, Roberts, and Rochlin	281

8.2.2	Weick and Sutcliffe's Concept of Mindfulness	285
8.2.3	HRO and the Capacity for Safe Operations	288
8.3	Sagan and "The Limits of Safety"	290
8.3.1	NAT and HRO in a Historical Case	290
8.3.2	NAT and HRO in Debate	293
8.3.2.1	Competitive versus Complementary Approaches	293
8.3.2.2	Are Accidents Preventable?	294
8.3.2.3	Tightly Coupled and Interactively Complex Systems.....	294
8.3.2.4	Organizational Structure	295
8.3.2.5	Technology and Human Operators.....	295
8.3.2.6	Outcome of the Debate	296
8.4	Further Development.....	296
8.4.1	Further Development of NAT	296
8.4.2	Further Development of HRO	298
	Study Questions.....	301
	References and Further Reading	301
Chapter 9	The 1990s and Onward: Swiss Cheese and Safety Management Systems.....	305
9.1	Introduction	306
9.1.1	Thinking about the System Had Been Long in the Making	306
9.1.2	Impossible Accidents.....	307
9.2	Swiss Cheese	308
9.2.1	Defenses-In-Depth and Barriers	308
9.2.2	The Impetus for Swiss Cheese	310
9.2.3	Resident Pathogens.....	311
9.2.4	Porous Layers of System Defenses.....	314
9.2.5	Shared Assumptions between Reason, Heinrich, and Bird.....	317
9.3	Linearity, Judgments, and Bureaucratic Order.....	319
9.3.1	Linearity and Proportionality.....	319
9.3.2	Judgments Rather than Explanations	324
9.3.3	Administrative Ordering and Safety Bureaucracies	325
9.4	Swiss Cheese and Safety Management Systems	327
9.4.1	Directing Attention Away from the Sharp End Alone	327
9.4.2	Demonstrating That Safety Risks Are Well Managed.....	328
9.4.3	The Safety of Work, or the Work of Safety?	330
	Study Questions.....	335
	References and Further Reading	336

Chapter 10	The 2000s and Onward: Safety Culture.....	339
10.1	The Origins of Safety Culture.....	340
10.1.1	Continuing the Trend into the Blunt End.....	340
10.1.2	Political Origins.....	341
10.1.3	Theoretical Origins.....	345
10.1.4	Safety Climate.....	347
10.2	Safety Culture Today.....	348
10.2.1	What Is It Exactly?.....	348
10.2.2	A Functionalist Approach to Safety Culture.....	351
10.2.3	An Interpretivist Approach to Safety Culture.....	359
10.3	Problems and Critique.....	363
10.3.1	Cultures That Are 'Better' or 'Worse'.....	363
10.3.2	Consistency and Agreement Versus Conflict and Contradiction.....	366
10.3.3	Safety Culture and Power.....	368
10.3.4	Methodological Individualism.....	370
10.3.5	Is Safety Culture Useful for Regulators or Investigators?.....	372
10.3.6	Do Safety Culture Assessments Have Predictive Value?.....	379
10.3.7	Safety Culture Says so Much, It Ends up Saying Very Little.....	385
	Study Questions.....	387
	References and Further Reading.....	388
Chapter 11	The 2010s and Onward: Resilience Engineering.....	391
	<i>Johan Bergström and Sidney Dekker</i>	
11.1	The Need for Resilience.....	391
11.1.1	Resilience Engineering as the Assurance of Capacity to Adapt.....	391
11.1.2	Resilience and Complexity.....	395
11.1.3	Complex Systems Operate Far from Equilibrium....	398
11.1.4	Resilience in Other Fields.....	399
11.2	Resilience Engineering as a New Discipline in Safety Science.....	402
11.3	Resilience Ideas of Rasmussen, Woods, and Hollnagel.....	410
11.3.1	Tracing Resilience Engineering to the Risø Community in the 1980s.....	410
11.3.2	Woods: The Adaptive Universe.....	413
11.3.3	Hollnagel: Cornerstones, Functional Resonance, and Trade-Offs.....	414
11.4	Dimensions of Resilience Engineering.....	417
11.5	Three Analytical Traps for Resilience Scholars to Avoid.....	418
11.5.1	The Reductionist Trap.....	418

11.5.2 The Moral Trap	420
11.5.3 The Normative Trap	422
Study Questions.....	424
References and Further Reading	424
Postscript	431
Index	437

I wrote this book foremost for safety practitioners and students. Confession: I never wrote a lot about it too, or about topics affiliated with it. But I was never educated how to fly a big jet. Well, check that: out of curiosity, I did once take a week-long course that awarded me a Certificate IV in Occupational Health and Safety. But to say that it either educated or qualified me would be a stretch.

Over the past decades, I have worked increasingly with those who have been trained as safety practitioners—in a range of industries. Much of the education they have gone through was organized around applicable laws, regulations, policies, best practices, methods, and techniques, often driven by peer-to-peer influence—inspirations from what others in other organizations have done—and hand-me-down knowledge.

And actually, not all safety practitioners were educated as safety practitioners. In fact, many safety practitioners have backgrounds in operations, in HR, in engineering or chemistry or a mechanical trade or psychology, or something else altogether.

Whether it is a background in safety practice or something else, they are all great ways to get into, as David Provan would say, the safety of work and the work of safety. What I have learned, though, is that all could benefit from a more solid grounding in the foundations of the science of safety (such as it is, I hear Erik Hollnagel justifiably say (Hollnagel, 2014)).

I have found that without that grounding, it is easy to reinvent the wheel and happily embrace an idea or slogan simply because it is shiny and seemingly new. Without that grounding, it is tempting to apply a putative solution (such as putting a barrier in place) to a problem that is not only immune to the solution, but may well bite back by spawning more problems than the safety practitioner bargained for. Without that grounding, it is seductive to fall for expensive solutions (enterprise-wide introduction of risk matrices, hazard awareness campaigns, goggles for supposed eye protection) and force-feed them into the organization, even when they are based on a particular conceptualization of danger that is not applicable at all.

I have chosen an episodic approach to organizing this book. That is, I have divided it up into time slices. Every chapter is founded on the ideas of a particular era—each roughly a decade from the past century. It then explores how these have influenced our thinking in safety in other decades or ever since. Of course, the lines and categories of what belongs to which decade, or what inspired what exactly, can always be debated, as it should. They are not in this book to radiate an impression of linear, historical truth. Rather, they are a way for me to organize the ideas, and for you to start thinking with them.

How are today's 'hearts and minds' programs, for example, linked to a late-19th-century definition of human factors as people's moral and mental deficits? What do Heinrich's 'unsafe acts' from the 1930s have in common with the Swiss Cheese