Prologue

What is arguably one of the most influential papers in contemporary psychology starts rather tantalisingly as follows:

> My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. ... The persistence with which this number plagues me is far more than a random accident. ... Either there really is something unusual about the number or else I am suffering from delusions of persecution.

(The paper in question is George Miller's 'The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information' published in 1956. This paper introduced to the general public the notion of limitations in human short-term memory and attention, and proposed as quantification an integer that since then has become legendary – but also widely disputed.)

My problem is not that I am persecuted by an integer, but rather that a certain idea has stuck in my mind, leading me to see examples of it everywhere. That in itself is not so strange. We all know that the moment we start to think of something – or buy something such as a new car or a new gadget – then we also begin to notice instances of it everywhere. This is what psychologists call the phenomenon of selective attention, i.e., that the way we look at the world is heavily influenced, or determined, by our expectations and preconceived ideas. The phenomenon is aptly captured by the adage that 'if your only tool is a hammer, then everything looks like a nail' (attributed to the American psychologist Abraham Maslow, but also said to be a Japanese proverb). In the world of accident investigation it has been expressed as the *What-You-Look-For-Is-What-You-Find* or *WYLFIWYF* principle, to be described in Chapter 5. In other words, our (current) understanding of the world heavily influences what we pay attention to or notice, both the larger 'picture' and the nuances. In consequence of that it also excludes from our awareness that which we are not prepared for, that

which we do not expect, and that which we are otherwise unwilling to 'see.'

My problem is that since I started to think about the efficiency–thoroughness trade-off (ETTO) principle as a way to make sense out of what people do, I seem to find examples of ETTO everywhere. This is not something that I do intentionally, but the efficiency–thoroughness trade-off principle is seemingly ubiquitous. Indeed, the obviousness of the phenomenon is so strong that reason seems to demand that it should be questioned. But try as I might to eradicate it, it still persists. Writing this book can therefore, in a sense, be seen as a way to get rid of the ETTO demon, or at least to pass it on to someone else, like the *Monkey's Paw*. If that does not succeed, then I stand corrected and there is no such thing as the ETTO principle. But if it succeeds, then it may have significant consequences for how we perceive, analyse and understand human and organisational performance in general, and how we view the role that humans play for safety in particular.

Yet this book does not really describe anything new, in the intellectual sense that no one has ever thought of it before. As the examples, large and small, throughout the book will show, people – practitioners and experts alike – have for many years been thinking along the same lines and have expressed it in ways that are not too dissimilar from what is done here. The present text consequently does not and cannot pretend to be an intellectual breakthrough or even an innovation. It is rather a way of drawing together the experience from many different fields and summarise a wide collection of findings coherently, with a view to their practical consequences and their practical applications.

Everything around us changes and it often changes so rapidly that we cannot comfortably cope with it. In consequence of that, the descriptions that we make and use are never complete. This means that neither the situations we are in, nor future situations, can be completely described. There is therefore always some uncertainty, and because of the uncertainty there is also risk. If something is going to happen with certainty – or not going to happen with certainty, which amounts to the same thing – then there is no risk. (While philosophers may argue about whether something ever can be absolutely certain or known with absolute certainty, the rest of us can normally distinguish between what is certain and what is uncertain on a purely practical basis.) But wherever there is risk, there is also a need to understand the risk.

Although people and societies have tried to protect themselves against hazards and risks at least as far back as *The Code of Hammurabi*, the consequences of the rampant technological developments that we have seen since the middle of the 20th century – according to the Western way of counting, of course – have made this more necessary than ever.

Regardless of whether risk is defined from an engineering, a financial, a statistical, an information theoretical, a business, or a psychological perspective, the concept of uncertainty is a necessary part. This has of course been so at all times, but it is a quality or a characteristic that has become more important as the systems we depend on and the societies we live in have become more complex. Two hundred years ago, to take an arbitrary number, countries only needed to care about their nearest neighbours or their coalition partners, and were largely independent of the rest of the world. The same was the situation for institutions, companies, societies, and individuals at the appropriate scale. Neither financial nor industrial markets were tightly coupled and events developed at a far slower pace. Today the situation is radically different, basically because we have been caught in a self-reinforcing cycle of technology-driven development. In 1984, the sociologist Charles Perrow, who will be mentioned several times in these pages, observed that 'on the whole, we have complex systems because we don't know how to produce the output through linear systems.' The situation has not become any simpler in the years since then. Because there nearly always is too little time and too much information relative to what needs to be done, it is inevitable that what we do will be a compromise between what we *must* do in order not to be left behind, and what we *should* do in order to avoid unnecessary risks. In other words, a compromise or trade-off between efficiency and thoroughness.

About the Style of this Book

This book is not written in the style of an academic text, and therefore dispenses with the references that are normally found in such works. This has been deliberately done to make it an easier read and to make it more accessible to people who, for one reason or another, are reluctant to start on a conventional textbook or work of science. However, in order to meet some modicum of academic credibility, each chapter will conclude by a short section that provides links to the most important

references and literature. This section can safely be skipped by readers who have no interest in such matters. On the other hand, the section may not provide the full set of scientific references for the more inquisitive reader, and therefore in itself represents an ETTO.

Sources for Prologue

When George Miller published the paper about 'The Magical Number Seven, Plus or Minus Two' in 1956, he offered a powerful simplification that quickly spread beyond experimental psychology. The 'magical number' was instrumental in disseminating the idea that the human mind could be described as an information–processing system, with all that this has led to. In relation to safety, the idea was later used as support for the idea that the human was 'just' a complex machine, and that this machine could fail or malfunction in the same way that other machines do.

According to the information–processing viewpoint that George Miller helped introduce, humans receive information from the environment and then process it. Humans are therefore described as passive or reactive 'machines.' Philosophers and psychologists have, however, long known that such is not the case. Humans actively seek information rather than passively receive it. In psychology and cognitive engineering this is represented by a perception-action cycle. This describes how our current understanding and expectations, sometimes called 'schemata,' determine what we look for and how we interpret it. In other words *What-You-Look-For-Is-What-You-Find*, whether it is on the level of individual perception or a collective activity such as accident investigation.

The Monkey's Paw is one of the classical horror stories. The modern version of it, written by W. W. Jacobs, was published in England in 1902. The basic plot is that three wishes are granted to anyone who possesses the paw of a dead monkey, but that the wishes come with a terrible price.

The Code of Hammurabi was enacted by the sixth king of Babylon, Hammurabi, about 1760 BC. One part of it describes what is known as *bottomry* contracts, a type of insurance for merchant ships. It essentially means borrowing money on the bottom, or keel, of a ship. The money would be used to finance a voyage, but the repayment would be contingent on the ship successfully completing the voyage.

In 1984, the US sociologist Charles Perrow published a book called *Normal Accidents* which argued that accidents should be explained as the near inevitable result of increasingly complex and incomprehensible socio-technical systems. This soon became known as the *Normal Accident Theory* (*NAT*), accepted by some and disputed by others. Further details will be provided in Chapter 1.

For the record, the first public airing of the ETTO principle was during a panel discussion at the 8th IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of human–Machine Systems that took place in Kassel, Germany, 18–20 September 2001. The first printed reference is E. Hollnagel, (2002), *Understanding accidents – from root causes to performance variability*, in J. J. Persensky, B. Hallbert and H. Blackman (eds), Proceedings of IEEE 7th Conference on Human Factors and Power Plants: New Century, New Trends, 15–19 September, Scottsdale, AZ. A description can also be found in Chapter 5 of Hollnagel, E. (2004), *Barriers and Accident Prevention* (Ashgate). And last but not least, the earliest use of 'ETTOing' as a verb is, as far as I can find out, in an email from Captain Arthur Dijkstra, 20 September 2005.