# SAFETY MANAGEMENT:
## A QUALITATIVE SYSTEMS APPROACH

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# Safety Management

Recent work has demonstrated that incidents, accidents and disasters tend to result from complex socio-technical failures, rather than just 'human error' on the one hand, or simple technical failures on the other. For the reduction of accidents, therefore, it is necessary to deal with systems factors, in which both technical and human-factors elements play an equal and complementary role. However, many of the existing techniques in ergonomics and risk management concentrate on plant/technical issues and downplay systems factors and 'subjectivity'. The present text describes a body of theory and data which addresses this issue squarely, drawing on systems theory and applied psychology, and which stresses the importance of human agency within systems. The central roles of social consensus and reliability, and the nature of verbal reports and 'functional discourse' are explained in some detail.

This book therefore presents a new 'Qualitative Systems Approach' to safety management, offering both greater safety and economic savings. It presents a series of methodological 'tools' whose reliability and validity have been shown through extensive work in the rail and nuclear industries and which allow organisational and systems failures to be analysed much more effectively in terms of quantity, precision and usefulness.

This is a textbook for undergraduate and graduate students in occupational psychology, human factors, ergonomics and HCI, and the sociology of disasters and risk. It is also useful for safety managers and professionals in many safety critical firms and organisations, reliability engineers, risk managers, and human factors specialists.

# Figures

# Tables

# Preface

The ideas in this book were first developed in the late 1990s during our work with the railway industry (CIRAS: Confidential Incident Reporting and Analysis System), and the nuclear industry (SECAS: Strathclyde Event Coding and Analysis System). In the railway industry, as we developed CIRAS and analysed the reports, we discovered to our surprise that we were gaining very little information from staff about what was classically referred to as 'human error'. Instead, they gave us data relating to systems features, organisational problems and sociological aspects of the industry, producing a picture very far from the classic 'individualistic' view of a single operator committing an 'error'. At the same time, in our work with the nuclear industry, we were finding that a key concept in error taxonomies is 'reliability'. However, it took us some time to realise that the way we were using the word (as social scientists) was very different from the use of the word in the engineering context. Consequently, taxonomies were not being properly tested for reliability (in the sense that we were using it: agreement between users on individual classifications), which seemed to be viewed as a trivial part of the validation process that could easily be dispensed with.

It wasn't until some time later that we saw that these issues were two sides of the same coin, and it was as a result of this that we were led to question the 'cognitivist' paradigm which has often been used as the main psychological model in safety management and human factors. We started to think that perhaps 'cognitivism' was holding back the increasing (and welcome) developments in the field that emphasised systems features of the accident and error process. One of the key problems with ergonomics, we started to think, was that writers who emphasised the systems aspects of 'error' also tended to emphasise 'cognitivist' aspects, despite the fact that, in our opinion, these two viewpoints were incompatible.

In search of an 'alternative paradigm' that matched the reality of what we were finding in our research work, we started on an exciting exploration of the new 'post-cognitivist' work that has been done in psychology in the last twenty years. What was particularly gratifying in this 'voyage of discovery' was discovering the links between apparently disparate thinkers. Studying 'systems' theory and cybernetics led us forward to connectionism

and 'dynamicism' but it also led us back to hermeneutics and phenomenology. And this in turn led us to new views of epistemology, which led to a redefinition of the word reliability, and a restatement, within our new 'paradigm', of why it was so important. We discovered links that we had never dreamed existed: between Continental philosophy, ordinary language philosophy, and the most up-to-date, 'cutting edge' research of the Artificial Life, and Parallel Distributed Processing (PDP) communities.

At the end of this process we had 'woven' a distinctive approach to human error, accidents, disasters, error taxonomies and so on. But, at the same time we had discovered, not just new ideas (or new to us, at least!), but new methodologies. The reader will, therefore, hopefully discover thematic development in the book, in that it generally moves from the theoretical to the practical. The first few chapters explain the 'philosophy' that lies behind our approach, before we move onto the specific projects that led to our development of alternative methods and techniques. There then follow discussions of some 'traditional' philosophies in the field and explanations as to why they have not always functioned as well as they might have been expected to. Finally we conclude with new, practical solutions to traditional problems.

As the title of this book suggests, our approach is best described as a Qualitative Systems Approach (QSA). It is qualitative, because we feel that researchers should pay attention to the discourse and language used by the actual managers and staff trying to lower risk and increase safety. However, despite the fact that it is individuals that use language, we should never forget that these individuals exist in an organisation (or a system), and that their behaviour is constrained by and constructed within this system. It is only by continually moving ('dialectically') from the individual to the system and back again, from the discourse and behaviour of individuals to the rules and structures of the company or organisation, that a full view of safety practices (and shortcomings in these practices) can be given.

We should conclude by mentioning that the main absence in this text is reference to our debt to the Pragmatists: John Dewey, William James and, of course, C. S. Peirce. However, we feel that to make specific references would miss the point; we would hope that the pragmatic spirit animates the whole volume. We have attempted to create a volume of practical solutions to practical problems. We hope that after finishing the book, the reader will feel we have succeeded.

# Notes on contributors

**Professor John Davies** is director of the Centre for Applied Social Psychology (CASP) at the University of Strathclyde in Glasgow. He has an extensive research and publication record in the areas of Human Factors and Public Health. He has contributed widely to national and international conferences on both these topics. He is also director of Human Factors Analysts Ltd. (HFAL).

**Alastair Ross** is a Senior Research Fellow in the Centre for Applied Social Psychology (CASP) at the University of Strathclyde. He has developed taxonomies and coding systems for a number of high-consequence industries. He has an interest in discourse and attribution, in particular the psychology of sport and the way in which natural explanations of élite athletes relate to subsequent performance.

**Dr Brendan Wallace** is a Research Fellow in the Centre for Applied Social Psychology (CASP) at the University of Strathclyde, with a special interest in the psychology of arousal and attention, systems theory and Continental philosophy. He is also interested in new approaches in psychology (such as ecological psychology and situated cognition). He has been closely involved in the development of taxonomies trialled in the nuclear and rail industries.

**Dr Linda Wright** is a researcher at the Technical University of Delft in the Netherlands. She was central to the development of the CIRAS system. She has a particular interest in minor-event reporting systems and the predictive power of near miss reports with respect to major accidents and incidents.

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# Contents

# 1 Safety, risk and responsibility

## Science and subjectivity

First and foremost, this book is about safety and safety management. It seeks to make the point that a number of key features of effective safety management are subjective in nature, and that the role of 'objective science' in this domain, whilst essential, is also limited. But the book is also definitely about *science*. Unfortunately, the word 'science' is still frequently interpreted as meaning 'science according to Newton'. That is, science is seen as the search for truth by individuals without personal bias or motive, who merely serve as the passive mouthpieces for facts and conclusions which are determined by the universe itself. Only one 'truth' exists, and any other account is wrong. A central feature of this view concerns the nature of 'facts'. Facts, it is felt, are either objective or subjective, and only the former are fixed, certain and reliable. Edwards *et al.* (1995) have summarised this view as follows: 'Science is at its best the selfless and disinterested pursuit of truth.' However, whilst this book is about science, it is not about the kind of science described above.

There are a number of alternative ways of looking at science, and consequently when anyone makes use of that word it is quite in order to ask 'What type of science are you talking about'? 'Science' comes in various guises with quite different implications for the types of investigative methods used and the types of conclusions that these methods give rise to. It could be argued that the view of science briefly characterised above, centred around discoverable truths in a fixed and determined universe, represented the state of the art until the middle of the nineteenth century. That view (devastatingly effective for solving problems of a certain class; that is, problems that are *amenable* to solution via that route) has, however, been progressively undermined by new discoveries giving rise to alternative theories about how the universe works, including the theories of relativity, quantum mechanics, and chaos. A brief outline of these alternative 'sciences', and their implications by analogy for work that involves living, thinking, people, is given in Chapter two. Furthermore, the actual *nature* of scientific progress as a system based on objective observations, theory

formation, and theory rejection on the basis of a single refutation (e.g. Popper 1959) has been honestly dismantled by Kuhn (1970) who sees the nature of scientific progress as determined by personal motives and as having things more akin to changes in fashion rather than the resolute and dispassionate pursuit of enlightenment.

One of the bases of empiricism (Ayer 1936), and thus a cornerstone of any kind of science, is reliance on the act of personal observation. The argument here is that our own experience of our fellow human beings tells us that they have motives and opinions, that their views are frequently biased, that they have vested interests which colour what they do and say, that their answers to questions vary according to where they are and who they are with and that their opinions, including the opinions of experts and scientists, frequently disagree. If we have personal insight, we will also be aware that the things we do and say are tempered by our own personal interests and situation, and that when arguing a case we are frequently not so much advancing arguments with an inescapable logic, as thinking of a means to defend a position that we feel we have to defend for reasons that may have nothing to do with scientific investigation. Similarly, when it comes to reviewing incidents or near misses, the process of identifying causes and recommending actions to deal with the consequences is frequently not so much a search for 'truth' as a search for a cause that we are prepared to accept as a cause, and for an action that is affordable and that we are prepared to implement.

These things we can readily observe in ourselves and in others. Since we have direct personal experience on these matters, it is *scientific* to adopt methods which take these observed (empirical) facts into account. By contrast, to cling to a view that sees events, circumstances, causes and consequences as ultimately untransformed by the passage through human minds, and as having an objective reality which is knowable and unaffected by human processes, is blatantly *unscientific* since it flies in the face of our own observations. The belief in a certain universe revealed by motiveless scientists is becoming increasingly absurd, especially in areas such as safety management and accident investigation where the selection and interpretation of 'facts' involves human beings at every twist and turn, with all that that implies. In short, it is scientific to adopt an empirical approach which acknowledges subjectivity, and an act of scientific denial to pretend that such subjectivity has no role to play.

What is needed therefore is a pragmatic approach which acknowledges those things which clearly work within a deterministic framework, but integrates this knowledge with an approach that takes into account the variability and uncertainty that arise whenever human beings are involved. Such an integration is the next logical step in the development of scientific methods for safety management, and it can be argued that the sometimes disappointing results of our endeavours stem from a blinkered approach to human action that rules out a reflexive and contextual approach whenever

human beings report things or express opinions, and turns a blind eye to the subjectivity of which we are all, secretly, aware. A truly scientific approach, by contrast, takes such things into account within its methodology; as sources of additional information rather than as error. It remains only to add that the failure to take into account the variability and subjectivity of the raw material that safety managers and others have to deal with leads, we believe, to false conclusions, inappropriate or unnecessary actions, and waste of resources, and perhaps most of all, a failure to capitalise on the potential benefits of the available data, much of which is subjective by its very nature.

## The need to be safe

Human beings have a need to be safe. In 1943 Abraham Maslow wrote his much cited paper, 'A Theory of Human Motivation' (Maslow 1943) in which he outlined a number of needs which require to be satisfied if human beings are to work and perform happily and satisfactorily. At the bottom end of the 'needs' continuum he postulated the basic physiological needs (so-called 'drives') which have to be satisfied, the classic examples being hunger, thirst and sex. Once these are satisfied other higher order needs come to the fore, of which the first is the need for self-preservation and avoidance of injury; that is the safety needs. As is well known, the top end of Maslow's hierarchy is the somewhat metaphysical (or at least, difficult to define) need for 'self-actualisation', an existential need for self-fulfilment ('What a man *can* be, he *must* be' writes Maslow). However, our main topic for discussion is safety, and specifically Maslow's suggestion that the safety needs, at some point between having a full stomach and playing the Bruch violin concerto, become the dominant source of motivation. 'They may serve as the almost exclusive organisers of behaviour, recruiting all the capacities of the organism in their service, and we may then fairly describe the whole organism as a safety-seeking mechanism.' So people need safety. Survival is, after all, a basic instinct.

## Risk and responsibility

However, general statements often break down at the level of specific instances (see, for example, Cardwell 1971: 56–61) so it is useful to look at this general statement in more detail. Overlooking the philosophical issues which arise when any organism is described in terms of the machine analogy (i.e. describing living things as machines is an act of preference; not in itself an act of 'science') there are everyday observations that reveal that Maslow's suggestion about the role of the safety needs, whilst perhaps true at a general level, requires considerable modification at the level of specifics. For example, most people travelling on buses, trains or aeroplanes implicitly expect those who run the buses and trains or fly the planes to