Uncertainty and Risk

Uncertainty and Risk

Multi-Disciplinary Perspectives

Edited by Gabriele Bammer and Michael Smithson
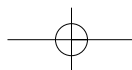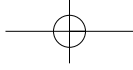
To the memory of Aileen Joy Plant

From Gabriele Bammer:
For Warren Bond and Norbert and Maria Bammer
From Michael Smithson:
This one's for Susan

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Preface

Jerome Ravetz

It is a pleasure and an honour for me to contribute a preface to this distinguished and important volume. Australia has long been to the fore in the study of uncertainty, starting with Michael Smithson's classic *Ignorance and Uncertainty: Emerging Paradigms*, and I am very pleased to have the opportunity to join in what is both a celebration and a growth point of this crucial work.

Although there has been some very good scholarship in this area (and this volume bears witness to that), the main impetus to the current study of uncertainty has arisen in policy issues. We can actually date the events that brought uncertainty to the fore, after a long period of languishing on the margins of philosophy and common sense. This was the 1950s introduction of civil nuclear power, a novel technology that seemed to some to pose great dangers and which (in spite of all the aspirations of its promoters) had the taint of association with Hiroshima and Nagasaki. A new field of science was created to cope with this reaction, producing the elaborated models of probabilistic risk assessment. But the confidence of the official American scientists in their demonstrations of the safety of nuclear power came to be interpreted as arrogance. Uncertainty (deeper than mere quantifiable risk) was one of the critics' points of contention. After more than a decade of debate, they were vindicated by the 1979 events at a nuclear power plant at Three Mile Island in Pennsylvania in the US. At that point, uncertainty came in with a vengeance. During that fateful week it was clear that the operators and the outside experts had no idea of what was going on behind the wild printouts of the monitoring equipment, or indeed of whether the reactor was heading for a 'China Syndrome' meltdown. Suddenly, this technology, with all its huge investments, scientific prestige and government support, became (for Americans at least) pure 'Mickey Mouse'. The quantitative science of risk assessment was never the same again. Radical uncertainty could no longer be excised from science policy (although many 'decision sciences' still remain in blissful ignorance of the category).

There has, recently, been a shift in the politics of uncertainty. The invocation of uncertainty is nearly always a defensive manoeuvre, intended to stop

something happening, and in the 1950s, the post-war period, what was happening was technological development, based on an optimistic, even hubristic, conception of human dominance over nature. Paul Ehrlich's motto, 'Nature always bats last', was fine rhetoric, but made little impact outside those already converted to environmentalism. But now, facing global climate change, we are generally aware of our ignorance of its detailed effects. The side on the defensive is that of the big fossil-fuel corporation, so for the last decade we have had uncertainty invoked against measures designed to mitigate anthropogenic climate change. This was adopted most strongly in the US, as part of a self-consciously designed corporate propaganda strategy by the fossil-fuel interests, analogous to that previously adopted by the large tobacco corporations against initiatives to reduce smoking.

So strongly has the tide shifted away from the previously dominant assumptions of certainty, that we have even had pearls of Socratic wisdom dropping from the lips of former US Secretary of Defense, Donald Rumsfeld, in his musings on the 'unknown unknowns' that derailed the military intervention in Iraq, which started in 2003 and which still continues. This turnaround has been unsettling for some radical social theorists, who had believed that the true path to wisdom lay in the demystification of knowledge and the celebration of uncertainty. But it can also be an enrichment, as uncertainty moves beyond its embattled stance and becomes part of mainstream culture. And, I am pleased to confirm, this present volume makes a signal contribution to that process of enrichment.

As a contributor to the current effort of validating uncertainty and ignorance, I would like to remind us that uncertainty has its own philosophical history, one that deserves to be rediscovered and re-created for the present age. In reviewing that history, one must always keep in mind that 'scepticism' is not so much a doctrine as a tactic in an ideological debate. Whatever the supposed certainties that someone was denying, they were chosen for their relevance to practical issues of pressing concern. Karl Popper's observation that fruitful philosophy has always derived from living issues is at least as true here as anywhere else.

As a very brief recapitulation: 'scepticism' appears in a few key locations in Classical thought. Socrates himself played sceptical games with his 'victims', allowing them to state obvious truths about life and morality, and then turning them (both the truths and the interlocutors) inside out. In this he was adopting the tricks of the 'sophists', but applying them to the noble task of teaching awareness of one's ignorance. But it was difficult in practice for him to distance himself from others who would upset conventional wisdom and morality for their own ends. He had his warning in the play *The Clouds* by Aristophanes, and then two decades later there was the fatal judgment of the people's court of Athens.

Although there were well-recorded debates between 'sceptics' and 'empirics' in Classical medicine, scepticism only really got going in the Renaissance.
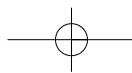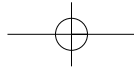
Erasmus himself wrote *In Praise of Folly*, in which he satirized the conventional wisdom of the liberally educated classes. Lesser figures, such as Cornelius Agrippa von Nettesheim, made broadside attacks on all the official academic learning of their day. And, to be sure, these did present easy targets. The greatest of all the sceptics was Michel de Montaigne, who observed the idiocies and barbarities of the world around him and reflected in private. His essay 'On cannibals' is a devastating critique of conventional morality, turning all our ideas of propriety on their heads.

This narrative of mine is not just a history of ancient ideas. Bacon and Descartes, in particular, were self-consciously in dialogue with these sceptical currents. Out of their solutions to the challenge of scepticism came ideas that have formed the implicit framework of our own thinking. Descartes' early philosophical endeavour can be seen as an attempt to embrace the whole Renaissance sceptical critique, the better to conquer it and then banish ignorance forever. His 'methodological doubt' was just such a move, and scepticism (including the cannibals) has other important echoes in his thinking. He succeeded, at least to his own satisfaction, and the stripped-down conception of knowledge that he defined has served to blight philosophical thought from then to now.

When Descartes banished ignorance, he also discarded awareness of ignorance. Since Socrates, this had been recognized as the key to wisdom, but for the next three centuries 'ignorance of ignorance', the condition that had been most severely warned against by philosophers, was the normal state of the educated classes of Europe, particularly those in science. The second half of the twentieth century will, in retrospect, be recognized as the era of a radical transformation of educated common sense, returning to a renewed awareness of uncertainty and ignorance. And Australia can take pride in the fact that Michael Smithson was the first effective philosophical voice in this new movement for awareness of ignorance.

The consequences of this inherited ignorance of ignorance, and effectively of ignorance of uncertainty as well, may prove to be devastating to ourselves and to the planet. This truncation of awareness defines the mindset of reductionist science. Its leading article of faith is that to every scientific problem there is one and only one solution. The real world outside the laboratory, where things are messy and unpredictable, is to be ignored. For example, since researchers can manipulate DNA and alter some properties of whole organisms, we are instructed to assume that genes are just beads on a string of base-pairs, to be modified quite precisely with molecular snippers and tweezers. As a result, we have now artificially disrupted and destabilized genomes diffused on a global scale. No one can predict how Nature will bat last in this particular game of ignorance-of-ignorance science.

Although my reflections up to now have tended to negative, I should say that I welcome this volume especially because of its reminding us, so effectively, of the positive aspects of uncertainty. As the various essays show, embracing
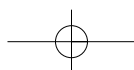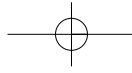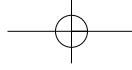
uncertainty, and nurturing improvisation, are at the heart of creativity. Indeed the denial of uncertainty in any area of life leads to a cramped and ultimately brittle experience. How very important it is to remind a largely secular world that religious faith and personal doubt are *not* incompatible opposites. The secular mind would be much enriched if it could comprehend that the deepest faith and the most testing doubt reinforce each other most fruitfully. It might then become generally appreciated that religious belief is not necessarily an abdication of reason, but rather that it can possibly be among the most courageous and self-critical of commitments. For me personally, this may be among the most important of the lessons of this volume. In addition to showing that there can be rich and varied scholarship on the theme of uncertainty, it offers this wise insight about knowledge, belief and uncertainty.

Another special source of strength of this volume derives from its Australian provenance. It displays the refreshing indifference to status and conformity that is the glory of that nation. Few academic productions in Europe would dare to combine analytical approaches with street-wisdom the way that is done here in connection with health and public policy. Among academics elsewhere, the realities outside the ivory tower (with their special sorts of uncertainty) would be treated as evidence to be studied and tamed, rather than accepted into the argument itself. I congratulate the authors as much for this aspect of their achievement as for any other.

I believe that the exceptional strength of this volume derives in large part from the harmonious complementarity of the perspectives of the editors. With her theory of Integration and Implementation Sciences, Gabriele Bammer provides a solid practical foundation for planning and evaluation 'integration', which can so frequently become a pious expression that in context means everything and hence nothing. Asking the crucial questions – 'For what and for whom?', 'Of what?', 'In what context?', 'By whom?', 'How?' and 'What are the measures of success?' – provides a sort of pedigree for any such effort. For his part, Michael Smithson reviews the psychology of uncertainty, and by explicating the various approaches, he shows how culture-bound they all are. Indeed, he cites evidence that different cultures even conceive uncertainty in different ways. It is not fanciful to imagine that the management of uncertainty could become a key symptom in distinguishing among both personality types and cultures. The differences could be accepted and celebrated rather than being used to denigrate those whose lived-world is different from our own. The three chapters of integration (a significant achievement in themselves, given the heterogeneity of the material) show how fruitful, for scholars and for practitioners, such a collaboration of complementary perspectives can be.

In conclusion, let me repeat my appreciation of the work of the authors and editors of this fine volume. I hope that it will enjoy the successful reception that it so richly deserves.

Acknowledgements

I

Setting the Scene

1

Introduction

Gabriele Bammer and Michael Smithson

Uncertainty is a fact of life. Despite this, until recently, relatively little effort had gone into acquiring knowledge about uncertainty. In an age when human beings can travel into space and map genomes, ideas and methods for understanding and managing uncertainty are comparatively unsophisticated. There is, however, increasing appreciation of the limits to certainty, so that in the last 60 years there has been a flurry of activity in numerous disciplines and practice areas to rectify the centuries-old neglect of uncertainty. The major limitation in this activity has been the paucity of exchange across disciplines and practice areas, so that specialists are usually unaware of developments elsewhere. Trading information and building on the resulting new insights are the objectives of this book.

To this end, we have brought together diverse expertise. For example, we include physics, the only discipline to have an uncertainty principle; jazz improvisation, which deals with uncertainty in the moment; history, where certainty equates with patriotism; the law's reliance on precedent, which means that consideration of uncertainty is taboo; and politics, which requires skill in the art of turning uncertainty to advantage. We synthesize this broad range of ideas, building on current knowledge about uncertainty, and we conclude the book by focusing on the implications for risk assessment, management and communication.

Before providing a more detailed orientation to the contents and genesis of this book, we provide a brief overview of the multi-faceted aspects of uncertainty from the perspective of tackling complex societal problems.

THE PERVASIVENESS OF UNCERTAINTY

Any decision has to deal with uncertainty. As the issues become more complex, the different dimensions of uncertainty become more apparent. Consider, for
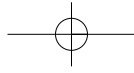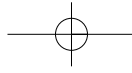
example, how society should best deal with illicit drug use. The first uncertainty is how society should approach the problem. Should it be as a criminal problem – young people wilfully breaking the law – with the focus on how to encourage greater respect for the law, as well as what the most appropriate and effective punishments for transgression might be? Should it be seen as a medical problem? That might lead to a focus on whether there is a genetic predisposition to taking risks and trying illicit drugs, how upbringing and schooling can ameliorate these innate tendencies, and what the best treatment is for those who become drug dependent. Or should the focus be on why society has deemed some drugs to be illegal and whether this is really warranted? The aim here is not to advocate one approach over another, but to illustrate that there are many ways of tackling a complex issue and that there may be no 'right' or even 'best' way. Taking any one approach necessarily ignores or marginalizes other legitimate aspects of the issue. So if illegal drug use is treated as predominantly a criminal problem, considerations of the appropriateness of the laws are ignored and little emphasis is put on treatment.

Attempts could be made to reduce this uncertainty by taking multiple approaches simultaneously – tackling young people's disrespect for the law, the most effective punishments *and* treatments, and whether society has the best laws. But this does not eliminate uncertainties, it merely changes them. One consequence is that decisions have to be made about how to allocate finite resources – should more money and effort be spent on law enforcement or treatment? What criteria should be used for making this decision? Such multiple approaches have contradictory components. How can young people's respect for the law be encouraged at the same time as questioning the rationale behind why only some psychoactive drugs are illegal? The point here is that there will always be uncertainties in how to approach a complex social issue and, no matter what approach is used, there will always be myriad loose ends.

Another important aspect of uncertainty is that it is unlikely that everything will be known about the factors pertinent to a given issue or about how the factors interrelate. Some unknowns simply result from lack of interest in finding out. There is little known, for example, about the extent to which acceptance of drug use in popular culture influences young people's decisions about whether to try illicit drugs. Popular culture acceptance includes drug references in music, films showing drug use, frequent (and often high-profile) media reporting of drug issues, and some norms, like using ecstasy at 'raves'. There has been little interest in conducting or funding research to explore these issues.

Some unknowns result from not having the appropriate methods or tools to find things out. Until the recent revolution in gene technology, for example, the ability to undertake research on human genes was very limited. Even now, it is not clear how (or whether) researchers should look for 'genes for illicit drug use'. Should scientists look for a heightened physiological response to one or more illicit drugs, some of which depress the central nervous system, others of which

stimulate it? Should they look for genes associated with high levels of risk taking? Or should they look for genes linked to antisocial behaviour?

An even greater difficulty is that some things are simply unknowable. Breakthroughs in physics and in mathematics have shown that some unknowables are consequential. Quantum physics demonstrates that both the location and momentum (speed and direction of travel) of a subatomic particle cannot be known with precision (see Chapter 6). The challenge on a day-to-day level, such as in dealing with illicit drugs, is that sometimes there is no certainty whether the things currently not known are really unknowable or whether the right questions have been asked or the appropriate methods developed. For instance, it is currently not possible to accurately estimate the number of illegal drug users (Chapter 14), but it is not clear whether the hidden nature of drug use means that this is something that can never be known, or if some as yet undiscovered statistical technique will enable accurate estimates to be made after all.
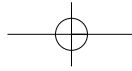
So far we have discussed uncertainties that are known, but there is another class of uncertainties, the so-called unknown unknowns. Thus there are some aspects of drug use that simply have not been thought about. In general, these unknown unknowns can be appreciated only in retrospect. For example, until fairly recently it was widely believed that all drug users came from dysfunctional homes. It was not until ordinary parents gathered the courage to speak out and band together that it became obvious that the social backgrounds of drug users are much more diverse. Further, some unknown unknowns follow a logic of simple precedence. It is only when a disease is discovered, for instance, that it becomes evident whether there is knowledge about how to treat it.

This is a brief introduction to just a few key aspects of uncertainty. Essentially, all decisions confront uncertainty, whether they are made as individuals or as members of communities, by government on society's behalf, or by businesses and other organizations which affect the lives of many. There are uncertainties in how to frame or approach issues, as well as lack of information because relevant areas have not been investigated or because available methods are limited. Furthermore, some things are unknowable and sometimes decision-makers are not aware of what they do not know. The aim of this book is to enrich understanding of these aspects and more, by exploring them in greater depth, by broadening the territory under consideration, and by starting to map out ways of approaching and managing uncertainty.

NAVIGATING THE BOOK

Jerome Ravetz kicks off with a stimulating preface highlighting the book's interlocked sections. We further set the scene based on our own research on ignorance and uncertainty (Smithson) and Integration and Implementation Sciences (Bammer), respectively. These introductory chapters are followed by the core of the book – 20 chapters, each presenting a perspective on uncertainty
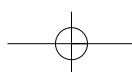
from a specific discipline, profession or practice domain. The third section of the book then presents our integration of these perspectives. We use Smithson's framework (introduced in Chapter 2) to explore three different aspects of uncertainty: the nature of uncertainty; uncertainty metaphors, motives and morals; and coping and managing under uncertainty. The final section focuses on the implications of these new insights for risk assessment and management. We have been extremely fortunate in attracting two of the world's foremost risk researchers, Roger Kasperson and Nick Pidgeon, to contribute to this section.

Setting the scene
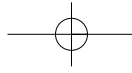
The book has its foundations in our research. Michael Smithson has a long-standing interest in the related areas of ignorance and uncertainty and the paradigms used to deal with them. His 1989 book *Ignorance and Uncertainty: Emerging Paradigms* elucidates how Western intellectual culture has been preoccupied with the pursuit of certainty. He also argues that the current re-emergence of thinking and research about uncertainty and ignorance is the greatest creative effort since 1660, when probability theory emerged. He notes a corresponding difference emerging in responses to ignorance and uncertainty. Earlier efforts aimed to eliminate or absorb uncertainty, whereas the focus now is on coping with and managing it.

Gabriele Bammer's interest is in bringing together many disciplines and practice sectors, specifically in integrating those different areas of knowledge to address complex problems. This has led to the development of the new discipline of Integration and Implementation Sciences, elaborated in Chapter 3. This new discipline specifically recognizes dealing with uncertainty as a cornerstone for making more effective decisions about difficult complex issues.

Genesis of the book

We started the production of this book with a symposium which brought together participants representing 20 distinct discipline-, practice- and problem-based perspectives on uncertainty. The symposium built on the complementary skills of its three organizers. Gabriele Bammer's development of Integration and Implementation Sciences and Michael Smithson's expertise in uncertainty and ignorance have already been outlined. The third organizer was Stephen Dovers, who brought a solid base of experience of interdisciplinary teamwork on environmental problems that highlighted the need to develop integrated approaches to uncertainty.

The choice of participants was an iterative process guided by a small number of principles and constrained by the practicalities of finding interested, appropriate and available people, funding, and discretionary time. We wanted to include representatives from a broad variety of academic disciplines, key practice areas and a small number of problem-focused areas, but limit the numbers to

allow for maximum interaction. We also did not want anyone to be isolated, so we deliberately aimed at clusters of participants. As well as having academic, practitioner and problem-based clusters, we also had clusters in science, the arts/humanities and the social sciences. We did not want to be confined to people we knew and we also wanted to introduce participants to new people and perspectives. This involved a lot of cold-calling, some detective work, and hoping that people unfamiliar with us would nevertheless take an interest and become involved.

The 'price of admission' for each participant was to produce a paper for circulation before the symposium, describing the approaches to uncertainty in their area of expertise. The main activity of the symposium was presentations by participants, each commenting on two allocated papers and using these to reflect back on their own. The allocated papers were selected to be as different as possible from the commentator's own field and participants could comment on more papers if they wished. The papers in the core section of this volume are based on the 'admission' papers, but have been revised in light of the symposium commentary and discussions.

The symposium was highly successful, generating a lot of energy and insights. For example, Judith Jones realized how little uncertainty is explicitly considered in the law and how this could open an entirely new area of research. Steve Longford gained a new appreciation of the importance of individual perceptions of uncertainty and used this in a workshop to re-evaluate his company's approach to intelligence. Alan Hájek and Michael Smithson fell to discussing a paradox in formal decision theories, and decided to mount a collaborative research effort to resolve it. The combination of individual and group insights was an important aspect of the integration undertaken in the third section of this book. We acknowledge our symposium colleagues as the 'Goolabri Group', named after the resort where the symposium was held.

The core chapters

The 20 perspectives in the core section of the book are drawn from academic disciplines, professional groups and practitioners focusing on specific problems. Each author was asked to write from their area of expertise, rather than being comprehensive in depicting their discipline, profession or practice area. They were asked to write for non-specialists, to avoid jargon, but not to 'dumb down'. Some chapters cover conceptually difficult material – requiring more exertion from the reader – but this effort is richly rewarded. Although they can be read in any order, the chapters as presented are loosely linked thematically.

We start with Aileen Plant's insider account of managing the response in Vietnam to the outbreak of SARS, when it was a new disease packed with unknowns. Plant was awarded the People's Medal for Health by the Vietnamese government for the work she describes. We contrast her practice-based exploration of uncertainty with Stephen Pickard's more theoretical, but equally
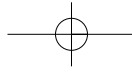
compelling, exploration of uncertainty in religion, where he concludes that faith should not be equated with certainty but instead with trust, and that uncertainty stimulates creativity in theological thinking, generating diversity and richness in modes of expression of faith. The metaphysical realm leads us to Stephen Buckman's account of uncertainty in physics. He begins by focusing on measurement, the basis of empiricism and a primary response to uncertainty. From this foundation he leads us into the world of quantum physics, where some uncertainties cannot be eliminated and probability displaces deterministic natural laws. Robyn Attewell and Alan Hájek pick up this theme. Attewell shows how probabilities pervade everyday life, not just the quantum domain, arguing for the importance of statistical literacy as a staple of good citizenship. But lest we think that statistics can provide all the answers, Hájek unpicks probability theory, revealing unsolved conundrums in its foundations.

We then change pace with John Mackey's account of improvisation in jazz and the training required to enable an immediate creative response when the time comes to 'take a solo'. The importance of uncertainty in stimulating creativity is expanded by Sasha Grishin's introduction to the visual arts. He shows how artists from Leonardo da Vinci to the Surrealists drew on uncertainty and then explains how Australian artist John Wolseley uses uncertainty in nature as an active collaborator. For example, Wolseley may bury his work under a rock, allowing natural processes to complete the picture. From art history, we move to history, where Ann Curthoys presents debates about how certain historical knowledge can be and the dilemmas faced by historians when the public not only wants the 'truth', but also wants the truth to be in line with how a nation wants to see itself. We contrast reflections on the past with understandings of the future. Kate Delaney provides a glimpse into how futurists approach their work, trying to release decision-makers from the prisons of their assumptions and familiar operating modes. Pascal Perez discusses related themes in complex systems science. He argues for concepts drawn from post-normal science and collective design to shape a new kind of science that would effectively support decision-making in the face of unknowable futures.

Alison Ritter extends the complexity theme by demonstrating that the problem of tackling illicit drugs confronts many different types of uncertainty. These range from the difficulties in estimating the size of the population of users to challenges for policymakers in managing conflicting outcomes and the dilemmas for clinicians making potentially life-or-death decisions. Michael Moore and Liz Furler then take us further into the policymakers' world, reflecting on their experiences as a politician and a public servant respectively. Moore shares his insights into improving accountability, swimming against the tide of political wisdom, which eschews specific targets and goals. He also demonstrates the power of delay as a political tool to heighten uncertainty and prevent action. Furler uses her observations in the area of health policy to lay out the consequences of a disturbing trend away from harnessing political power to tackle
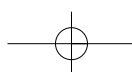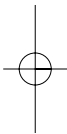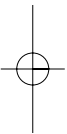
uncertainties in achieving social health goals to shaping health policies in the service of reducing political uncertainties, specifically shoring up support in marginal seats.

The focus then shifts to economics, the discipline which exerts the most power on policymaking. John Quiggin explores formal decision theory in economics, demonstrating how it has been influenced and strengthened by the ongoing debates between those who claim that uncertainty can be tamed by careful consideration of information and elicitation of preferences, and critics who argue that uncertainty is fundamentally irreducible. His introduction to formal decision theory paves the way for a discussion of the psychological aspects of uncertainty by Michael Smithson, who presents an overview of how psychology attempts to account for how people perceive and respond to uncertainty.

Human psychology is also essential for the field of intelligence. Steve Longford describes the methods intelligence analysts use to avoid various forms of cognitive bias, which can reduce uncertainty, but dangerously distort the meanings given to information. From intelligence, which is used to inform decision-making, we move to emergency response, which is all about coping with the unforseen. John Handmer describes the range of uncertainties which disasters bring to light and different strategies for reducing them, embracing them and, at times, denying them. Stephen Dovers and colleagues (including symposium participants Paul Perkins and Ian White) explore other consequences of disasters, laying out the pervasive uncertainties in the environment and sustainability, typified in a case study of a capital city water catchment made unusable when the vegetation was destroyed by a bushfire. Michael McFadden, Rod Lyon and Roy Pinsker then introduce us to a near relative of disasters, terrorism. They explain how terrorists aim to promote uncertainty and fear to achieve their political goals and then explore the consequent challenges for law enforcement, one of which is to reduce uncertainty in the community through transparency and accountability. This section of the book concludes with Judith Jones' eye-opening account of how uncertainty is dealt with or, more accurately, not dealt with in the law. She clearly outlines the contradictions between delivering justice and paying proper attention to uncertainty, thereby opening up a whole new field for exploration by legal scholars.

Despite their diversity of ideas, this collection of chapters is no mere 'cabinet of curiosities.' Numerous themes recur throughout, and the third section of the book is devoted to drawing these out and knitting them together.

Unifying diversity

This book is a step in fostering interaction and integration across different approaches to uncertainty. It both reflects and responds to growing recognition that uncertainty cuts across disciplinary and practice boundaries and that ideas and experiences need to be connected, contrasted and synthesized to develop
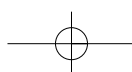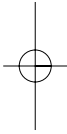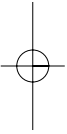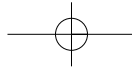
better tactics and methods for conceptualizing and coping with uncertainty. Exposure to current debates and competing perspectives highlights unresolved issues and stimulates new understanding and approaches. In the third section of the book we look at uncertainty from three angles to amplify and direct the synergies among the core chapters.
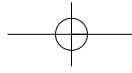
In the first chapter of this section we re-examine the nature of uncertainty, showing how different disciplines and professions give it quite different emphases. We also explore two attempts to structure uncertainty: distinguishing between what is known and not known, and elucidating the different kinds of unknowns via a taxonomy of uncertainty. The frameworks outlined in this chapter can accommodate many discipline and practice perspectives but not all, indicating some significant areas for future work.

The second chapter in this section investigates how people think and feel about uncertainty through the metaphors they use, their motivations for responding to uncertainty and their moral orientations. While it may seem odd to consider the notion of 'good' and 'bad' uncertainty, it turns out that many disciplines and professions harbour such views. This realization is one of the first steps to understanding the kinds of uncertainty that people are motivated to maintain rather than eliminate.

In the third chapter of this section, we survey the ways of coping and managing under uncertainty presented in the core chapters, especially in relation to meeting the adaptive challenges posed by uncertainty. These are (a) dealing with unforeseen threats and solving problems, (b) benefiting from opportunities for exploration and discovery, (c) crafting good outcomes in a partially learnable world, and (d) dealing intelligently and sociably with other human beings. Meeting these challenges might seem to be simply a matter of planning, but in his provocative book *The Black Swan*, Nassim Taleb admonishes, 'We cannot truly plan, because we do not understand the future – but this is not necessarily bad news. We could plan *while bearing in mind such limitations*' (2007, p157, emphasis in the original). Accordingly, the third chapter maps out alternative strategies for managing uncertainty itself. These range from outright denial or banishment to acceptance and even exploitation of uncertainty. Each has strengths and weaknesses and may be adaptive given the 'right' circumstances.

In each of these three chapters we pay particular attention to the three problem areas featured in the book – Aileen Plant's insights into controlling infectious disease outbreaks, Alison Ritter's exposition on tackling illicit drug use and the review by Stephen Dovers and colleagues on responding to environmental problems. In doing so we emphasize again that complex problems require the integration of disciplinary and practice insights on uncertainty, which constitutes the basis for this book.
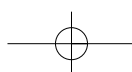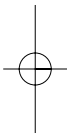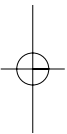
Implications for risk assessment and management

The final section of this book consists of two chapters written by experts in risk who were not participants in the symposium described earlier. These chapters perform two important functions. First, they present responses to the book's content from the standpoint of knowledgeable outsiders with long-term interests in its subject matter. Both authors articulate their responses in reference to their own domains, drawing out the implications for risk assessment, management and communication. Second, these chapters bring the book to an essential summation by addressing how its contents bear on some of the most crucial prospects and choices facing humankind.

Roger Kasperson's contribution focuses on 'deep uncertainty', which is characterized by high levels of ignorance, a predominance of subjective judgments substituting for actual experience, and decision-making predicated on ethical or moral grounds as much as any kind of risk assessment. Squarely facing the question of whether viable strategies are available for dealing with this kind of uncertainty, he critically assesses six potential elements of such strategies. An intellectual humility pervades his recommendations, in contrast with the rather hubristic atmosphere of much late-twentieth-century decision theory. This is exemplified in such advice as candidly acknowledging the limits to one's knowledge, encouraging lateral thinking and implementing inclusive participatory decisional processes. His insights appear as salutary responses to the deep-seated problem captured in economist Kenneth Arrow's retrospection that:

> *Vast ills have followed a belief in certainty, whether historical inevitability, grand diplomatic designs or extreme views on economic policy. When developing policy with wide effects … caution is needed because we cannot predict the consequences.* (Arrow, 1992, p46)

Nick Pidgeon's chapter carries Kasperson's themes regarding deep uncertainty into the realm of risk communication and politics. He observes that in times characterized by pervasive disagreements over the nature and importance of risks, establishing a workable consensus is not merely a matter of educating the public about expert knowledge. Pidgeon describes the major approaches to understanding risk perception (cognitive science, socio-cultural and interpretive) and their implications for understanding how risks become salient or hidden. The growing realization that public perceptions of risk involve numerous factors other than those that experts would take into account has dramatically transformed debates over the role that public and expert views about risk should play in societal decision-making. One emerging point of resolution in these debates is that input from the public is valued for its contribution to 'social rationality', which encompasses matters of preference, culture, values and ethics.

One of the main messages of the book is that uncertainty is not just a problem to be overcome or managed, it is also an essential source of opportu-

nity, discovery and creativity. We also believe that the study of uncertainty has a rightful and central place in the world's intellectual endeavours, a belief that has been a core motivation for producing this book. We hope that it stimulates you to join us in adding to the understanding of uncertainty and the roles it plays in the complex problems confronting humankind.
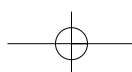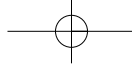
REFERENCES

Arrow, K. J. (1992) 'I know a hawk from a handsaw', in M. Szenberg (ed) *Eminent Economists: Their life and Philosophies*, Cambridge University Press, Cambridge, UK

Taleb, N. N. (2007) *The Black Swan: The Impact of the Highly Improbable*, Penguin Books Australia, Melbourne

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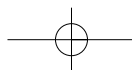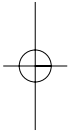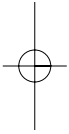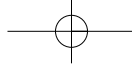
The Many Faces and Masks of Uncertainty

Michael Smithson

INTRODUCTION

Uncertainty is a topic that does not fall neatly within a single discipline. Instead it sprawls across a considerable variety of disciplines, professions and problem domains. Consequently, there is no cogent, readily identifiable body of literature on uncertainty. The topic lacks a home. The relevant literature is scattered throughout the entire realm of intellectual culture. The terms employed by various traditions to refer to uncertainty are themselves multifarious, and as a result researchers and scholars from different traditions have difficulty communicating effectively with one another.

It is difficult to communicate clearly about uncertainty, and even more difficult to find out very much about it. However, it is not so difficult to find out how people talk about uncertainty, what they think it is, and how they deal with it. To a large extent, that is what this book is about. The purpose of this chapter is to equip readers with several concepts, strategies and questions that may assist in understanding the chapters that follow. Accordingly, here is a brief outline of the destinations on our tour through uncertainty in this chapter.

The first section concerns views about the nature of uncertainty. Every discipline and profession has (often implicit) assumptions and beliefs about the 'unknown'. Some think there is only one kind of uncertainty; others think there are many kinds. These views encompass questions such as whether there are irreducible uncertainties, when information or knowledge is worth acquiring, and how uncertainty is produced.

The second section deals with motives and values that people associate with uncertainty. Common metaphors about uncertainty reveal not only how we think about it but how we feel towards it. We adopt ethical and moral stances

towards uncertainty. What underpins our judgments of which uncertainties are 'bad' or 'good', which are exchangeable, and which can be blamed on people? Despite a generally negative bias towards uncertainty, people do have uses for it – what are they? Uncertainty is not always a negative aspect of human affairs. In fact, it is an essential component in social relations, organizations and culture. People are motivated to create and maintain uncertainty, rather than always trying to reduce or banish it. Uncertainty also presents genuine dilemmas in management and control.

The third section raises the question of how people deal with uncertainty. Despite the fact that we do this every day, only recently has it become an object of systematic research. Coping strategies may range from fatalism to optimistic (even heroic) interventionism. Likewise, various alternative managerial approaches to uncertainty are open to consideration and often are contested.

THE NATURE OF UNCERTAINTY

How do people represent uncertainty and communicate about it? Is there more to it than mere absence of knowledge? Can various uncertainties be compared or even quantified? Where do our ideas about uncertainty come from? At first glance, uncertainty might seem uncomplicated – after all, isn't it merely the lack of sure knowledge? A little more thought, however, suggests uncertainty is not as simple as that.

Imagine that Amy is fortunate enough to participate in a game of 100 coin tosses in which every time a fair coin is tossed and comes up Heads, she receives $1. While we may be uncertain about how much money Amy will receive from this game, we can still calculate an expected amount by multiplying the probability of Heads (1/2) by $1 by 100 tosses, which comes to $50. We could even go on to calculate the probability that she will get any possible monetary amount from the game, from $0 to $100. The uncertainty regarding the outcome of the game is probabilistic. It is quantifiable.

Now consider a situation where all we know is that Amy is going to be bequeathed a sum of money anywhere from $0 to $100. We cannot apply probability theory here. Even the notion of averaging $0 and $100 to get an 'expected' value of $50 is contentious because we have no good reason to prefer $50 to any other estimate between $0 and $100. The type of uncertainty in this situation is not captured by probability, it is *vagueness*. It is not readily quantifiable.

Readers will encounter many different kinds of uncertainty in this book, but they will also encounter disciplines using the same terms for uncertainty in different ways. While life might be simpler if everyone shared the same definitions, there is much to be gained from appreciating the variety of viewpoints. The widely scattered literature on this topic lacks an agreed nomenclature, but let us begin by considering a term for the overarching concept in this domain. Böschen and Wehling (2004) use the term '*nichtwissen*' (the English equivalent is

'nonknowledge'). A relatively popular if more radical alternative is 'ignorance' (Moore and Tumin, 1949; Smithson, 1985 and 1989; Merton, 1987). Knorr-Cetina (1999) introduces the term 'negative knowledge', in other words knowledge of the limits of knowing, mistakes in attempts to know, things that interfere with knowing and what people do not want to know. Outside the social sciences the most popular generic term seems to be 'uncertainty'; this is, for example, the case in artificial intelligence (Krause and Clark, 1993) and in economics (see Chapter 17).

Knorr-Cetina (1999) and Smithson (1989) make the important observation that anyone referring to uncertainty cannot avoid claiming to know something about who is uncertain about what. Smithson's (1989) definition handles this issue by stating that A is uncertain from B's viewpoint if A fails to agree with or show awareness of ideas which B defines as actually or potentially valid. This definition allows B to define what she or he means by uncertainty. It also permits self-attributed uncertainty, since A and B may be the same person. Most important, it incorporates the possibility that A and B might not agree about uncertainty. Uncertainty does not simply impose itself on us from the natural world; it is socially constructed. Cultures differ considerably in how uncertainty is conceived and expressed, and so do subgroups within the same culture. It probably does not matter greatly what generic term we choose as long as our definition of it recognizes this point.

People also behave as if there are different kinds of uncertainty and as if that matters to them. If we want to understand how people orient towards uncertainty, we need to take such distinctions into account. How can we assess which distinctions are worth making? Smithson (in press) suggests four criteria, namely whether candidate kinds of uncertainty:

1 are consistently distinguished from other kinds when referred to in communication by members of the same linguistic community;
2 are accorded statuses or roles distinct from other kinds in the same situations or for the same purposes in social interaction;
3 produce different social consequences for those to whom they are attributed; and/or
4 are (dis)preferred to other kinds of uncertainty.

For instance, in relation to the first criterion, if we wish to understand how artists have employed 'chance' in art-making (see Chapter 10) versus how statisticians or probabilists work with 'chance' (Chapters 7 and 8), then we should start by understanding what artists and statisticians mean by this term and how they use it rather than immediately insisting on our own terms or definitions. An example fulfilling the second criterion in my list is the commonsense observation that conveying outright misinformation (distortion) is socially riskier than conveying vague or partial information for purposes of being tactful.
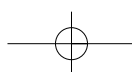
Correspondingly, the third criterion is exemplified by the belief that the consequences of being found out uttering a falsehood will be worse than being found out omitting part of a truth. Evidence for both propositions stems from studies such as Burgoon and colleagues' 1994 investigation of equivocation or omission versus falsification in doctor–patient interviews, in which about 85 per cent of the participants admitted to omission but only 34 per cent admitted to falsification. Likewise, in many situations people will provide a vague statement in order to avoid being judged afterwards to have been wrong, because it is easier to deny particular interpretations of vague statements. Finally, an example of the fourth criterion is evidence that for many people probabilistic uncertainty is preferred to ambiguity (Ellsberg, 1961), which in turn is preferred to conflict (Smithson, 1999).

One additional important concept to add to our mental toolkit is metacognition about knowledge and uncertainty. The most popular distinction is between knowing that we don't know and not knowing that we don't know (Smithson, 1989; Kerwin, 1993; Ravetz, 1993). In his dialogue with Meno, Socrates pointed out the difference between what he called 'ignorance' and 'error'. People in error believe they know that which they do not know, while ignoramuses are conscious of their lack of knowledge. Merton (1987) described a similar distinction between 'unrecognized' and 'specified' ignorance, with the latter being useful for focusing further inquiries or learning. I prefer the terms 'meta-ignorance' and 'conscious ignorance'.

METAPHORS, MOTIVES AND MORALS

Where do our ideas about uncertainty come from? Smithson (in press) points to two sources: commonsense realism and commonsense sociality. Commonsense realism encompasses everything we believe or think about how the non-social world works. Commonsense sociality refers to our beliefs about the social world and includes our commonsense ideas about people. The main reason for distinguishing these two sources is that a number of important characteristics we attribute to people (for example intentions) we do not attribute to objects in the non-social world, and that has direct consequences for how our commonsense theories direct us to think about uncertainty.

Although out intuitions about uncertainty may be socially constructed, we should bear in mind that some of them appear to be shared with other species and may have been selected in evolutionary processes. Many species (including ours) behave as if events or influences that are nearby or in the near future are more certain than those farther away or further into the future (see Rachlin, 1989, for an excellent overview of the research on delay). The underlying metaphor is that certainties are here and now. Uncertainties are later and farther away. Distance is uncertainty. Delay is uncertainty. Moore's chapter on politics (Chapter 15) devotes an entire section to the use of delay as a political tool,

highlighting the fact that with delay comes uncertainty. And as Hájek (Chapter 8) points out in his survey of probability theories, normalized quantities such as distance and time may have nothing to do with probabilities but still may exhibit identical formal (mathematical) properties.

Common metaphors for uncertainty are highly informative about how it is regarded and used in a society. Following Lakoff and Johnson (1980), here is a sample from English-speaking cultures of ten metaphors for uncertainty that stem from commonsense realism:

1   Uncertainty is obstructed vision. Uncertainty is blindness. To know is to see. Vague ideas are blurry, murky, hazy, unclear, obscured. Knowledge is brilliant, illuminating and enlightening. Uncertainty is dim and dark.
2   Ideas can be felt. Vague or uncertain ideas are soft and woolly. Objective knowledge, truth and logic are hard. Incomplete ideas are rough.
3   Learning and discovery are a journey. To know or discover is to arrive at a destination. A path can be cleared or paved to help us learn or discover. Learning is finding one's way. Uncertainty is straying from the path, getting lost, going in the wrong direction, going around in circles, wandering aimlessly, failing to arrive.
4   The unknown is an ocean. Knowledge is an island. The bigger the island, the larger the border between the known and unknown.
5   The unknown is wilderness. Knowing is domesticating and taming the wild. The border between the known and unknown is a wild frontier. Learning and discovery push back the frontier, diminishing the extent of the unknown.
6   Seeking knowledge is gathering and hunting. The unknown is prey. Sought-after ideas, facts and truths can be elusive, hard to find, slippery. They can be apprehended, grasped or homed in on. They can also escape. Errors or bad ideas are off-target, wide of the mark.
7   Ideas are food (for thought). Bad ideas are half-baked or even raw. Raw data have yet to be cooked into knowledge. Thinking or analysing is cooking.
8   Uncertainty is gaps or holes. Knowledge covers a surface or fills a container. An ignoramus is devoid of knowledge, whereas an expert is brimming with knowledge. An incomplete theory has holes or gaps, whereas a complete theory covers the terrain.
9   Ideas, theories and arguments are buildings. Uncertain or erroneous ones are shaky, badly constructed, unfounded. They collapse, don't hold together, fall apart, can be knocked down.
10 Uncertainty is variability. Certainty is constancy.

Likewise, here is a sample of ten metaphors stemming from commonsense sociality:
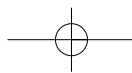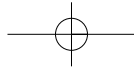
1   Inquiry is invasion. Learning is conquering. Uncertainty is conquered or overcome by knowledge and ideas.
2   Ideas and knowledge are resources. Knowledge and information are currency. Uncertainty is poverty. Bad ideas are worthless, bankrupt. An expert has a wealth of knowledge.
3   Argument is war. Rational argument is still war. Ambiguity or indecision is internal war.
4   Knowledge is power. ~~Uncertainty~~ is helplessness and impotence. Uncertainty or doubt is still impotence. We succumb to uncertainty.
5   Uncertainty is being stuck, enslavement. Knowledge makes you free.
6   Innocence is chastity. Scepticism, doubt or uncertainty is still chastity. To be known is to be violated. To believe or be persuaded is to be seduced.
7   Information exchange is sexual intercourse. Good ideas are fertile and can procreate. Bad ideas are sterile or barren.
8   Ignorance is inequality. Shared knowledge is generosity, democracy, freedom. Unshared knowledge is selfishness, autocracy, elitism, oppression. Secrecy is selfish. Privacy and expertise are elitist.
9   The unknown is a secret. Even nature keeps secrets. The unknown is locked away. Discovery or learning is unlocking and revealing.
10   Uncertainty is insecurity and fear. We are afraid we don't know. Certainty is confidence.

It should be apparent that most of the metaphors regarding uncertainty have a negative cast to them. The negative stance towards uncertainty is a mainline thesis pervading Western culture to the extent that, as Smithson (1993 and in press) points out, Western intellectual culture has been effectively blinded to most of the positive functions uncertainty performs. Of course, there are excellent reasons in many circumstances to be negatively disposed towards uncertainty. In this volume, Plant's chapter on infectious disease outbreaks (Chapter 4), Longford's on intelligence (Chapter 19) and Handmer's on emergency management (Chapter 20) all are good cases in point, because they highlight the need for effective ways of being decisive where uncertainty is essentially an antagonist.

Nevertheless, uncertainty can motivate people positively as well as negatively. People find uses for uncertainty and do not always want to be rid of it. Readers having difficulty conceiving of positive aspects of uncertainty might wish to consider what freedom, discovery, creativity and opportunity really require, namely uncertainties about what the future will bring so that there actually are choices to be made. No uncertainty, no freedom. In this volume, Mackey's chapter on jazz improvization (Chapter 9) and Grishin's overview of how visual artists have employed aleatory devices to open up creative possibilities (Chapter 10) provide ample demonstrations of this fundamental connection. Curthoys' meditation on the double character of history as both science and narrative art (Chapter 11) and Buckman's account of how physicists
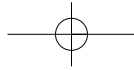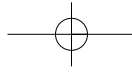
have come to grips with irreducible uncertainties in an 'exact' science (Chapter 6) illustrate the mixed motives that people often possess when it comes to uncertainty. Indeed, Horgan's book *The End of Science* (1996) was reviled by many scientists in part because its central thesis – that science is running out of unknown things to discover – is quite dismaying to scientists. Ignorance is treated by Horgan as a resource that must be replenished to feed the insatiable appetite of science.

In a somewhat more sinister vein, people may use the deliberate production of ignorance and uncertainty as a way to dominate or manipulate others. Proctor's (1995) work on the tobacco industry's efforts to manufacture doubt about the hazards of tobacco is an excellent case study of the use of pseudoscience by an industrial giant to protect and expand its investments. Likewise, Michaels has elaborated the thesis that opponents of health and environmental regulation are able to prosecute their ends 'without being branded as antienvironmental, by focusing on scientific uncertainty and by manufacturing uncertainty if it does not exist' (Michaels, 2005 pS43).

People regard some kinds of uncertainty as having moral antecedents and consequences. Imposing or increasing risks for other people, for instance, is widely regarded in the Western world as morally bad (see Furedi, 2002, for an extended polemic regarding the moralizing aspects of risk perception and management). In earlier times and in some present-day cultures, attempting to alter uncertainties has been perceived as spiritually dangerous or even blasphemous (Bernstein, 1996). As Pickard points out in Chapter 5, for religious fundamentalists any consideration of uncertainty regarding their religious tenets is off limits.

Throughout Western societies and their institutions, we find numerous laws and structures championing people's rights to knowledge. Democracy and secrecy, it would seem, are incompatible. On the other hand, it is not difficult to find examples of 'virtuous' uncertainty and secrecy in the same Western cultures. Would it be a good thing if everyone knew the location of the Wollemi Pines?[1] On a more mundane but also more general level, how would politeness (for example tact or white lies) be possible without the deliberate creation and maintenance of uncertainty? What would gift-giving be like if surprises were forbidden? As Smithson (1989) points out, politeness often operates via disinformation (for example promoting a false impression of approval), or by referential abbreviation (particularly vagueness and ambiguity, as in tactful utterances). In their 1997 book on miscommunication, communications scholars Mortensen and Ayers clearly align themselves with 'the ideal of maximum communicative value – clarity, fluency and explicitness' (pp69–70). But they are compelled to acknowledge that there are plenty of occasions where prevarication and even deception are socially acceptable, ranging from mundane concerns such as protecting the feelings of others to rather grandiose issues such as protecting life or maintaining national security (pp70–71).
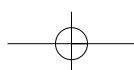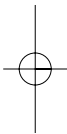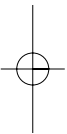
Contrary to the view of ignorance and uncertainty as primarily negative, human engagement with ignorance or uncertainty is almost always a mixed-motive enterprise. People sometimes are motivated to discover or create, maintain and use uncertainty. The very concept of research, for example, presupposes conscious uncertainty about the object of research at the outset; otherwise there is nothing to research. Much the same is true of artistic creations.

People can have quite defensible reasons to remain ignorant about information directly relevant to themselves, even when that information is readily available. The uptake rate on genetic marker tests by individuals with a hereditary risk of a life-threatening disease such as Huntington's Chorea or colon cancer is notoriously low, and the same is true regarding the diagnosis of carrier status of such conditions (see, for example, Fanos and Johnson, 1995). More 'positive' examples include the majority of parents-to-be not wanting to know the gender of their unborn child (Wilson et al, 2005), social arrangements such as surprise gift-giving, entertainment (for example avoiding prematurely finding out about the ending of a novel or film), and games.

Why do (or should) we care about uncertainty? I propose here that our primary interests in uncertainty stem from four adaptive challenges that we routinely face:

1   dealing with unforeseen threats and solving problems;
2   benefiting from opportunities for exploration and discovery;
3   crafting good outcomes in a partially learnable world; and
4   dealing intelligently and sociably with other people.

The first point is perhaps obvious to most of us. After all, this has been the main thrust of Western intellectual and technical culture at least since the Enlightenment. Many of the chapters in this book place this concern at centre stage. Ritter (Chapter 14) characterizes the issue of heroin dependency in terms of three problem arenas, each with their own kinds of uncertainty: epidemiology and etiology, policy formulation, and treatment of dependent users. Dovers and colleagues (Chapter 21) find the scientific and policy domains of sustainability are pervaded by uncertainty, due to extended time scales, complexity, and competing values and knowledge claims, in addition to mere lack of information. McFadden and colleagues (Chapter 22) expand the law-enforcement charter regarding anti-terrorism to include the reduction of uncertainty in the community through transparency and accountability. Likewise, Handmer's chapter on emergency management (Chapter 20) emphasizes the observation that emergency managers cannot wait for certainty; they must act under increasing scrutiny from a variety of powerful stakeholders.

The second point has already been canvassed in this chapter but usually is neglected when we think about uncertainty. The most obvious examples of how
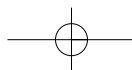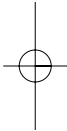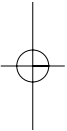
people benefit from opportunities for exploration, discovery, entrepreneurship and creativity thrown up by uncertainty are in the intellectual domains of the arts and sciences and the practice domains of politics and business. But Pickard (Chapter 5) raises quite similar points in the realm of religion, first by observing that for some theologians doubt is an intrinsic component of faith (in other words that faith is not reducible to certitude) and then linking religious uncertainty with the innovative potential of religion itself.

The third point is closely related to the first, with the added caution that some uncertainties are irreducible and the world is only partially learnable. Quiggin (Chapter 17) provides a sobering realization that only recently has work begun in economics on modelling economic behaviour for situations where decision-makers do not know all of the possible outcomes beforehand. Moore's chapter on politics (Chapter 15) invites the reader into a realm where this is the everyday state of affairs; Perez's chapter o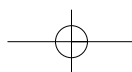n complexity science (Chapter 13) introduces readers to a field in which this state of affairs is taken as given; and Delaney's survey (Chapter 12) reveals that assuming crucial aspects of the future are unknowable forms the basis for much work in futurology.

The fourth point merits some elaboration, although it raises complex issues far beyond the scope of this chapter. To begin with, numerous social relations depend on systematic uncertainty arrangements. I will provide just one example. Trust has long been recognized as a major contributor to social capital (see, for example, Fukuyama, 1995). Despite long-running debates about the nature of trust, there is widespread agreement among scholars that trust 'entails a state of perceived vulnerability or risk' (Kramer, 1999, p571). A primary source of that risk is a virtual requirement that the trusting remain partially ignorant about the entrusted. If a person believes another is monitoring them or insisting that they self-disclose or account for their actions, that person will infer that the other does not trust them.

Likewise, there are plenty of pragmatic and political motives for creating and using uncertainty. Uncertainty or the lack of knowledge can be used as a justification for evading culpability or responsibility, for example. And as Moore observes in his chapter on political practice (Chapter 15), it is generally safer for politicians to ally themselves with uncertain progress than to have clear, measurable goals where success and failure are unambiguous.

COPING AND MANAGING UNDER UNCERTAINTY

Various chapters in this volume describe, criticize or recommend ways of dealing with uncertainty. The integrative chapter on coping with uncertainty (Chapter 26) provides an overview of those chapters. Here, I present a brief survey of the central issues entailed in dealing with uncertainty. Human strategies for managing under uncertainty are typically oriented towards the issues of how uncertainty can be:

- understood;
- represented, quantified or estimated, and communicated;
- eliminated or reduced;
- accepted or tolerated; and
- controlled, harnessed or exploited.

Clearly many such strategies address only subsets of these issues, but, as a whole, this list is intended to be exhaustive. Most strategies, nevertheless, are attempts to incorporate mixed (and sometimes conflicting) motivations regarding uncertainty and one or more of the adaptive challenges listed earlier.

Starting with understanding and representing uncertainty, a large body of cognitive psychological research suggests that people use cognitive shortcuts and selective attention to make decisions under uncertainty, rather than attempting laborious (and in some cases impossible) computations or a comprehensive understanding of uncertainties. People also tend to regard alternatives that have missing information as inferior to those where the informative content is complete, and they become more indecisive in the face of uncertainties that make decisions more difficult (Anderson, 2003). So here we find motivations for and against the explicit representation of uncertainty that will be explored in Chapter 26. We will see that some domains have clear mandates for quantifying and calculating uncertainties, whereas others have equally clear injunctions against doing so.

Tetlock (2002) extends this theme to describing how people deal with social uncertainty; his templates are the 'intuitive politician', 'intuitive prosecutor' and 'intuitive theologian'. The relevant adaptive challenges here are dealing with accountability, negotiating or defending the ground-rules for accountability, and protecting sacred values or ideals. Those challenges in turn influence whether people deal with uncertainty by eliminating, tolerating or exploiting it.

Many institutional practices involve adaptive mixed-motive dealings with uncertainty. The interface between legislated policy and judiciary practice is fraught with uncertainties that simultaneously present interpretive difficulties and enable flexibility and adaptability. As Jones points out in Chapter 23 on environmental law (and as Durkheim averred long ago), there is constant pressure to adapt laws to changing circumstances, giving rise to controversy about the extent to which new judgements change the law. Well-written policy often must be vague enough to be adaptable and usable in unforeseeable circumstances, albeit at the expense of short-term ease of interpretation.

Professionals, politicians and risk managers must also contend with stakeholder perceptions of uncertainty and the competing interests invoked thereby. As Brown (2004) observes, discussions and increased interest in scientific uncertainties have started to filter into policy formation. An example is the new European Union Water Framework Directive requirement that scientific uncertainty is addressed within the development of integrated water management plans at a European scale. In another related arena, the nature and determinants
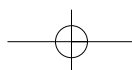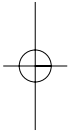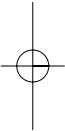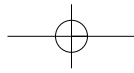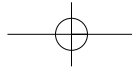
of public risk perception have been hotly contested for more than three decades, and at the heart of these debates is a long-running argument over the veridicality of such perceptions and the presentation of risks by outlets such as the media. In the 'social risk amplification' framework, for instance, the core concern is whether risk communication produces (in)appropriate intensification or (in)appropriate attenuation of public risk fears. As Leiss (2003, p357) makes clear, risk managers and policymakers have interests directly vested in these outcomes, especially inappropriate intensification or attenuation. Here, the potential for public ignorance about risk (as viewed by managers and policymakers) provides justifications for managerial decisions or policy directives.

In settings characterized by competing interests, it is not difficult to find examples of tradeoffs or even genuine dilemmas in dealing with uncertainty. I previously (Smithson, 1989) somewhat inaccurately referred to both tradeoffs and dilemmas as 'dilemmas', but the distinction between them is worth preserving. Tradeoffs amount to perceiving uncertainty as both a good and a bad thing simultaneously, sometimes simultaneously for the same agent. In dilemmas, on the other hand, the pursuit of self-interest by too many actors results in poor outcomes for everyone. Nevertheless, the actors are motivated to pursue self-interest out of fear (of being played for a sucker) and/or greed (the possibility of taking advantage of others). I will conclude this section with a few examples of uncertainty tradeoffs and dilemmas.

'Collingridge's Dilemma' (Smithson, 1989) is really just a tradeoff problem. The less well entrenched a system is and the shorter the time it has been operating, the more easily and inexpensively it can be changed, but the greater is our ignorance of its likely effects or problems. By the time ignorance of those effects has been reduced, it is too expensive and difficult to change the system. In this tradeoff, time is both knowledge and money.

The persuasion-versus-information-glut dilemma, on the other hand, is a special case of the standard common-pool resource social dilemma. Any party with an educational or persuasive interest will wish to broadcast its message in a public forum. Too many messages in an unregulated forum, however, may result in the public tuning out messages altogether. The scarce resource in this case is not information or knowledge, but attention.

'Mattera's Dilemma' (Smithson, 1989) is an example of a conundrum in social regulation that has both tradeoff and dilemmatic components. The tradeoff arises from the fact that a climate favouring creativity and entrepreneurship requires the toleration of uncertainty in the service of freedom. Insistence on full knowledge and control eliminates the latitude needed for creativity. The dilemmatic component arises from the fact that the greater the attempts to regulate behaviour, the more reactive people become and the more they attempt to generate uncertainty in the would-be controllers by withholding information or giving false information. If both parties pursue their self-interests, then the end result is a system of constraints and controls built on disinformation.

In closing, let us return to two popular metaphors mentioned earlier, both invoking the notion of knowledge as covering terrain, but with nearly opposite views on the progress of knowledge. In one metaphor, the border between the known and unknown is a wild frontier. Learning and discovery push back the frontier. The advance of knowledge diminishes uncertainty. In the other, the unknown is an ocean and knowledge is an island. As the island is made larger, the extent of the border between the known and unknown becomes larger as well. The advance of knowledge increases our awareness of what we do not know.

A third metaphor that captures the sense of a question-answer-question sequence in the process of inquiry could be called the 'dark room' metaphor. This metaphor is expressively used by the mathematician Andrew Wiles to liken the experience of doing mathematics (Singh, 1998, p258) to the exploration of a darkened mansion. There is a long period of stumbling around in the first room, bumping into things and gradually becoming familiar with every object in the room. Eventually the explorer finds the light switch and turns it on. Everything in that room is clearly visible now. But there is a door that leads into another dark room. And perhaps the mansion has infinitely many rooms.

NOTE

1   In 1994, a grove of trees of a species previously believed to have been extinct for 60 million years was discovered in the Wollemi National Park in New South Wales. To protect the grove, its location has been a closely guarded secret.

REFERENCES

Anderson, C. J. (2003) 'The psychology of doing nothing: Forms of decision avoidance result from reason and emotion', *Psychological Bulletin*, vol 129, pp139–167

Böschen, S. and Wehling, P. (2004) *Wissenschaft zwischen Folgenverantwortung und Nichtwissen*, Verlag für Sozialwissenschaften, Wiesbaden, Germany

Brown, J. D. (2004) 'Knowledge, uncertainty and physical geography: Towards the development of methodologies for questioning belief', *Transactions of the Institute of British Geographers*, vol 29, pp367–381

Burgoon, M., Callister, M. and Hunsaker, F. G. (1994) 'Patients who deceive', *Journal of Language and Social Psychology*, vol 13, pp443–468

Ellsberg, D. (1961) 'Risk, ambiguity and the Savage axioms', *Quarterly Journal of Economics*, vol 75, pp643–669

Fanos, J. H. and Johnson, J. P. (1995) 'Barriers to carrier testing for adult cystic fibrosis sibs: The importance of not knowing', *American Journal of Medical Genetics*, vol 59, pp85–91

Fukuyama, F. (1995) *Trust: The Social Virtues and the Creation of Prosperity*, Free Press, New York

Furedi, F. (2002) *Culture of Fear* (revised edition), Continuum, London

Horgan, J. (1996) *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*, Little, Brown and Co, London
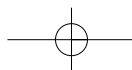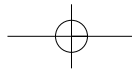
Kerwin, A. (1993) 'None too solid: Medical ignorance', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp166–185

Knorr Cetina, K. (1999) *Epistemic Cultures: How the Sciences make Knowledge*, Harvard University Press, Cambridge, MA

Kramer, R. M. (1999) 'Trust and distrust in organizations: Emerging perspectives, enduring questions', *Annual Review of Psychology*, vol 50, pp569–598

Krause, P. and Clark, D. (1993) *Representing Uncertain Knowledge: An Artificial Intelligence Approach*, Intellect, Oxford

Lakoff, G. and Johnson, M. (1980) *Metaphors We Live By*, University of Chicago Press, Chicago, IL

Leiss, W. 'Searching for the public policy relevance of the risk amplification framework', in N. Pidgeon, R. E. Kasperson and P. Slovic (eds) *The Social Amplification of Risk*, Cambridge University Press, Cambridge

Merton, R. K. (1987) 'Three fragments from a sociologist's notebooks: Establishing the phenomenon, specified ignorance and strategic research materials', *Annual Review of Sociology*, vol 13, pp1–28

Michaels, D. and Monforton, C. (2005) 'Manufacturing uncertainty: Contested science and the protection of the public's health and environment', *American Journal of Public Health Supplement*, vol 95, ppS39–S48

Moore, W. E. and Tumin, M. M. (1949) 'Some social functions of ignorance', *American Sociological Review*, vol 14, pp787–795

Mortensen, C. D. and Ayers, C. M. (1997) *Miscommunication*, Sage, Thousand Oaks, CA

Proctor, R. N. (1995) *Cancer Wars: How Politics Shapes what we Know and Don't Know about Cancer*, Basic Books, New York

Rachlin, H. (1989) *Judgment, Decision and Choice*, Freeman. New York

Ravetz, J. (1993) 'The sin of science: Ignorance of ignorance', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp157–165

Singh, S. (1998) *Fermat's Last Theorem*, Fourth Estate, London

Smithson, M. (1985) 'Toward a social theory of ignorance', *Journal for the Theory of Social Behaviour*, vol 15, pp151–172

Smithson, M. (1989) *Ignorance and Uncertainty: Emerging Paradigms*, Springer Verlag, New York

Smithson, M. (1993) 'Ignorance and science: Dilemmas, perspectives and prospects', *Knowledge: Creation, Diffusion, Utilization*, vol 15, pp133–156

Smithson, M. (1999) 'Conflict aversion: Preference for ambiguity vs. conflict in sources and evidence', *Organizational Behavior and Human Decision Processes*, vol 79, pp179–198

Smithson, M. (in press) 'Social theories of ignorance', in R. N. Proctor and L. Schiebinger (eds) *Agnotology: The Cultural Production of Ignorance*, Stanford University Press, Stanford, CA

Tetlock, P. E. (2002) 'Social functionalist frameworks for judgment and choice: Intuitive politicians, theologians and prosecutors', *Psychological Review*, vol 109, pp451–471

Wilson, T. D., Centerbar, D. B., Gilbert, D. T. and Kermer, D. A. (2005) 'The pleasures of uncertainty: Prolonging positive moods in ways people do not anticipate', *Journal of Personality and Social Psychology*, vol 88, pp5–21