

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 multifaceted 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 unforeseen. 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-20th-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

opportunity, 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

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