1 The Foundations of Risk Management

Smart quotes

The revolutionary idea that defines the boundary between modern times and the past is the mastery of risk.

Peter Bernstein

As we saw in the introduction, we face a multitude of risks in our daily lives and the number and complexity of these has grown, particularly over the last 50 years or so. Complexity is a major driver of risk because of its ability to distort our understanding and cloud our judgement. In some cases, it can make us feel like rabbits caught in the headlights of a speeding car – not knowing which way to turn. But despite such complexity, risk is a fundamental discipline within all businesses, irrespective of their market sector, size or composition.

In very simple terms, risk management involves following a deliberate set of actions designed to identify, quantify, manage and then monitor those things, events or actions that could lead to loss, which in most cases equates to financial loss. This implies that risk management is an active process requiring commitment and focus. But in many instances there is insufficient data about a risk to define it precisely, which makes the process more difficult and necessitates greater vigilance. As a result,

great attempts have been, and continue to be, made at modelling and assessing risk, which in some cases have bordered on pseudo-science.

But irrespective of how precise the process is, it involves the application of judgement and requires the organization to make certain assumptions about the future. For example, although assessing the likelihood of a road accident is quite easy, assessing the risk of nuclear meltdown is very difficult. This is because in the case of road accidents there is plenty of information available against which the risk can be modelled but in the nuclear meltdown case there is very little. This separates risk (which can be managed) from uncertainty (which generally cannot be managed without the construction of theoretical models – because there is insufficient historical information on which to assess the risks). Therefore, in order to manage risks effectively it is necessary to categorize the types of risk that organizations are exposed to and then manage them accordingly. A classification of risk is discussed in greater detail in Chapter 2. This chapter outlines why risk management is important, describes its evolution and spends some time covering its central concept; probability.

Smart quotes

Risk management is about taking risks knowingly. An effective risk management structure allows an organization to understand the risks in any initiative and take informed decisions on whether and how the risks should be managed. Corporate governance and risk management is about how an organization can better understand its risk, to improve and deliver its objectives.

KPMG

Risk management matters. Put very starkly, companies cannot survive without some degree of risk management. Those that undertake projects, develop new products, seek to raise debt on the markets and

trade globally all have to manage uncertainties and hence the risks that their ventures may fail. For those that undertake projects, there is no guarantee that they will succeed. For those that develop new products, they have to contend with the uncertainties of product failure and acceptance. For those that want to raise debt, they have to demonstrate good corporate governance in order to get the highest credit rating, which in turn means a lower interest rate. And finally, for those who trade globally, they have to deal with issues associated with currency variations, and the political and economic stability of their overseas hosts, as well as the activities of non-governmental organizations. Failure to manage the risks in any of these areas, and the many other ventures within a company, leads to loss and, in extreme cases, can result in their failure. It is clear that, without the effective management of risk, companies can literally go bust in a very short space of time, as we saw when the dotcom boom turned rapidly to bust and when Nick Leeson took down Barings Bank (now immortalized in the film *Rogue Trader*).

Interest in risk management has certainly grown over the last few years and its increasing significance has ensured that it has moved up the corporate agenda. Although there are a number of reasons for this, the principal reason is the demand for more effective corporate governance from a wide range of stakeholders, including:

- institutional shareholders
- non-governmental organizations
- insurance funds
- private shareholders
- employees, especially in relation to workers' councils

- trade unions
- the press
- single-focus pressure groups
- professional bodies
- regulatory bodies
- governments.

These groups' vociferousness has increased for a variety of reasons and not least because of the excesses of boardroom behaviour, and especially concerning pay (which has increased dramatically without the commensurate improvements in shareholder value or performance). Other reasons include the apparent disregard for the environment by major business, the inability of corporations to make wise investment decisions – often associated with poorly executed mergers and acquisi-

Smart quotes

The term 'risk management' is loaded with connotations of caution and timidity, carrying unpleasant reminders of dreary sessions with insurance agents and infuriating lectures from parents on the dangers of having a good time. People who think about risk management at all are likely to think of it as a grim necessity, at best. From another perspective, however, risk management is absolutely riveting, for it is a way to gain more power over events that can change your life. Risk management can help you to seize opportunity, not just to avoid danger. Since good risk management can mean the difference between wealth and poverty, success and failure, life and death, it is worth some of your attention.

Dan Borge

tions – and the general disregard of the employee. As a result, boards of directors have come under intense scrutiny to ensure that they and the businesses they run are behaving responsibly.

But, as we all know, pressure for improved self-regulation is not the only thing that boards of directors have to contend with. Risk management is also driven by the survival instinct. Every CEO wants to emulate Jack Welch and achieve hero status with their employees and the markets. CEOs like the power that the position provides and will do their utmost to lead their company to success. This means navigating their company through the turbulent waters of the economy, the markets in which they operate, change and a multitude of other factors. But, there is a flip side to this: just as the survival instinct can lead to great innovations and the smart taking of risk, it can as easily lead to the taking of unnecessary risks and the covering up of mistakes. Thus, we need to watch out for the warning signs of corporate failure (see 'Smart people to have on your side' on p.18).

In general, the combination of more stringent regulation and the uncertainties of the local and global economics dictate that every CEO must adopt a proactive stance to risk and risk management. Being proactive requires that they establish the basis for managing risk throughout their enterprise so that every employee is able to take those risks that are necessary to earn good returns for the business and to continue to advance its capabilities. The purpose behind risk management is therefore not about eliminating risk, as this is impossible, but about becoming more adept at spotting and dealing with those future events that could upset the business equilibrium. And it should be recognized that risk management is not just about being defensive; it is also about taking risks that will facilitate innovation and allow the business to grow (more about the relationship between innovation and risk in Chapter 8).

Smart people to have on your side: Larry Elliot and Richard Schroth

Larry Elliot, president and CEO of EDA, and Richard Schroth, a consultant and adviser on emerging technology and business strategy, are the authors of *How Companies Lie*. Elliot and Schroth believe that companies such as Enron, WorldCom, Global Crossing, Waste Management and Tyco represent just the tip of the iceberg, and they have identified the following warning signs of potential failure:

1. The mechanics of mendacity – companies begin to believe in their own hype, myths and lies and make bad decisions.
2. The art of artful dodgers – companies become expert at covering up the important facts, which would otherwise highlight their problems, by using as much misinformation as they can lay their hands on.
3. Words without foundation – companies become expert liars, always hoodwinking the audience (be they institutional shareholders, auditors or private investors); but without trust and truth there can be no long-term value.
4. The fog of corporate complexity – complexity can shield a multitude of sins, as we saw with Enron.
5. Dysfunctional governance – corporate governance is not working well, standards are inconsistent and out of touch with the way businesses operate.

We should recognize that the importance of risk is a matter of perspective. Where you sit within an organization's hierarchy will determine which risks will concern you. The same is true of your functional role. For example, if you are operationally focused and work, say, within a manufacturing plant, it is unlikely that you will be required to manage strategic risks. Equally, if your role is to deliver change into an organization through projects and programmes, your primary focus will be the management of project-related risks. Thus, when it comes to establishing an effective risk management framework for the organization as a whole, it is important for this to encapsulate the complete panoply of risks that require management.

Smart voices: The South Sea Bubble[1]

Since 1688 England had been in an almost constant state of war with the French. As a result, national debt had spiralled out of control and so had taxes. In order to address this terrible state of affairs, Parliament established the Bank of England in 1694. Its purpose would be to lend money to government in return for 8 per cent interest per year. It was also allowed to print its own money in order to manage the debt. However, by 1710 the government owed £8 million. With nowhere to turn, a new approach was needed.

On 10 September 1711, the South Sea Company was formally created as a mechanism to reduce Britain's national debt and, as its backers hoped, rival the Bank of England. The company would ask the government's creditors to exchange the money they were owed for shares in the South Sea Company. In addition, and in order to service the interest on the debt, the company would be paid £500,000 a year by the government. The company would export a multitude of goods, including silk, cheese and slaves, to raise revenue.

As expected, there was enormous interest from investors who bought thousands of pounds' worth of shares, believing they would make their fortune. Before long, the company had become a financial corporation to float the national debt, even though it had made no money from slaves or wool. The new monarch, George I, was convinced to invest in the company and by 1715 it had several thousand shareholders. Then, in 1719, the company was allowed to convert additional government debt into shares and the company's capital grew to be in excess of £12 million. Still the company had made no profit from any of its activities.

By 1720 government debt had risen to £31 million and the South Sea Company was keen to take this on, because it believed the greater the debt, the greater the profit from selling shares in the national debt. The profits were potentially enormous so long as the share price continued to rise. However, in order to take on such debt there had to be agreement from Parliament. After a seemingly tortuous debate, the South Sea Bill was passed and the share price rose to 400. In order to maintain and increase the share price

the company instigated a number of schemes, including bribes and lending money to potential investors to purchase shares. In other words, investors' money was being recycled to bolster the stock.

The company's success had also spurred a number of similar schemes (in the same way that the early dotcoms did) – everyone wanted a piece of the action. But everyone was unaware of the risks they were running. By early June 1720 shares in the South Sea Company stood at 830, as the company spent investors' money as quickly as they received it. The bubble couldn't last and those that foresaw its demise exited, along with their handsome profits. The company was not deterred and continued to offer more and more shares to the unsuspecting public. The share price rose to above 1100, valuing the company at more than £300 million – ten times the debt it was holding. And still no ships went anywhere near the South Seas. Unfortunately, its shareholders owed it almost £60 million, double the original debt and possibly more than the wealth of the entire nation.

Public confidence was shaken when the government took action against the South Sea Company's rivals. Stocks plummeted, and investors were saddled with large debts, which could only be repaid by selling their shares in the South Sea Company. The selling depressed the share price. Attempts at bolstering the share price by launching additional share offers were initially successful as the power of the bubble was holding out. Then, in a fit of pique, the company announced a dividend of 30 per cent, which implied annual profits of £15 million, which was patently absurd.

Finally, the truth was out: investors realized that the company had no trading prospects, that the annual profits of £15 million were nonsensical and the South Sea Company was not a proper company at all. The rout had begun. The share price dropped and by early September 1720 was down to 180. Nearly every notable family in England had been caught out and many were ruined by their losses. Some even took their own life. The impact on the economy was significant and lasted for many years. It took the stock market almost 100 years to recover.

A short history of risk[2]

Smart quotes

Nothing in life is certain. In everything we do, we gauge the chances of successful outcomes, from business to medicine to the weather. But for most of human history, probability, the formal study of the laws of chance, was used for only one thing. Gambling.

Larry Gonick

There should be no doubt that without an understanding of risk we would not be living in the complex world we now inhabit. We would not have been able to advance science to the extent that we have, develop the concept of life assurance against which we can provide financial security for those who are left behind after our deaths, or travel into space. Despite the complaints that life is getting too complex to cope with, it is fair to say that we are more equipped to cope with it than our forebears were because of our tacit understanding of the world around us and of risk management.

This is a far cry from the world of our ancestors, who had little grasp of the world around them and no real concept of how to navigate through their short and usually difficult and brutal lives. And we do not need to go that far back to reach a time when people placed their lives in the hands of the gods and the soothsayers who purported to do their bidding. Few could comprehend what the future would hold for them on a daily basis, let alone a year or decade ahead. They would pray for the return of the growing season, for the sun to reappear the next day after setting in the evening, and place magical powers in animals, celestial events, sacrifices and those among them that appeared more knowledgeable. Our ancestors did not understand the concept of

risk, and neither did they understand the concept of the future – both go hand-in-hand.

Irrespective of how well we manage risk, the very fact that it is part of our common language is due to the culmination of thousands of years of evolution, insight and research covering numbering systems, probability, sampling, and the normal distribution.

The evolution of risk began with the development of numbering systems. After all, without numbers there could be no management of risk because it would be impossible to assess the probability of an event. Counting is, of course, easy with fingers, and nearly all ancient populations were able to count to ten very easily, but not much further – although you could argue that it would be possible to reach twenty by using all your fingers and toes. There is in fact one tribe in New Guinea that uses combinations of hands and feet to define numbers.

According to historians, our ability to count probably started some 4000 years ago and primarily for religious reasons. One of the best examples is Stonehenge in the UK, which was constructed around 1800 BC to allow pagan priests to calculate the frequency of natural events, in this case the summer and winter solstices. But counting, although useful, was not helpful because there was no convenient system that would allow numbers to be displayed. The first major advance was the introduction of simple symbols that could represent numbers, such as how many people lived in the village, head of cattle and so on, and such systems were typified by lines in sand or notches on wood. Unfortunately, these became cumbersome even at relatively small values.

The next leap forward was the invention of the place-value notational system of multiples of ten. This system of numbering used the additive law in which the sequence of symbols could be added together, as with Roman numerals (XXII would become 10 + 10 + 1 + 1 = 22). But this

too was problematic as it was difficult to manipulate large numbers, and symbols did not lend themselves to the discovery of probability and calculus. Of course, the Romans were not alone in this. The Egyptians, for example, used a combination of vertical lines for numbers up to and including nine and symbols thereafter. For instance, a lotus flower was used to represent 1000 and a pointing finger for 10,000. Other ancient civilizations, including the Babylonians, Mayans and Grecians, had their equivalents.

It wasn't until the Hindus developed their numbering system around AD 500, on which ours is based today, that things really advanced. The central component to its success was the use of zero. This revolutionized our ability to manipulate numbers in two ways. First, it was possible to use only ten digits (from zero to nine) to create every conceivable number and, second, it made the numbering system visible and clear to everyone. This allowed the field of mathematics to advance considerably, particularly during the Renaissance.

One of the main interests of many thinkers and early mathematicians at this time was the game of chance. For example, the Franciscan monk Luca Paccioli was interested in determining how to settle an incomplete game of Balla. The game was stopped at five games to three (the winner would have been declared on winning six games). This conundrum proved to be very significant because it marked the beginnings of the detailed and systematic analysis of probability, which as we know lies at the heart of risk. Many people followed Paccioli, including Cardano, Galileo, Pascal and Fermat, all of who helped to advance the underlying concepts of probability and, of course, risk.

John Graunt, who in 1662 published a book that addressed births and deaths in London between 1604 and 1661, did much to advance the concept of statistics and is considered by some to be the father of this field of mathematics. He recognized that the information he had about London's population was only a fraction of the total; in other words,

he was working with a sample and drawing wider conclusions from it, especially in terms of London's total population. He also began to use the data he had collected to predict the ages at which people would die. Such sampling was at the heart of the emergent insurance industry that started in the coffee houses of London during the second half of the seventeenth century, when trade between England and the colonies grew significantly.

Edward Lloyd opened his business in 1687 and this soon became extremely popular, with it open almost 24 hours a day to cope with demand. Lloyd launched his now famous list in 1696. This was populated with news and information about shipping routes, weather and other intelligence through a network of correspondents in the major ports. The people who would frequent Lloyd's and the other coffee houses were risk takers, those willing to underwrite the ships and their cargos. It wasn't long before the insurance industry had expanded beyond shipping.

The first serious analysis of risk was made by the Swiss mathematician Daniel Bernoulli in 1738. Bernoulli drew the distinction between games and real life by observing how people view probability and hence risk. Unlike in games, where people are less concerned about outcomes, in every day life people will try to maximize the expected utility of the outcome (in other words, they will weight it) and will be more concerned about the outcome of any risk they take. He also stated that people will assign different values to risk depending on their own psychological make-up. Therefore, those who are more willing to take risks will tend to follow a high-risk high-return policy and those who want to avoid negative outcomes will avoid risk as much as they can. This helps to explain why some people are more risk averse than others.

Other members of the Bernoulli family continued to take an interest in risk and probability, but it was De Moivre, a Frenchman who

fled to London following the renewed persecution of protestants by King Louis XIV, who made the next leap forward with the creation of what we now call the normal distribution. The bell curve, as it is often known, enabled him to calculate a statistical measure of dispersion around the mean and became one of the principal ways of evaluating the probability that a given number of observations would fall within a particular population of data. And as we all know, the normal distribution forms the core of most systems of risk management. But as we will see, risk management is not just about the normal distribution, as those who seek to exploit and profit from risks will seek out events that fall outside the normal patterns of life.

Since the fundamentals of risk were discovered, there has been a significant push to make their application more sophisticated in order to deal with the increased complexities of life. In the main, these have focused on financial instruments, such as derivatives and hedging, rather than on the mainstream application of risk within organizations. Risk management has now become a profession in its own right. In every organization you now see a plethora of people whose role is almost exclusively focused on the management of risk, including:

- internal auditors
- chief risk officers
- compliance officers
- credit risk officers
- environmental risk officers
- health and safety officers.

Others too are focused on risk, but not necessarily on a full-time basis. Such people include:

- chief financial officers
- chief operating officers
- project managers
- programme managers
- corporate treasurers
- operational managers.

Furthermore, there are consultancies and third-party suppliers that provide expert risk management advice and support, which ranges from environmental risk management through to project and programme risks. And, of course, there are the tools, techniques and software systems that allow organizations to manage their risks as effectively as possible.

Risk management is now big business and we continue to advance its application. Our love affair with risk and risk management has spanned hundreds of years and, since the destruction of the Twin Towers and the demise of Enron, it has taken on an even greater significance (see Table 1.1 for a summary of the key events that have framed our understanding of risk and risk management).

History is undoubtedly important, but at the heart of risk management lies probability, and the failure to grasp this essential concept is the cause of many misconceptions and errors of judgement. It is this to which we will now briefly turn.

Table 1.1 Key events

AD	Event
500	Hindus develop the numbering system we use today
1200	Hindu–Arabic numbering system reaches the West
1494	Franciscan monk Luca Paccioli publishes *Summa de arithmetic, geometria et proportionalita* (very great abstraction and subtlety of mathematics), which introduces the concept of double-entry bookkeeping
1545	Girolamo Cardano publishes *Ars Magna* (Great Art), the first work to concentrate on algebra
1565	Girolamo Cardano writes, but fails to publish, *Liber de Ludo Aleae* (Book on Games and Chance), which develops the statistical principles of probability
1657	Huygens publishes a book on probability
1662	Port-Royal monastery publishes *Logic*, which discusses philosophy and probability. The last four chapters of the book are dedicated to probability and include a description of a game in which ten players risk one coin in the hope of winning the coins of the others
c.1670	John Graunt publishes a distribution of life expectancy from ages 6 to 76 that provides the inspiration for the UK's Central Statistical Office
1675	Emergence of coffee houses in the City of London which were used to swap news and information about sailing times, weather conditions and such like for merchant shipping
1693	Edmund Halley publishes *Transactions*, in which he calculates annuity rates based on life expectancy. This will form the basis for the future life insurance industry
1696	Edward Lloyd launches the Lloyd's list that contained details on the arrivals and departures of ships, and conditions abroad and at sea. The list was later expanded to include daily information on stock prices, foreign markets and high-water times at London Bridge
1733	Abraham De Moivre publishes *Doctrine of Chances*, which introduces the normal distribution (bell curve) that allowed him to calculate the dispersion about the mean of a set of observations (the standard deviation). This provided the basis of the assessment of an event's probability
1738	Daniel Bernouilli publishes a paper that discusses the new theory on the measurement of risk

AD	Event
1801	Carl Friedrich Guass publishes *Disquistiones Arithmeticae*, which discusses the theory of numbers
1820–1853	Lambert Quetelet publishes three books on probability
1933	Glass-Steagall Act separates commercial banking from investment banking activities
1936	John Maynard Keynes publishes the *General theory of employment interest and money*
1952	Portfolio selection revolutionizes the process of investment management by elevating risk to equal importance with expected return
1960	James Tobin and Bill Sharpe design the Capital Asset Pricing Model (CAPM)
1972	The Mercantile Exchange in Chicago creates the International Money Market that specializes in foreign currency futures and options on futures on major currencies
1982	Options on fixed income securities introduced
1990	Equity index swaps introduced
1992	COSO and Cadbury control standards introduced; differential swaps introduced
1996	CoBiT control standard introduced
2002	New legislation (the Sarbanes-Oxley Act) is introduced to avoid the accounting irregularities associated with Enron, WorldCom and others. Under the new laws, CEOs and finance directors will have to sign off their accounts as true statements. If these prove to be wrong, they can face long jail sentences. In addition, the time to close the books and report accounts will be reduced significantly by 2005
2003	The Higgs Report in the UK recommends the separation of the chairman's and chief executive's role, the appointment of a senior non-executive director who should be available to shareholders, the widening of the pool of independent directors and the development and disclosure of policies on induction training for new directors, continuing professional development and board evaluation

Smart answers to tough questions

Q. When it comes to risk management, what are you ...

- a fatalist – willing to react to events without any prior thinking or activity;
- a fanatic – believing that there are no risks to manage, as you have total faith in your abilities to achieve whatever you want to achieve;
- a pessimist – never willing to take any risks because of a strong fear of failure; or
- a pragmatist – understanding that there is balance between risk and reward and that risks have to be carefully identified and actively managed?

A. It is clear that being a pragmatist achieves the right balance between risk and reward. Blindly believing that you can change the world, or take unnecessary risks (the fanatic), is destined to failure. We saw this with the dotcom boom, when its proponents stated that the Old Economy was dead. The reverse was true. Just as bad is believing in fate – what will be, will be – as this is an equally poor way to manage risk. The fatalists will do little to assess and manage risk and they roll with the punches. And not taking any risk at all, as with the pessimist, ensures that there is no advancement or opportunity to grow. The optimum approach is to take the stance of the pragmatist, who recognizes that risk is a balance that requires an intelligent approach to its management. Unfortunately most organizations contain few pragmatists but plenty of fanatics, fatalists and pessimists. This has to change.

Probability – the heart of risk management

The purpose of this section is to provide a brief summary of the key aspects of probability, as they affect the way organizations manage risk. I cannot hope to cover the subject in any great depth, as there is not the space. However, I hope there is enough here for you to understand its importance to the management of risk and, more importantly, start to recognize some of the pitfalls and problems that occur when we do not understand what probabilistic statements actually mean and what

healthchecks need to be applied to them. All too often, we accept them at face value when we shouldn't.

You cannot escape the responsibility of tomorrow by evading it today.

Abraham Lincoln

Understanding risk management requires us to get to grips with some basic definitions of certainty, uncertainty and probability. The *Oxford Reference Dictionary* defines each as:

- Certainty – 'an undoubted fact; an indubitable prospect ... absolute conviction.'
- Probability – 'being probable; likelihood ... something that is probable, the most probable event ... the extent to which an event is likely to occur, measured by the ratio of favourable cases to all possible cases.'
- Uncertainty – 'being uncertain; any of various similar restrictions on the accuracy of measurement.'

Smart quotes

A tendency to drastically underestimate the frequency of coincidences is a prime characteristic of innumerates, who generally accord great significance to correspondences of all sorts while attributing too little significance to quite conclusive but less flashy statistical evidence.

John Allen Paulos

These definitions help, in so far as they clarify the distinction between certainty and uncertainty and where probability might fit into this spectrum. But we all tend to get a little confused about the relationship between probability and certainty. Very often we believe that a probability is somehow an indication of certainty, when it is really providing us with an indication of how likely an outcome may be, given a set of factors.

A risk, by definition, has a degree of uncertainty associated with it. If an event were certain, there would be no risk, as it would occur, no matter what we did to prevent it. Unfortunately, most of the population suffers from fuzzy thinking when it comes to risk and uncertainty. Much of this fuzziness is generated by the way in which risks and statistics are presented in the press, which perpetuates the problem. According to Sharon Friedman, Professor of the Department of Journalism and Communication at Leigh University,[3] the media make limited use of actual numbers when describing risks. Words such as safe and unsafe, or low and high, are used but without any clarification of what they actually mean in real terms. They also create simple causal links between a factor, such as toxic waste, and, say, birth defects, but without taking into account the other wide-ranging factors that can also lead to birth defects, such as genetic predisposition, smoking, alcohol abuse, drug abuse and diet. This tardiness helps to excite people's concerns about the health hazards of toxic waste, and the environment in general. If this approach were used in scientific study, the results would be laughed out of any self-respecting journal.

Similar problems arise when the media presents information pertaining to our diets and what we should and shouldn't eat. Take fat, for example, and its links to levels of cholesterol in our bloodstream. We should not eat butter and instead opt for low-fat spreads. But low-fat spreads are not necessarily good for us either and the direct correlation between fat and high levels of cholesterol in our bloodstream has not been proven conclusively. Indeed, look at the current obsession with the Atkins Diet. This seems to fly in the face of convention because it recommends the consumption of fat and protein to the exclusion of everything else. People swear by it but, like everything else, there is a flip side. In Atkins case it is kidney stones and even premature death. What this proves is that in order to weigh up any risk we need all the relevant information, not just that which is interesting or controversial.

The media's misrepresentation of risk helps to foster the general ignorance in the wider population, which includes businesses as much as the general public. Our ability to understand risk depends almost entirely on our grasp of probability. Without this we can fall into a number of traps, including those highlighted by Gerd Gigerenzer, as follows.[4]

The illusion of certainty

We are often seduced by statistics and will believe that an event described in statistical terms is more certain than it actually is. This is because we take the information at face value rather than assessing it more intelligently. In other words, we are not able to understand just how certain or uncertain something is. For example, we have been reading for some time that there is a link between the mumps, measles and rubella (MMR) triple vaccination that is given to young children and autism. Doctors and researchers continue to publish and debate the issue very publicly, using statistical evidence to back up their conflicting viewpoints. The reaction from the public has been somewhat typical, with many refusing to vaccinate their children because of this alleged link. As a result, there is now an increase in the childhood diseases the MMR vaccination was meant to prevent, especially in cities, where the transmission of disease is generally easier.

People will believe the statistical evidence without understanding what the actual risk is because they fail to place the information into the wider population of children having the inoculation. Although there might be a link (which itself is uncertain and for anyone following the debate is still inconclusive), the chances of a child contracting autism are believed to be remote. Interestingly, there has been a knock-on effect from the MMR debacle which has involved doctors removing babies and young children from their registers so that they are still able to meet government targets for inoculation. This illustrates

the systemic nature of risks very neatly – an action will always have a consequence elsewhere.

The same sorts of attitudes are evident with terrorism. Again this is a remote risk, but most of us, and especially those who work in cities or are frequent flyers, believe that it is more likely than it is. I know of people who are unwilling to fly because of the events of September 11th and yet the risk associated with being killed in a terrorist-related incident is highly remote. As I stated in the introduction, we are more likely to be killed in a car crash than die in a terrorist attack. But, as we saw above, the treatment of risks by the media reinforces our sense of paranoia. I saw this first hand when presenting at a conference on risk just before the Second Gulf War. The US participants pulled out at the last minute because they believed they would be a target of terrorist attack as they flew across the Atlantic.

Contrast this with when a colleague and I were in the Sudan on September 11th. This was a country that had harboured Bin Laden and was bombed by the USA in 1998. Having witnessed the destruction of the Twin Towers on CNN 200 miles south of Khartoum, our families were clearly concerned. After all, we were in a Muslim country, which was believed to be associated with terrorist activities. Our view was very different. We weighed up the risk very carefully, taking into account the run-up to the First Gulf War, where it took months before the coalition had been built and was ready for war. It was clear that the risk to ourselves was remote. So, we stayed on and completed our assignment, which we did without any problem. Judgement is of paramount importance in managing risk. All too often it is lacking.

Ignorance of risk

This point follows from the last in so far as our failure to interpret the underlying numbers associated with statistics and probability ensures

that we have difficulty in understanding how significant the risks we face actually are.

Miscommunication of risk

If we do not understand the nature of numbers and probability then it should come as no surprise that we cannot communicate them in a way that other people can understand. Gigerenzer cites an example of a doctor who, when he prescribed Prozac to his patients, would inform them of the risks associated with a loss of sexual desire. To begin with he would tell them that they had a 30 to 50 per cent chance of losing their sexual appetite. Many believed, quite wrongly, that they would lose it for up to 50 per cent of the time. Even so, no one bothered to ask what it meant to them; they assumed. He then changed tack and told his patients that out of every ten patients, between three and five would experience problems. This resolved the issue and, as a result, patients were more likely to ask questions and be clearer about the risks they faced.

Clouded thinking

This final trap is associated with our inability to draw conclusions from the risks that we face. Even though we may know what the risks are, we are unable to draw the necessary conclusions. This is particularly evident within medical testing. Patients and clinicians wrongly assume that the results of, say, a blood screen, a cervical smear or any other such test are conclusive. There are occasions where the tests come back as a false positive; in other words, they are wrong because of human or computer error. There are a number of instances where complete batches of smear tests for women have been found to be false, causing huge scares among those patients who have been given a clean bill of health as much as those who had been told they had cancer. A particularly insidious example is that of Therac-25, in which the operator of the system insisted to a patient, who had just been administered an

unusually high dose of radiation, that the equipment could not have given an overdose because it was computer controlled. In other words, there was no risk of an overdose, which of course was patently wrong as it was later found that there was a subtle error in the software which was eventually linked to a number of deaths.

Smart people to have on your side: John Allen Paulos

John Allen Paulos is Professor of Mathematics and Presidential Scholar at Temple University, Philadelphia, and the author of *Innumeracy: Mathematical illiteracy and its consequences*. Paulos believes that innumeracy (the inability to deal comfortably with the fundamental notions of number and chance) plagues too many people and he asserts that failing to have a feeling for large numbers and probabilities ensures that people misunderstand the significance of the risks they face.

So, how do we avoid the traps identified by Gerd Gigerenzer? The trick is to understand some of the basic principles associated with probability.

In very simple terms, probability helps us to describe uncertainty by providing us with the language and mathematical notation with which to deal with it. We can view an event in probabilistic terms as falling between the two poles of certainty – certainty that an event will never occur and certainty that it will. Probability is usually expressed in numerical terms which range between 0 and 1, where 0 equates to a situation that is impossible and 1 to a situation that is certain. This is represented as $0 \leq p \leq 1$, where p is probability. Probabilities are also expressed in percentages, with the 0 representing zero per cent and the 1, 100 per cent.

We all tend to be familiar with the rudimentary aspects of probability. For example, we know that there is a one in two (or 50 per cent)

chance of a coin turning up either heads or tails if we toss it. Similarly, we know that if we rolled a die, a six would have a one in six (16.66 per cent) chance of being rolled. But when we start to deal with more than just coins and dice we tend to lose the plot. This is partly because of the added complexity and partly because many of the risks we face in organizations are not based upon the collection of large amounts of historical data or statistical modelling. Many risks we face are unbounded by known extremes.

Few people really appreciated the risks associated with the rise of the dotcoms. Businesses did not recognize the risks relating to a sudden loss of highly talented people and the dotcoms themselves failed to appreciate the risks associated with having no effective business model. They assumed that the money would flow forever, which of course it didn't. There are of course organizations, functions and people that apply the core principles of probability on a daily basis, including market research agencies, actuaries, investment bankers, medical researchers and government statisticians to name but a few. Other organizations, such as credit agencies and credit card companies, use it in the measurement and management of fraud-related risks. But for those of us who use these principles all but very occasionally, we ought to keep some of the basic tenets fresh in our minds.

For our purposes we should understand that probability could be one of the following:

Subjective probability

This depends on the application of judgement of the person making an estimate. Such statements usually have no basis in statistical modelling, as there is no population of data on which to base the estimate. We are not dealing with a repeatable event. A lot of risk management, especially within business, is therefore subjective in nature. For example, project and programme risk depends almost exclusively on the

project manager's experience and expertise. Given that most projects are unique events, the risks tend to be unique. However, we do know from information collected about projects the likelihood of their failure, which is around 66 per cent (or a two in three chance).

Conditional probability

Here the probability of an event is related to another. So, for example, if we wanted to know the probability that a smoker is also an alcoholic, we would have to first select all smokers and then ascertain whether they were also alcoholics. In other words, the outcome would be conditional on the person being a smoker. We would not be interested in just alcoholics.

Conditional probability can confuse. Gerd Gigerenzer provides this example:

If a woman has breast cancer, the probability that she will test positive on a screening mammogram is 90 per cent. Many mortals, physicians included, confuse that statement with this one: If a woman tests positive on a screening mammogram, the probability that she has breast cancer is 90 per cent. That is, the conditional probability that an event A occurs given event B is confused with the conditional probability that an event B occurs given an event A. This is not the only confusion. Others mistake the probability of A given B with the probability of A and B.

Relative probability

This, as the name suggests, is the probability of an event occurring relative to the total number of events. This is best illustrated by flipping a coin. If we flip a coin 50 times and it comes up heads 20 times then the relative probability will be 20 divided by 50, giving 0.4, or 40 per cent. Relative probabilities tend to crop up in medical and scientific experiments.

Complementary probability

If the probability of being knocked down by a bus was 0.3 (or approximately one in three) then we could state that the chances of not being knocked down would be 0.7. This is the complementary probability and is simple to calculate as it involves subtracting the probability of the given event from 1 (100 per cent certainty). We often look at risks in this way when weighing up the outcomes of a particular event. Returning to the project example, we would know that if two-thirds of projects failed, one-third should succeed.

Independent probability

We should recognize that events are not always dependent on each other. If we take the UK's Lotto game, a player has approximately a 1 in 14 million chance of winning. If, after a draw, the same balls were placed back into the container and drawn again, the two events would be independent. In other words, your chances of winning would remain the same because the second draw would not be influenced by the first.

In addition to the above, we should also get a bit more familiar with such things as populations, the normal distribution and standard deviations, if only to understand their significance in relation to risk.

Taking populations first, when we read that 67 per cent of men like football we may assume that every single man in the country has been canvassed as to their views on football. This is of course untrue, as this approach would be both expensive and time consuming. A sample of men will have been questioned, but certainly not all. If this subset of the total number of men is of a sufficient size, it can be classed as statistically significant. In other words, it is of a sufficient size and diversity as to provide a reasonable representation of the complete male population (it should sample a wide age profile, socio-economic make-up

Smart quotes

Making probability judgements has become very important in the modern world. For example, courts (and juries) are asked to make judgements about whether particular disabilities are related to occupational exposures or environmental hazards for which organizations are responsible. Since there is simply no way of saying 'this cancer was for sure caused by that exposure,' instead experts argue about the probabilities that people exposed develop cancer as opposed to the probability that someone not exposed develops cancer. Another example involves environmental impact statements for new, private or public projects or products. There can be no justifiable statement about exactly what the impacts will be; instead we must make some probability judgements about how likely various impacts are to occur.

Robyn Dawes

and location). It is important to know this as it will help us to draw any conclusions. If the population on which the statistics are based is too small, we could end up deriving the wrong conclusion and taking actions that will lead to problems and potential failure down the line.

Market research organizations, such as Mori, take great care to ensure their samples are statistically significant. But how many times do we read about the probability of contracting such things as heart disease or cancer from particular foods, or how certain foodstuffs can prevent disease, without checking the size of the population from which these conclusions have been drawn. An associated factor with medical statistics is the length of studies, as this too is very important. Medical studies take place over many years, often decades, in order to ensure there is confidence in the results.

As we saw earlier, it was De Moivre who first recognized the normal distribution and its important characteristics. The normal distribution is a bell-shaped curve that is perfectly symmetrical, hence its common

name, the bell curve (see Fig. 1.1). When looking at any graph that shows a distribution, it is possible to estimate the mode (the value with the highest frequency) and median (the middle point) visually. It is harder to estimate the mean, however, as this depends on the range of values within the distribution. But within the normal distribution the mean coincides with the mode and median so, in this case, the mean, mode and median all have the same value.

Because the mean is at the centre of the curve, 50 per cent of the observations fall either side of it. The normal curve is characterized by the relationship between the mean and the standard deviation (the standard deviation is a measure of how spread out your data is across the sample – see 'Smart answers to tough questions', p.42). This allows us to determine the proportion of the data within a certain range – classified by the standard deviation. The distance between the mean and one standard deviation will include 68 per cent of all observations; 95 per cent of the observations will fall within two standard deviations; and 99.7 per cent will fall within three standard deviations. This is illustrated in Fig. 1.2.

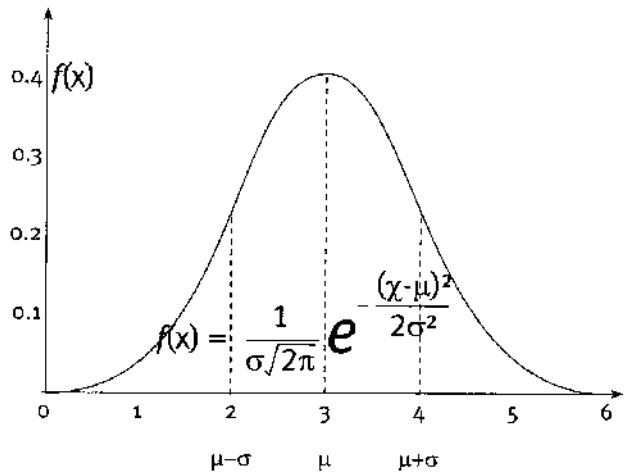

Fig. 1.1 The normal distribution

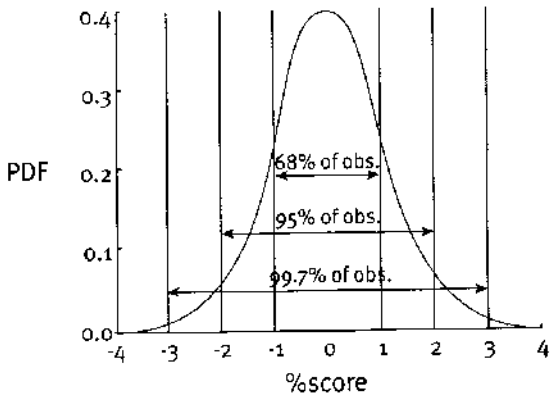

Fig. 1.2 Standard deviations

Therefore, once you know the mean and standard deviation of the bell curve you can estimate what proportion of a sample's observations will fall above or below a particular value or between two values. This is helpful to risk managers because it provides them with an indication of the likelihood of a risk occurring. Clearly, if an event falls outside three standard deviations, it will be unlikely to occur, but if it falls within one standard deviation, it has a high probability of occurring.

Thus, the normal distribution and its unique characteristics can be helpful to those risk managers who rely on historical data to assess their risks. Indeed, this lies at the heart of financial risk management and is particularly important in trading environments, such as investment banking. Naturally, the sophistication of the risk management tools used within these environments goes far beyond the rudimentary analysis provided here and there are plenty of books that deal with these tools exclusively, so I do not intend to discuss these any further. What I hope to have illustrated here is the importance of understanding probability and how a basic grasp of the normal distribution will help the risk manager make a more intelligent assessment of risk. I also hope that it has illustrated several of the pitfalls associated with some

of the clouded thinking that surrounds probabilistic statements and, as a result, forearmed you with questions you might want to ask before accepting information at face value.

Risk management has evolved to become one of the core disciplines of every organization. It touches on a lot of what we do in our daily lives and yet we seem to be oblivious to its significance. It is clear to me that people in general – and those with responsible positions within organizations – do not appreciate the underlying concepts of risk management and, as a result, tend to make errors of judgement. Risk management is, as we know, an essential discipline within any company, irrespective of its size. If this is the case, organizations have

Smart answers to tough questions

Q. How do you calculate the standard deviation and what can it tell us?

A. The standard deviation is calculated in the following way:

1. Compute the mean for the data set.
2. Compute the deviation by subtracting the mean from each value.
3. Square each individual deviation.
4. Add up the squared deviations.
5. Divide by one less than the sample size.
6. Take the square root.
7. This is the standard deviation.

The standard deviation shows how spread out the bell curve is. So, if the standard deviation is one, the curve will be tall and thin, which implies the data is very concentrated and has little variation. If the standard deviation is two, the curve will be flatter and more spread out. This implies that there is greater variation in the data. Finally, if the standard deviation is three, the curve will be flatter still and have the greatest variation in the data.

to become smarter at understanding and managing risks, which is the purpose of this book. But before we can turn to the smart thinking that is required to manage risks more effectively, we must first spend some time understanding the wide-ranging nature of risk within the typical corporation. This is the subject of the next chapter.

Notes

1 For a full account of the South Sea Bubble, see Balen, M. (2002) *A Very English Deceit: The Secret History of the South Sea Bubble and the First Great Financial Scandal*, London: Fourth Estate.

2 This section is sourced from a collection of articles and books that cover the history of numbers and risk. The most notable of these are: *A Short History of Numbers*, which can be found at www.giance.com; *A Short History of Ancient Numerals*, which can be found at www.math.byu.edu; and Bernstein, P. (1996) *Against the Gods: The Remarkable Story of Risk*, New York: John Wiley & Sons.

3 Friedman, S. (2002) *The media, risk assessment and numbers: They don't add up*, www.piercclaw.edu/risk/vol5/summer/friedman.htm.

4 Gigerenzer, G. (2002) *Reckoning With Risk: Learning to Live With Uncertainty*, London: Allen Lane, The Penguin Press, pp. 24–5.