Introduction
Fortune and the prepared mind

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Serendipity was recently voted the most popular word in the English language. From only a handful of references in the late 1950s, a Google search today reveals nearly 8 million references (up from 3 million references a year ago). Ironically, 'serendipity' is also one of the most frequently queried words in the dictionary, and one of the hardest to translate. It is typically used as synonymous with luck, chance or coincidence. Thus, nearly one in ten of the most cited scientific papers mention serendipity as contributing to breakthrough innovations (Campanario 1996). Aside from bringing us such powerful agents as aspirin, the contraceptive pill, penicillin, laughing gas, vaccination, vitamin K, amphetamine, antihistamines, benzodiazepines, quinine, insulin, sulfa drugs, valproic acid, propafenone, magainins, nitrogen mustard, nitroglycerin, warfarin, the smallpox vaccine and cloretazine, it produced Scotchgard, Teflon, Velcro, Nylon, the Post-it Note, Kodak's Weekender camera, the technology behind the HP Inkjet printer (based on seeing a coffee percolator at work), electromagnetism, photography, dynamite, the phonograph, X-rays, radioactivity, and even Ivory Soap, liquorice allsorts and Coca Cola (patented, in 1886, as 'Pemberton's French Wine Coca' for medicinal purposes, as a nerve and tonic stimulant and a possible cure for headaches). In sum, the proposition that the process of discovery has a distinct logic may have been vastly overstated (Simontan 2004: 7). Yet, being what we are – fallible human beings with a penchant for predictability and control – we continue our vast investments into powerful statistical tools, automation, advances in molecular biology and novel technologies, so as to squeeze every last drop

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of success out of scientific discovery programmes. In today's research, how much scope, if any, remains for serendipity? Looking behind, how justified are we to attribute past discoveries to serendipity? What is serendipity really?

The answers to such questions may lie in part in serendipity's history and etymological origins. Serendipity has a colourful history. As early as 1679, Robert Hooke alluded to the importance of serendipity in advancing research, describing invention as 'being but a lucky bitt of chance'. 'We shall quickly find', he wrote, 'that the number of considerable observations and Inventions this way collected will a hundred fold out-strip those that are found by Design.'[1] Joseph Priestley, writing in 1775, corroborated Hooke's conclusion by stating that 'more is owing to what we call chance, that is, philosophically speaking, to the observation of events arising from unknown causes, than to any proper design, or preconceived theory'.[2] Likewise, the physicist and Nobel laureate Percy Bridgman commented: 'how seldom the course of scientific development has been the logical course . . . Much more often the course of development is determined by factors which are quite adventitious as far as any connection goes with immediate human purpose', as did the French biologist Charles Richet: 'It will be a rather humiliating profession of faith, since I attribute a considerable role to chance.'[3] So too did Michel de Montaigne, attributing success in medicine principally to good fortune (Thiry-Cherques 2005). Claude Bernard wrote that ideas are often born by chance; Robert Root-Berstein (1989) thought invention to be guided by intention, but discovery by surprise; Martin Harwit, upon examining 43 cosmic phenomena concluded that about half took place in a 'serendipitous' manner (Campanario 1996). Particularly well-known examples include penicillin – or the discovery by Alexander Fleming of a mould with anti-bacterial properties in one of his cultures, a discovery which he made twice (1919 and 1928), and one which put him on the trail of similar observations by Tyndall, Roberts, Pasteur and Joubert, and Duchesne – and the elucidation of the DNA molecule by James Watson

[1] As quoted in Merton and Barber 2004, p. 161
[2] ibid. p. 162
[3] ibid. pp. 164–5

and Francis Crick in 1953. We wish colleagues 'good luck', not to insinuate that they are incapable but because we all realize that effort alone is hardly sufficient in making breakthrough discoveries (Rescher 1995). Our lack of omniscience, if nothing else, leaves plenty scope for luck.

What is curious is that using serendipity as synonymous with luck seems far removed from its etymology. Horace Walpole, in 1754, wrote of a critical discovery he had made, of an exciting old Arabic tale. One fine day, so goes the tale, three princes from Serendip (Ceylon, or modern-day Sri Lanka) were sent by their father on a prolonged journey to acquire empirical experience as part of their training. Misfortune befell the princes when happening upon a camel driver, who enquired of them about a camel he had lost. Though the princes had not seen the animal, they were nonetheless able to accurately describe it: it was blind in one eye, lacking a tooth, and lame. Furthermore, the camel was carrying butter on one side and honey on the other, and was being ridden by a pregnant woman. Their description was so accurate, in fact, that the camel owner accused the princes of having stolen his camel, and formally charged them in the emperor's court. However, in the presence of Emperor Behram, it became clear that the princes were entirely innocent, having merely pieced together various events. They explained that they thought the camel blind in the right eye because the grass had been cropped only on the left side of the road. They inferred that it was missing a tooth from the bits of chewed grass scattered across the road. Its footprints seemed to suggest that the animal was lame and dragging one foot. Also, finding ants on one side of the road and flies on the other, they concluded that the camel must have been carrying butter on the ants' side, and honey on the other. Finally, as for the presence of a pregnant woman, a combination of carnal desires on the part of the princes, and imprints of hands on the ground sufficed to bring about this final conclusion.

Clearly, the princes did far more than make chance observations. The tale is instructive precisely because the princes relied on their ability to recombine observations and deduce 'correct' – or meaningful – associations so as to generate a surprisingly effective (and, as it happens, entirely accurate) plot. To redefine serendipity as a consequence of recombining observations into unusual but meaningful associations suggests it is a close relative of creativity. To use an analogy, serendipity reflects the

ability to create a tune from a handful of musical scores from different genres and composers, torn into small bits by an enterprising toddler, and scattered randomly across the floor. Serendipity results not from reconstructing existing harmonies but from recombining small sequences of musical notes into something unusual, something altogether different. The ability to *imagine* such unusual but meaningful combinations lies at the heart of those drug discoveries credited almost exclusively to luck. After all, many a man floated in water before Archimedes, and apples fell from trees as long ago as the Garden of Eden.[4]

The ambiguity surrounding 'serendipity', in terms of etymology and practice, is reflected in eight beautifully crafted chapters. Their contributors are all masters of their respective arts, whose personal and professional experiences have given them unique perspectives on the diversity of forms and roles that serendipity can take.

Sue Alcock sets the concept of serendipity in the context of the human past, exploring the origin and subsequent 'coming of age' of the term itself – both of which are recent in the extreme when considered in light of our history. But is it really a recent concept? She goes on to explore, from the perspective of archaeology and classics (and classical archaeology in particular), the *stratigraphy* of the concept – the layers of its history and its meanings. The role of serendipity in archaeology, and in her own experiences as a practising archaeologist, forms the latter part of the chapter. Here we see the extent to which serendipity can be either embraced or denied in research, and all the combinations of planning, expertise and fortuitous circumstances that progress our exploration and understanding of the past.

The combination of preparedness and readiness to seize unexpected opportunity is a strong theme in Richard Leakey's contribution, as he touches upon the role of serendipity in his own, and in his parents', remarkable careers. But he goes on to focus also on the extent to which this concept can, or cannot, be applied to the discovered as well as the discoverer – the process of evolution, and human evolution in particular – and its role in the formation of the fossil record from which we draw our conclusions. He concludes by considering the extent to

[4] Walter Cannon, as quoted in Merton and Barber 2004, pp. 171–2

which we, as a species, will need to rely on our ability to sagaciously exploit our changing circumstances, and our adaptations, in the coming years, as changes in climate transform the world in which we have developed.

The relationships between humans and the natural world also form the core of Robin Weiss's contribution. The story of Alexander Fleming's discovery of penicillin is often cited as an example of serendipitous discovery, but the relationship between disease and exploitation of chance (albeit often lacking in sagacity) goes much further than this. Robin Weiss's work on infectious diseases, and in particular the HIV virus, provides a very particular perspective on the role of opportunism in human biology generally, and on microbiology specifically. Humans have in many cases constituted accidental hosts for infectious agents which, whilst not having 'prepared minds', have proven collectively highly adaptable to their new environment. But mutations in humans have also fortuitously led to resistance to some of these, and consequently been selected for too. He discusses how changes in microbes and parasites have taken advantage of human biology, and the evolution of human biology, and how our tracing of those changes can also tell us about the prehistory of our own species.

Simon Singh has written extensively on the topic of serendipity in science, and here gives an inspiring overview of the combination of chance events and the sagacity of certain individuals in the discovery of some of the most fundamental evidence for the nature and formation of the Universe. This includes the very origins of radio astronomy, as well as the detection of solar radio waves and the 'echo' from the Big Bang at the very beginning of the Universe (and taking in Velcro, Post-it notes and Viagra along the way). What these cases all have in common is the readiness of the researchers concerned to embrace the opportunity presented, often in the face of extreme frustration at the unexpected event.

Drawing upon his own work in the field of astronomy, Andy Fabian returns to the very concept of serendipity itself, and how the factors constituting serendipitous discoveries interact. He explores the relationship between preparedness, luck and aim in serendipitous discovery – and, in fact, the importance of the involvement of all three of those axes in truly novel discoveries. In discussing some of the most important discoveries in the field of astronomy, and the very way in which the field progresses,

he highlights the fact that the relationship between preparedness, aim and luck is not acknowledged as fully as it might advantageously be in the funding of research.

This critique forms a key element too of Richard Friend's essay, drawing upon his own and other critical discoveries in the realm of materials science and physics. He outlines a sequence of highly important discoveries (in the field of superconductivity in particular) which were made possible as a consequence of the right observations being made at the right time – when the necessary equipment was available – often in ways that could not have been anticipated. Not being constrained by 'received wisdom' or even 'understood laws' of physics is critical, and planning and method must be coupled with acting upon observation of unexpected phenomena. He presents a set of rules for the enthusiastic researcher who wishes to genuinely make new discoveries and progress in their field – not least of which is the importance of not being constrained by the structures of modern academic funding and refereeing, which in many respects fundamentally restrict such progress. He ends on the promising note that the prospects for serendipitous discovery, and its value, are as great now as they have ever been.

The role and management of unexpected events forms the basis of Oliver Letwin's contribution, which explores the very nature of liberal politics. Different (liberal or autocratic) modes of government revolve around the balance between government action and citizen reaction, and the effect of unanticipated outcomes on the effectiveness of policies with expected consequences. He argues that government action will typically only be effective through the *mediation* of uncertain citizen reaction, rather than the attempt to extinguish uncertainty. That mediation involves the exercise of judgement about the uncertain reaction and, perhaps, the ability to take advantage of unanticipated circumstances.

He argues that accepting the concept of uncertainty of reaction should change the way that politicians operate – a timely observation given the uncertain times most of us experience today in Britain as well as abroad. A liberal politician must create frameworks in which the reactions and decision-making of the population take place, the frameworks minimizing the unpredictability of those reactions, without being prescriptive. He

goes on to discuss the changing nature of these relationships between uncertainty and information in the modern world, and how this should affect the nature of political activity.

Being a professional writer would appear to require some particular traits – not least independence, spontaneity and a diligently creative approach to recognizing and developing subject matter from the world around. But Simon Winchester's engaging personal account of serendipitous events in his own career also highlights the core theme of the other chapters of this book – namely, the importance of an underlying ability to recognize opportunities when you see them, and, most importantly, to act upon them.

It still remains to offer some explanation of the recent burgeoning in popularity of the concept of serendipity. Perhaps part of this is due to what might be called a 'lottery mentality': the appeal of the tacit suggestion that 'great things' can be discovered or achieved by anyone, if in the right place at the right time. As will be seen from the following chapters, merely being in the right place at the right time on its own is not, in fact, enough to lead to truly serendipitous discovery. Perhaps there is an inherent appeal to the sense that no matter how much planning or preparation is carried out, true discovery relies on some mercurial extra ingredient. Whilst this might be the case, the chapters that follow illustrate that dispensing with preparation and planning will certainly not facilitate the course of serendipity.

But perhaps a less cynical explanation might be offered. There seems to be an inclination (certainly in the popular reporting of discoveries in science and the human past) to seek to identify 'magic moments': *the* moment or *the* event that furthered our understanding of the natural world, of social interactions, even of humanity itself. Thus, for example, we speak of *the* missing link between higher primates and humans, *the* moment when humans began to walk upright, or started to paint representations of the world around them, *the* turning point in history which led to the First World War – the list goes on. Of course, in reality these are very rarely single moments, but concatenations of circumstances and potentials – the potentials to respond to those circumstances – and these concatenations are actually rarely unique and even more rarely retrospectively identified.

The idea of serendipity, and considerations of serendipitous occurrences, however, appeals very strongly to this inclination to identify 'magic moments' when significant turning points occurred. And they are particularly appealing in this respect because they *do*, in fact, combine both of the above scenarios: serendipitous events or discoveries very often *are* attributable to a single 'moment', but at the same time are entirely dependent upon the relationship between the right circumstances and the potential to respond to them in an advantageous way; the meeting of fortune and the preparation to identify and react to that fortune.

Often it is observations of tiny things that lead to conclusions regarding some of the greatest. But it is not in the observation itself that serendipity plays its role – that may only be *chance* – but it is in the responses to those observations, the attitude and expertise, *sagacity* of the observer, that births *serendipity* from chance.

A note on the cover image

The cover image shows the 3.6 million-year-old trail of footprints at Laetoli, Tanzania. The footprints were initially discovered by Andrew Hill, a member of Mary Leakey's archaeological team, in 1976, and were subsequently excavated by Leakey's team during 1978 and 1979. Hill spotted the first prints whilst ducking to avoid elephant dung thrown by a colleague (Tattersall 1995). Fortunately the expertise of the discoverers allowed the importance of the prints to be recognized and, as in the story of the Princes of Serendip, conclusions could be drawn about the individuals who created the trail.

The prints were created by three Australopithecine human ancestors, two adults and one juvenile, as they walked together across a newly fallen layer of volcanic ash, which hardened and set like concrete after a rain shower shortly afterwards (Stringer and Andrews 2005). One of the adults walked behind the other two individuals, stepping into the footprints created by the adult in front. The prints unequivocally illustrate that these human ancestors walked bipedally 3.6 million years ago.

The photograph was taken by Martha Demas in 1995, during a programme of preservation undertaken by the Getty Conservation Institute in collaboration with the Tanzanian Department of Antiquities (see

Agnew and Demas 1998). The editors are very grateful to Dr Demas, the Getty Conservation Institute and Donatius Kamamba at the Tanzanian Department of Antiquities for permission to reproduce this image.

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