

distinctions is then not an occasion to be concerned, and warn of chaos and anomie. Instead, we can inquire into productive rearrangements. That is what Irwin and Michael want to do, and start discussing towards the end.

As it turns out, they do two different things. One is analytical and indicates a different type of governance: “fluid and contingent forms of leadership” rather than imposing rationality and order (page 152). They propose that creation and maintenance of EEA represent powerful means of enabling social change.

The other is, in a sense, a normative application: if we want to change the present coalitions, for example between government and industry in the case of GM food, and the corresponding downgrading of

citizen consultation, we should argue that fluid structures, de-differentiation of science, society and citizenship, in particular, breaking down firewalls between ‘public engagement’ and ‘technological innovation’ (pages 150–151) are good as such. In other words, fighting the good fight, supported by a political ontology where EEA are the basic building blocks.

As the authors confess in the preface, the book was partly written for themselves, to write up what they thought they had discerned. In presenting the result to others, it becomes clear that there is no sustained argument yet. The abstruse terminology in the second part does not help either. Yet the book sparks off thoughts with the reader, at least with this reader. That is good enough.

Pattern of accidental discoveries in science

Thomas Heinze

***The Travels and Adventures of Serendipity. A Study in Sociological Semantics and the Sociology of Science* by Robert K Merton and Elinor Barber**

Princeton University Press, Princeton NJ, 2004, 341 pages, US\$29.95/£19.95, ISBN 0-691-11754-3

Travels and Adventures of Serendipity is both a historical account of the origin of the word ‘serendipity’ and a detailed sociological analysis of the meanings it acquired as it was used and applied by different societal groups, first collectors, writers, literary scholars, and later scientists, applied scientists, social scientists, and science writers. *Serendipity* is particularly relevant for the sciences, because it describes an important pattern in scientific research — finding things that one did not set out to seek: “The serendipity pattern refers to the fairly common experience of observing an *unanticipated, anomalous, and strategic* datum which becomes the occasion for developing a new or extending an existing theory” (Merton, 1948, pages 505–515).

This book provides instructive examples of where and how serendipity in science occurred, spanning the 19th and 20th centuries. It discusses also how

“accidental discoveries” relate to the predominant semantics of science as a “rational” and “modern” enterprise of arguments and observations. Finally, *Travels and Adventures of Serendipity* deals with the micro-sociological environments in which serendipitous findings materialize most frequently.

Our understanding of the research process benefits from Merton and Barber’s perspective, not only because accidental discoveries in science is an underexplored topic, but also because their discussion warns against the view that scientific progress can be planned and basic research has limited value only. They argue convincingly that progress in the sciences depends on general and broad research planning, a proper degree of autonomy of the individual scientists in an organization, and the capacity of research directors to shift their attention to strategic, unexpected phenomena. Researchers, administrators and policy-makers will find stimulating material and thoughts (not always definite answers) on the institutional conditions for creative research and research evaluation at the individual and organizational levels.

The book is a ‘time capsule’, written in 1958 but not published until recently, first in an Italian translation by il Mulino (2002), and now as the first English edition by Princeton University Press (2004). The original text has been untouched except for a reorganization of the chapters and the addition of a short preface and a more extensive afterword by Robert K Merton, which discuss both the context of the original work and add new material and thoughts. In his introduction, James L Shulman conjectures that Merton’s (1965) famous monograph *On*

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the *Shoulder of Giants* displaced *Travels and Adventures of Serendipity*. In the afterword, Merton agrees to Shulman's interpretation and adds that, back then, it may have been overwhelmed "in the queue of work demanding to be done" (page 298).

Travels and Adventures of Serendipity begins (page 2) with a letter from Horace Walpole to his distant cousin in 1754:

"I once read a silly fairy tale, called *the three Princes of Serendip*: as their Highnesses travelled, they were always making discoveries, by accidents and sagacity, of things which they were not in quest of: for instance, one of them discovered that a mule blind of the right eye travelled the same road lately, because the grass was eaten only on the left side."

Walpole refers to the *Travels and Adventures of Three Princes of Sarendip* (the ancient name for today's Sri Lanka), the 1722 English edition of a book whose origins are Persian, but which seems to have been first translated into Italian in 16th century Venice and which was later translated into French and German (17th century). According to Merton and Barber, two unrelated circumstances led to the coinage of the word 'serendipity': both Walpole's idiosyncratic interest in odd and quaint things, which resulted in his creation of several neologisms of which not too many survived, and an increasing interest in mythology and tales of the Orient in the 18th century (triggered by Galland's translation of *Arabian Nights* into French) that also served as an inspiration for Montesquieu's *Lettres persanes* (1721) and Voltaire's *Zadig* (1748).

Walpole's private correspondence was published in several volumes starting 1818 (the 'serendipity letter' was first published in 1833), but not well received by the reviewers in early and mid-Victorian England. Under the moral and intellectual doctrines of utilitarianism and evangelicalism, Walpole was regarded as "a man who glorified the trivial, who was preposterously 'affected' and who made a cult of frivolity" (page 38).

Although there was already a discussion about the role of accident in discovery during the 19th century, nobody used the apt term coined by Walpole. It was not until 1875 that serendipity became a topic of sporadic correspondence in literary journals. One of the contributors, Edward Solly, was the first to use serendipity in his *Index of Hereditary English, Scottish and Irish Titles of Honour* (1880) to describe his "accidental" success in identifying a seemingly extinct baronetcy while searching for another title of honor.

At the turn of the 20th century, serendipity was made available to a wider circle of people by the eminent journal editor Wilfrid Maynell, but the word remained exclusively in the world of literature. It entered into unabridged, 'big' dictionaries, such as *The Century Dictionary and Cyclopaedia* (1909) and the early facsimiles of the *Oxford English Dictionary*

(1912), while only much later was it included in abridged and medium-sized dictionaries such as *Webster's New International Dictionary* (1934).

In the 1930s, the word diffused into the world of science via Walter B Cannon, a physiology professor at Harvard Medical School who enjoyed using the word frequently and whose "professional status and ... unpretentious authority did much to overcome potential hostility to this exotic and, in its origins, precious word" (page 64). Merton and Barber also argue that, unlike educated literature and antiquarianism, "science plays an important part in the lives of the vast majority of people, and as a result of the adoption of the word serendipity by scientists, the word became increasingly diffused in more and less popularized writings about science also" (page 64).

In an entertaining fashion, the authors of *Travels and Adventures of Serendipity* illustrate the changes in meaning that the concept has undergone from the very beginning of its diffusion. In his autobiographical afterword, Merton includes an extensive table of the various meanings of serendipity in English language dictionaries in the 20th century. The variety of meanings has to do with the term's ambiguity: "A discovery is accidental if the object discovered is not being sought — but whether it is merely not being sought at the time of its discovery, or whether for true serendipity its existence should be unknown to, and unsuspected by the discoverer, is not clear" (page 109).

So, in a strict sense, serendipity refers to the discovery of things not sought or previously undefined, but some of the early authors designated their discoveries as serendipitous because they found them at an unexpected time or place. However, the early users agreed that the "accidental discovery was conceived as complete in itself. ... the fact of accidental discovery was accepted as the beginning and the end of an experience" (page 58).

This changed considerably when scientists began to use the term in the 1930s. As Merton and Barber write: "For scientists, an accidental discovery is only the initial step, stimulating them to seek explanations for the unexpected or anomalous finding" (page 58), for instance, by constructing new hypotheses and setting up new experiments to make further observations. Therefore, the story of the three oriental princes leads to two different patterns of scientific thought. The first relies primarily on drawing useful inferences from careful observation, and is employed mainly by the historical or palaeontological sciences; the second is paramount to the research process in the natural sciences, in which serendipitous observations are embedded in laboratory settings where they initiate and stimulate new experiments.

It is in these laboratory settings that serendipitous observations have occurred most frequently, as Merton and Barber's collection of statements and comments from natural scientists, medical doctors, engineers, science writers and science historians illustrates. For instance, Claude Bernard's discovery

that sugar is produced in a dog's liver was the result of rigorous examinations following the unexpected observation of positive blood sugar tests, despite the animal's continued starving.

Likewise, Alexander Fleming's discovery of penicillin was made possible by his persistent studies following the chance observation that an accidental contamination with a mould had destroyed a bacterial culture. There are many more examples in *Travels and Adventures of Serendipity* that are interesting from a sociology of science perspective, because they raise the issue of legitimate expectations in scientific research and the attribution of success and reputation.

Merton's classic answers to legitimate expectations and scientific reputation are well known. First, the legitimacy of scientific knowledge rests on its particular rationality of deductive arguments and empirical-systematic observations that are made possible and are maintained by the "ethos of science", a set of prescriptive norms governing research as a particular type of human activity (communalism, universalism, disinterestedness, organized skepticism).

The belief in scientific rationality is reinforced by "the elegance and parsimony prescribed for the presentation of the results of scientific work" in the standard scientific article (SSA) that tends "to falsify retrospectively the actual process by which the results were obtained" (page 159). Second, the reward system of the scientific community accumulates prestige and reputation in people and research units that have already been selected as having contributed positively to the research enterprise — the so-called Matthew effect ("to those who have, more shall be given").

Chance observations and accidental discoveries challenge both the legitimacy and the reward system of science, in that they tend to be interpreted as beyond the scientist's control and responsibility and thus are non-rational elements in the production of knowledge. Therefore, Merton and Barber conclude, the accidental component has been either underestimated (by science historians), or exaggerated (by the lay public), or simply not understood, and "this limited understanding of the accidental component has led to an inadequate understanding both of the nature of science and of the qualities of the scientists" (page 159).

The authors suggest two interrelated lines of inquiry into the serendipity pattern. The first examines how serendipity is justified and embedded in the mainstream semantics of western culture, the second deals with the individual and institutional factors that influence serendipitous findings.

Justifications of the accidental component in research often point to early stages of any particular scientific enterprise, because serendipity is more likely to occur here than in established fields where many questions have already been answered and certain problems have been discussed time and again. According to Merton and Barber, the prevailing answer, however, emphasizes the outstanding

capacity of scientists to make careful observations coupled with particular personal traits. Like the three Princes of Serendip, such scientists make observations although they have not anticipated them. This goes hand in hand with personal qualities, such as alertness, flexibility, courage, curiosity, spontaneity, imaginativeness and assiduity. As Milton Rosenau, one of Walter B Cannon's colleagues at Harvard Medical School, argues:

"Many a scientific adventurer sails the uncharted seas and sets his course for a certain objective, only to find unknown land and unsuspected ports in strange parts. To reach such harbours, he must ship and sail, do and dare; he must quest and question. ... Only the determined sailor, who is not afraid to seek, to work, to try, who is inquisitive and alert to find, will come back to his home port with discovery in his cargo." (page 177)

In sum, justifications of serendipity with a focus on the scientific personality typically combine intellectual skills, such as curiosity and imaginativeness, with an emphasis on persistence, effort and goal-directedness. In terms of Talcott Parson's "pattern variables", serendipity is fundamentally modern and thus compatible with the predominant semantics of science as a social system. The reconciliation of the two seemingly unfitting principles of chance discovery and the rational orbit of science is also captured in Louis Pasteur's famous dictum (1854) that chance only favors the prepared mind: "*Dans les champs de l'observation, le hasard ne favorise que les esprits préparés*" (page 162).

However, it would not be Merton's sociology of science if the book concluded without providing insights into the sociological conditions under which serendipity flourishes. It is the opportunity structure for accidental discoveries to which Merton and Barber turn their particular interest in the concluding chapters of the book. They particularly discuss institutional factors that are conducive to serendipity. They argue that scientific research must not be strangulated by too rigid planning. Even though an organizational context sets limits on tasks and goals for the individual researcher, general planning of research, a proper degree of autonomy of the individual scientists in an organization and capacity of research directors to shift their attention to strategic, unexpected phenomena seem conducive to serendipitous discoveries (pages 200–206).

Merton and Barber quote the physicist Irving Langmuir, who argues:

"You can't make plans to make discoveries. But you can plan work that will probably lead to discoveries. ... you can organize a laboratory so as to increase the probabilities that things will happen there. And in doing so, keep the flexibility, keep the freedom." (page 201)

It is certainly worth discussing whether Langmuir's perspective holds in today's laboratories. Likewise, I wonder whether research leadership early in the 20th century was different from today. Yet the issue of research planning and research leadership are undoubtedly important institutional variables where innovation and creativity in research are concerned. Hence, the book raises relevant topics and suggests answers that need to be discussed against the background of contemporary research systems.

In his autobiographical afterword, Merton turns in more general terms to what he calls "serendipitous sociocognitive microenvironments". Here, he emphasizes interdisciplinarity as a serendipity-enhancing feature of research organizations. Merton reconstructs Crick and Watson's discovery of the double helix by their own accounts, which suggest the serendipitous, but pivotal contribution of their office mate at the Cavendish Laboratory of Cambridge University and American crystallographer Jerry Donahue, who pointed to erroneous textbook formulae and helped James Watson to hit on the correct form, the double helix (page 278). Crick and Watson, Merton writes,

"were at the outset simply ignorant about much they needed to know in order to search out the structure of DNA. ... Yet, ... these newcomers had the adventurous fortitude to acquire much of the knowledge they needed and the institutionalized good luck to have at their side the experts who could round out that knowledge sufficiently for them to do the job of imaginative scientific carpentry that led to their momentous model." (page 281)

What we learn from this analysis is that the serendipitous component in the discovery was both the result of the "prepared minds" of Crick and Watson and the interdisciplinary, sociocognitive microenvironment of the Cavendish Laboratory in which they worked.

Such microenvironments can also be found in the social sciences. When physicist turned sociologist-philosopher Thomas Kuhn stayed at the Harvard Society of Fellows, he experienced an intellectually nurturing atmosphere that encouraged wide-ranging thinking and interaction with fellow scientists from many other disciplines.

Kuhn's encounter with Ludwig Fleck's at the time almost unknown monograph *Genesis and Development of a Scientific Fact* (originally published in German 1935) and his conversations with Junior Fellow Francis Sutton at the Society were as much consequential for the writing of *The Structure of Scientific Revolutions* (1962) as was Kuhn's later stay at the Center for Advanced Study in the Behavioral Sciences at Palo Alto, another sociocognitive microenvironment of the social sciences, where he observed that the cognitive behavior of social scientists differed substantially from that of the natural scientists among whom he had been trained. This unexpected observation led him to develop the concepts of paradigm and

paradigm shift. Merton concludes: "The sociologically reoriented capacity of the individual scientist synergized with sociocognitive interactions in the serendipitous microenvironment to produce a consequential discovery" (page 266).

In his afterword, Merton sees his contemporary views on science in many ways concordant with John Ziman's (2000) diagnosis. In particular, he appears to agree with Ziman in his emphasis on the institutional dimension in the pattern of accidental discoveries. Places such as Cavendish Laboratory or the Center for Advanced Study in the Behavioral Sciences were (and may still be) centers of "institutionalized serendipity". Scientific research is, in both Ziman's and Merton's view, "much more than the enlightened exercise of personal curiosity." It is "not so much a personal trait or an attitude of mind as a virtue associated with a social role" (page 297).

However, Merton reminds the reader that the institutional analysis of serendipitous discoveries in the social system of science is still in its infancy. Without mentioning Latour, Woolgar or Knorr-Cetina, Merton expresses his "puzzlement" about the level of attention given to the "deconstruction" of the standard presentation of scientific work (for instance, in journal articles or conferences) in the last three decades, while the questions of research creativity, innovative organizational research capabilities and research leadership have been virtually absent from debates in contemporary sociology of science. Indeed, much needs to be done to understand those institutional differences among socio-cognitive environments that influence the frequency with which serendipitous findings materialize in today's scientific research. I conjecture that Merton and Barber's book will revive research efforts and policy attention in these three areas.

I strongly encourage everyone with an interest in the sociology of science to read chapter 9 ("The diverse significance of serendipity in science"), chapter 10 ("Serendipity as ideology and politics of science") and Merton's autobiographical afterword, which make up about 130 out of 300 pages. For those who want to study the social history of the word serendipity in detail, I recommend chapters 1 to 8 and the two extensive tables on serendipity definitions in English-language and non-English-language dictionaries. When you have finished your reading, do not hesitate to spend some time, too, with *Social Theory and Social Structure* (Merton, 1957) before placing your new acquisition next to it on the bookshelves.

References

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