50 Visions of Mathematics

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Recent years have seen an efflorescence of article anthologies about mathematics for a general (mostly nonmathematical) audience, such as Princeton University Press's annual series *The Best Writing on Mathematics*, now in its fifth year. The book under review is a welcome addition to this genre. It appears on the occasion of the fiftieth anniversary of the founding of the Institute of Mathematics and its Applications (the British mathematical organization, not the almost-identically named research institute in Minneapolis). Accordingly, this work consists of fifty short pieces by fifty authors—many taken from the Institute's journal *Mathematics Today*—about mathematics and its uses, together with fifty color images—mathematical 2D and 3D art plus a few photographs from the physical world—and, as a bonus, a set of mostly humorous variations on the theme of the Pythagorean theorem.

There is a great variety in the material here. Several of the pieces are biographical sketches of people in the mathematical sciences, all British (at least by birth and education) except for Emmy Noether. Others have to do with old friends from the mathematical universe such as the golden ratio, conic sections, "six degrees of separation," sphere packing, and non-Euclidean geometry. Probability and statistics are frequently featured, and (inevitably, I suppose) the noted ex-mathematician Professor Moriarty and his nemesis Sherlock Holmes put in a couple of cameo appearances. The other reference to fictional characters occurs in a piece entitled "Simpson's Rule," which is not about numerical integration; its topic is the penchant of the writers of a certain popular series of animated cartoons to insert sly mathematical jokes into their scripts.

Quite a few of the essays in this book describe the design and use of mathematical models in science, engineering, and everyday life. Let me discuss a couple of these to provide a sense of the range of ideas covered.

How does one navigate a spaceship from the earth to the moon? One might think that it's just a matter of applying Newton's laws, but it isn't so easy. A hundred thousand miles from earth, there is no GPS system to pinpoint one's coordinates, and one's trajectory must be calculated from incomplete and inexact information obtained from both computations and observations. Some mechanism is needed to prevent the ship from going seriously off course. A

similar problem arises in weather prediction; once again, future behavior must be estimated from seriously incomplete data about the recent past. In both cases, the mathematical devices that come to the rescue to increase the stability of the prediction algorithm are known as "filters," and they are associated with the names of Rudolph Kalman and André Robert, respectively. Each of these situations receives its own essay in this book—"Finding Apollo" and "Leapfrogging into the Future"; both are nontechnical, focusing on the nature of the problems to be solved and the history of their solution. I ended up wishing that they had been placed together rather than being separated by 60 pages, and that some comparative discussion of the filters could have been included.

The following are among the articles about the mathematics of the everyday world that I particularly enjoyed. "A Glass of Bubbly" analyzes the phenomenon that as the bubbles in a glass of champagne rise, they grow bigger and their velocity increases. Why does this happen, how are these phenomena related, and what are the equations that describe the size and velocity quantitatively? "Motorway Mathematics" considers the phenomenon of "phantom traffic jams," that is, patches of traffic congestion on a freeway that form without any apparent reason and dissolve just as mysteriously. And "Dimples, Grooves, and Knuckleballs" discusses the aerodynamics of sports balls such as footballs (British ones, i.e., American soccer balls), and in particular the fact that balls with surface irregularities perform better than perfectly round ones. The writers exhibit good taste in including just enough symbols and equations to make mathematical points clearly without enmeshing the reader in technical calculations.

Of course, a few of the essays in this collection fall short of the ideal. The mathematics in "Solving the Bristol Bridge Problem" (Bristol, like Königsberg, has a collection of bridges connecting the two banks of a river and two islands) is pleasant enough, but the step-by-step description of the writer's 33-mile trek to complete a Hamiltonian circuit of Bristol's 42 bridges is of less-than-universal interest. And, in spite of the assertion in "All Ravens Are Black: Puzzles and Paradoxes in Probability and Statistics" that the problem of the title has "a simple solution based on a little statistical understanding," the epistemological issues with inductive logic that the essay raises cannot all be resolved simply by choosing the right sample space.

But, as anthologies go, this one is remarkably good. By adhering to a high standard of writing and by paying attention to the well-known relation between brevity and wit, the editor and the authors have produced a collection of essays that can be enjoyed by mathematicians and laymen alike.

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