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Mircea Pitici, Editor: The Best Writing on Mathematics 2012, Princeton University Press, 2013, ISBN:978-0-691-15655-2

REVIEWED BY STEPHEN BUCKLEY

This is the third year in a row that Mircea Pitici has put together an anthology of texts related to mathematics that are aimed at a wide audience. In the introduction, he states his belief that *the best of the nontechnical writings on mathematics have the potential to enhance the public reception of mathematics and to enrich the interdisciplinary and intradisciplinary dialogues so vital to the emergence of new ideas.* If we take these as his goals—and they are worthy ones!—then he has certainly succeeded with this anthology. Also in the introduction, Pitici very briefly describes many books consistent with the goals of this anthology that came to his attention during the year, and at the end of the book there is a list of over 40 other texts that were considered for inclusion. These are very useful resources that will enable lovers of mathematics everywhere to embark on internet quests to find out more about whatever titles appeal to them.

As with the previous volumes, the included texts mostly concern either mathematics in relation to applications, history, and philosophy, or mathematics education, two broad areas that are of course closely interlinked. These texts are reprinted from a variety of primary sources, ringing from those aimed at professional researchers to those with a wider audience. But whatever the original source, most of the articles are stimulating, enlightening, and of a high expository standard.

The book begins with an interesting foreword by David Mumford who talks about how pure mathematics, applied mathematics, and physics had drifted apart from one another but remain linked because of the ideas that they contribute to each other. For instance,

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he discusses the influence of differential geometry and general relativity on each other. He also discusses how computer vision was initially viewed as a straightforward engineering problem, but Bayesian statistics and free boundary problems are both now important for progress in this area. He advocates saying things simply, and building slowly from the concrete to the abstract, in order to build bridges between the disciplines.

At a time when the value of fundamental research in mathematics and other fields is under increasing scrutiny, Peter Rowlett's article *The unplanned impact of mathematics* is very welcome. He gives seven examples of important areas of mathematics that subsequently were exactly the right toolbox for some application, often an application undreamt of at the time of the original research decades or centuries earlier. For example, quaternions—which failed to catch on as the toolbox of choice for the set of applications that William Rowan Hamilton had in mind[1]—are now important in various areas of computation including robotics, computer vision, and graphics programming because they capture all the geometry and group structure of three-dimensional rotations[2], and provide an efficient way of handling the resulting calculations.

On a related theme, Mario Livio's interesting article *Why math works* is in the spirit of Eugene Wigner's 1960 article on the unreasonable effectiveness of mathematics and the subsequent responses to that article. He discusses the difference between active versus passive effectiveness: the former involves mathematics designed for its application, or some related purpose, while the latter involves mathematics designed for a completely different purpose, perhaps with no real-world applications in mind. Even active effectiveness can be surprising, such as when the theoretical value of the magnetic moment of an electron agrees with the most recent experimental values to a few parts in a trillion, but passive effectiveness is typically more impressive. His first example of passive effectiveness is group theory, which originated in the work of Galois on polynomial solvability, and is useful in the Standard Model of particle physics. This example is however not entirely convincing, since Galois' contribution could be

[1]Of course vectors, which replaced quaternions for such applications, are simply a reduct of Hamilton's *right quaternions*, at least in the three dimensional space that was of interest in the late 19th century.

[2]More precisely, the group of unit quaternions can be identified with SU(2), the universal cover of the three-dimensional rotation group SO(3).

viewed as just one strand in the prehistory of group theory and the groups SU(n) which are useful for the Standard Model, are part of a strand much closer to physics in spirit that began with the work of Sophus Lie. His example of knot theory applied to string theory and loop quantum gravity sounds more convincing, but could be explained in more detail. He goes on to address the influence of biology on our mathematics, beginning with Michael Atiyah's hypothetical intelligent jellyfish that might never have invented the integers, and finishes with a discussion of the symmetry of nature that enables mathematics to be so effectively applied.

Several of the mathematicians mentioned in Rowlett's article return in later articles. Hamilton is discussed at more length in the article by John Baez and John Huerta on string theory and octonions, and in Charlotte Simmons' excellent article on Augustus De Morgan's relationship with Hamilton, Boole, and others. Other historical articles include Fernando Gouvêa's wonderful account of Cantor's correspondence with Dedekind, and Alexanderson's article on Johann Bernoulli and the cycloid.

The issue of whether mathematics is discovered or invented is one theme of the early part of this book, and is discussed at length by Timothy Gowers in a well-written and thought-provoking article. His main conclusion is that there seems to be a spectrum of possibilities, and that the amount of control of the researcher over the direction of a proof (such as whether or not many arbitrary choices are made) are an important part of the answer.

Ian Hacking contributes an interesting and wide-ranging article centred on the question of why so many eminent philosophers have been interested in mathematics. One strand of his answer relates to the question of whether mathematics is discovered or invented, while the other centres around the ability to find answers in mathematics by pure thought, answers that may subsequently tell us something about the world around us when we apply the mathematics to areas not conceived of at the time of the original research.

There are several interesting articles on mathematics education. I particularly enjoyed Bonnie Gold's article on the philosophical views of mathematics that are implicit in our teaching styles. There is much on which to reflect here in our ongoing efforts at becoming better teachers. Erica Flapan's candid discussion of her attempts at teaching innovation were also interesting. Her conclusions after various attempts are that you should listen to students with empathy and respect, and that being yourself is better than adopting a style that does not suit you. Lastly some issues such as complaints that you follow the textbook too closely naturally resolve themselves with experience. Timothy Gowers' article on the transition from high school to university mathematics, and Susanna Epp's article on the use of variables, were also interesting.

There are articles on a variety of applications of mathematics in areas ranging from the arts (photography, dance, music, origami) to the social sciences (routing problems, and an interesting article on dating and mating that is certainly unsuitable material for a first date dinner conversation!).

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