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Oxford figures: 800 years of the mathematical sciences, by John Fauvel, Raymond Flood, and Robin Wilson (eds.), Oxford University Press, Oxford, 2000, 296 pp., $60.00, ISBN 0-19-852309-2

> *Mathematics are studied, Your Grace knows very well, but little amongst us, especially by such as I should be glad to recommend to this Place.*

So wrote the scholar George Carter to Archbishop Wake (p. 155), describing the pitiful state of mathematical studies at the University of Oxford in the early 1720s. Although the impression conveyed was accurate at the time, this quotation exemplifies the long-held but mistaken belief that, of the two most senior English universities, Oxford has always held an inferior position to Cambridge in the mathematical sciences. This is reflected in the literature relating to the history of mathematics: it is over 100 years since W.W. Rouse Ball published his *History of the study of mathematics at Cambridge*, and yet until the book currently under review, no similar work had been undertaken for mathematics at Oxford.

One reason for this is that, although throughout its long history Oxford has been home to a host of great mathematicians, Oxford mathematics has often been overshadowed by that emanating from its traditional rival. No Oxford mathematician's scientific or cultural stature ever equaled that of Isaac Newton, and the fact that Newton was a Cambridge man played a big part in establishing the reputation of that university as the center for British mathematical excellence. This status increased with the emergence during the 18th century of the formidable mathematical "Tripos" exam, which every student at Cambridge had to pass in order to graduate. By the 19th century, Cambridge had come to be regarded as the leading British institution for mathematics and the sciences, while Oxford had to make do with a reputation for distinction in the arts and the humanities. As the Oxford mathematician Arthur Joliffe put it in 1912:

> *[I]t is undeniable that the average candidate [at Oxford] is not as good as the average candidate at Cambridge. The genius from the small grammar school, the promising student from a provincial university, the ablest boy at the large public school, all are sent to Cambridge in preference to Oxford as a rule.* (p. 26)

The comparisons with Cambridge, although at times misleading, are perhaps inevitable, since both universities are approximately the same age, with Cambridge being slightly younger, and their histories have many common characteristics. Indeed, possibly because for 600 years they comprised the sole institutions of higher education in England, many of the scholars regarded as Oxford mathematicians were also linked in some way to the University of Cambridge. But whereas Cambridge's mathematical tradition has been more or less continuous from the mid-17th century, the story of mathematics at Oxford is more fragmented and sporadic.

Yet despite the apparent dominance of Cambridge, Oxford has a longer history, both academic and mathematical. Founded at least a generation earlier than its rival, the University of Oxford is the oldest such institution in the British Isles and

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the third oldest in Europe, being exceeded in seniority only by Paris and Bologna. Although legend would have us believe that the university dates from as early as 886 AD, during the reign of King Alfred the Great, all existing documents point to a gradual emergence of a community of scholars in the late 12th century. It is the date 1188 that the editors of *Oxford figures* take as the starting point for their 800-year survey.

Not long after the foundation of the earliest colleges, Oxford mathematicians were making groundbreaking research contributions to the subject. By the 14th century, a group of scholars at Merton College (known as the Merton School, or the Mertonians), including Thomas Bradwardine, John Dumbleton, Richard of Wallingford, and the colorfully named Richard Swyneshead, were enriching the subject with detailed investigations into kinematics. The discovery of the Mean Speed Theorem in 1334 still stands as one of the crowning achievements of medieval mathematics.

However, this first "Golden Age" of Oxford mathematics was short-lived. The 14th century witnessed the devastation of Europe by the bubonic plague, and mathematical ability proved no protection from the scourge of the Black Death, with Bradwardine and many others succumbing in 1349. Inevitably, given the massive loss of life across the country, together with the social and political hardships resulting from the death of a third of the population, the university experienced a rapid decline in its fortunes for some considerable time. It would be three hundred years before mathematics at the university was able to return to the level and vitality of the Merton School.

However, when Oxford's mathematical fortunes were revived, they came back with a vengeance. The seeds for this recovery were sown by the endowment, in 1619, by Sir Henry Savile of two mathematical professorships, of geometry and astronomy. John Wallis, who held the Savilian professorship of geometry from 1649 to 1703, was responsible for creating what was, in effect, the first real mathematical research environment to exist in Oxford since the Mertonians. Through the encouragement and inspiration of Wallis, a new dynamic generation of mathematical scientists emerged, including Christopher Wren, whose work in dynamics and geometry presaged later research by Newton.

But once again, it appears that this mathematical renaissance was ephemeral. As the first quotation above shows, by the early 18th century, mathematical study at Oxford was again in a decline and, despite attempts to revive it during the 19th century, only really returned to its former glory in the 20th century. Under the charismatic influence of G. H. Hardy after World War I, Oxford mathematicians once again began to be recognized as a formidable research community, a phenomenon reinforced by the foundation of the university's Mathematical Institute in the 1930s.

The 20th century saw Oxford mathematicians make substantial contributions to mathematics, as illustrated by the fact that, by the mid-1980s, no fewer than three Fields Medallists (Sir Michael Atiyah, Daniel Quillen, and Simon Donaldson) were Oxford professors. Indeed, one of the last great mathematical events of the century could be said, in some way, to have been the work of an Oxford mathematician. In 1995, Fermat's Last Theorem was finally proved by Andrew Wiles, who although now a professor at Princeton and formerly a graduate student at Cambridge, had received his bachelor's degree from Oxford in 1974. Moreover, it is more than a little historically symbolic that his undergraduate education took place at Merton College, the birthplace of Oxford mathematics.

Oxford figures is a chronicle of the study and development of mathematics at Oxford from its foundation to the present day. Although its fifteen chapters dwell on the many highpoints in this story, the editors cannot be accused of trying to overstate Oxford's claim to mathematical greatness, since they do not shy away from documenting the many lows as well. A good example is the desultory state of academic standards for much of the 18th century, as epitomized by the career of John Smith, Savilian professor of geometry from 1766 to 1797, whose sole academic output comprised a pamphlet entitled *Observations on the use and abuse of the Cheltenham waters*!

What is particularly fascinating about the story of Oxford mathematics is how many famous names from other fields are intertwined with it. From the world of chemistry, there is Robert Boyle; from physics, Robert Hooke. Both the architect Christopher Wren and astronomer Edmond Halley were not only outstanding mathematicians, they also held Savilian mathematical chairs, with Wren being the professor of astronomy from 1661 to 1673, and Halley occupying the professorship of geometry between 1704 and 1742. Similarly, while many people today are aware that the children's author Lewis Carroll was actually a mathematics lecturer at Christ Church, how many know of Florence Nightingale's Oxford connection and what it had to do with mathematics?

With such a mass of historical information, stories, and anecdotes, one might almost be distracted from the book's *raison d'être*: the mathematics itself. However, illustrations of the variety of Oxford's mathematical produce over the centuries are placed surreptitiously throughout. The achievements of the Mertonians make an early appearance, while one of the crowning moments of British 17th-century mathematics, Wallis's formula

$$\frac{4}{\pi} = \frac{3 \cdot 3 \cdot 5 \cdot 5 \cdot 7 \cdot 7 \cdot 9 \cdots}{2 \cdot 4 \cdot 4 \cdot 6 \cdot 6 \cdot 8 \cdot 8 \cdots}$$

is also included. Other perhaps less well known results include Charles Dodgson's first precise statement of the Kronecker-Capelli Theorem (p. 168), a theorem by Henry Smith concerning the solution of systems of linear Diophantine equations (p. 208), and the extraordinary Rogers-Ramanujan identities (p. 200), such as

$$1 + \sum_{m=1}^{\infty} \frac{q^{m^2}}{(1-q)(1-q^2)\cdots(1-q^m)} = \prod_{n=0}^{\infty} \frac{1}{(1-q^{5n+1})(1-q^{5n+4})},$$

discovered by the Oxford mathematician Leonard Rogers in 1894, but not noticed until independently conjectured (without proof) by Ramanujan in 1913.

As evinced in the subtitle of the book itself, the authors' view of the subject is not so narrow as merely to include mathematics alone. Their definition of the *mathematical sciences* is very broadly construed and, in fact, changes over time in emulation of the evolving ingredients in the mathematical sciences over the past eight centuries, during which the subject and its teaching underwent massive changes. As a result, the book includes discussions of logic and medieval philosophy, astronomy, harmonics, optics, natural philosophy (i.e. physics), navigation, scientific instruments, and the more recent disciplines of statistics and computer science.

Consistent throughout the work is the situation of the university and its mathematics in the historical context of events in England during the eight centuries under consideration. After all, as the authors maintain, this book not only tells the story of the life of an academic community (both intellectual and social), but also

of its relationship and dealings with the outside world. Historical events such as the Black Death, the invention of printing, the English Civil War, and the Newtonian and industrial revolutions did not just affect British society, they had a profound influence on the study and development of mathematics at Oxford.

Thoroughly researched and well written, the book reveals the wealth of history behind Oxford's mathematical tradition and its impact on the wider world, as well as the many and varied characters who contributed to it. In addition to its scholarly merits, it is also an excellent read. Perhaps surprisingly for a learned work, it is written in an entertainingly droll style, which is at once informative and enjoyable. Despite no fewer than nine different contributing authors, the style remains consistent throughout, giving the pleasing impression of a single author—a testament, no doubt, to the editorial skill of Raymond Flood, Robin Wilson, and the late John Fauvel.

But perhaps its most outstanding feature is the vast array of images the editors have amassed to illustrate their work. Numbering over 250, they feature on nearly every page and, being strategically placed to highlight or exemplify a particular part of the text, augment each essay. The reader is overwhelmed (in the best possible sense) by the sheer mass of pictorial sources: medieval manuscripts, pages from early printed mathematical books (including the earliest mathematical text ever printed in Oxford), numerous portraits and photographs, and a variety of whimsical miscellanea from all eras. Indeed, the following examples illustrate that it is possible to learn as much from perusing the pictures as from the text itself.

A picture of the great astronomical clock (p. 28) designed by Richard of Wallingford in the 14th century gives more than a slight indication of the refinement and intricacy of scientific design and the dexterity of craftsman in the Middle Ages. A delightful photograph of the 19th-century number theorist Henry Smith laughing (p. 202), something rarely seen in Victorian images, perfectly captures the joviality and charisma that won him so many friends. Finally, an almost illegible letter from J.J. Sylvester (p. 237) complaining about the handwriting of Felix Klein gives us an insight into the eccentric character of one of Britain's foremost 19th-century algebraists.

One of the book's fundamental themes is that Oxford's comparatively recent return to mathematical greatness is merely a rediscovery of its historical roots. The fact that it has had not one but three mathematical "Golden Ages", of which the present is the most extended, is given as evidence that part of Oxford's strength lies in its willingness to respect and learn from past achievements, while at the same time consolidating and building on them.

Long-established institutions are often regarded as resistant to change, and, while this stereotype is partially true, this book clearly shows that mathematics at Oxford has moved with the times. With a history that is as lively and eventful as that of the country around it, the University of Oxford has experienced eight centuries of remarkable changes. It remains to be seen what the next eight hundred years will have in store for Oxford mathematics.

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