Change and variations, a history of differential equations to 1900 by Jeremy Gray, pp 261, £29.99 (hard), ISBN 978-3-03070-574-9, Springer Verlag (2021)

This book is based on the author's courses on the history of mathematics for third year undergraduates at the University of Warwick. It took me a while to adjust to the fact that the book actually is, as subtitled, 'a history of differential equations'. It is emphatically not a course in differential equations spiced up with historical anecdotes. For example, I don't think anyone teaching differential equations (as distinct from their history) would start with Debeaune's problem (posed in 1637), quoted on page 2 of Gray's book:

'Let there be a curve AXE whose vertex A, axis AYZ, and the property of this curve is that, having taken any point on it you wish, say X, from which the line XY is drawn as a perpendicular ordinate to the axis, and having taken the tangent GXN through the same point X, and extended the perpendicular XZ to it at X until it meets the axis, there will be the same ratio of ZY to YX as a given line, like AB, has to the line $YX - AY$.'

Passages like this from the history of mathematics are, at least for me, almost as hard to understand as Chaucer, but they raise questions such as 'What exactly was the problem?', 'Why was anyone interested in it anyway?', and 'How did they manage to solve it?'. It is these and similar questions which are answered in Gray's book. In this case the problem was one of a class of 'inverse tangent problems', in other words problems where we are given some special properties of the tangents to a curve, and asked to determine some properties of the curve. Debeaune's interest in such problems arose from his study of vibrations. And finding the solution? Ah, that is one of the two problems set for the reader at the end of chapter one.

There follow thirty largely independent chapters, each about ten pages long, tracking the historical development of ODEs, PDEs and the calculus of variations. The book has an 'applied' rather than 'pure' flavour (almost no δ-ε work), which simply reflects the historical development of the subject. All the great names are here—the Bernoullis and the brachistochrone problem, D'Alembert and the wave equation, Euler and Lagrange with their reformulation of dynamics, Fourier and his series, Gauss and the hypergeometric equation, Kummer and his 24 solutions, Riemann with his complex functions, Green with his functions, Hamilton's dynamics, Hilbert and some of his problems, and plenty more beside.

The book increases one's admiration for these mathematicians. The student today is presented with a fairly tidy theory, in a logical order, and quickly learns the tricks of the trade. But the pioneers were feeling their way, developing *ad hoc* techniques, and dealing with the problems in the order they presented themselves. The book comprehensively presents the details of who did what when.

Unfortunately the book is let down by poor editing. Some of this is just careless—for instance the canonical form of the hypergeometric equation is presented once in the text and once in the exercises, with a *different* misprint in each case. In presenting Galileo's carefully formulated problem comparing 'bodies falling along smooth planes' with bodies falling along a vertical, the author writes of 'balls rolling from O to P'. But a ball will not roll on a smooth surface, and a *rolling* ball will not have the same speed at the bottom as a falling ball as claimed. More generally the book appears to have been quickly put together from course materials. For example, Chapter 30 'Revision' fills only half a page. The first sentence 'This chapter is given over to revision and discussion of the final assessment, see H4' is followed only by a recommendation that students read the essay [156]. 'H' refers to an appendix on the assessments, which includes the schedule for submission, details

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of how the essays will be marked, and a warning against plagiarism. Surely this is more than the general reader needs to know.

There is a huge amount of information here. It is a book for a mathematically literate audience wanting to learn some history, *not* vice versa. The small number of mathematical exercises at the end of each chapter are challenging. The individual chapters are well written with a good balance of mathematical and historical interest. Perhaps a second edition can improve the framing of the material.

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Formulations: architecture, mathematics, culture by Andrew Witt, pp. 428, £23.15 (paper), ISBN 978-0-262-54300-2, Massachusetts Institute of Technology Press (2021)

The British architect Philip Steadman reflected on architects 'being a sort of jackdaw people' in their use of the arts and sciences. Taking a grand tour of their activities in this regard, the author of this book covers much ground both in terms of broad content and historical depth. The book is a celebration of the close connection between mathematics, art and architecture.

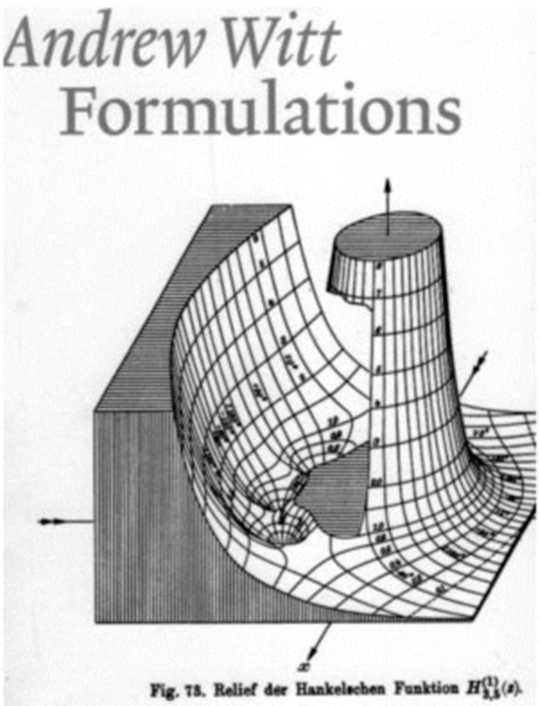

FIGURE 1: The book's front cover

The impression made by picking up this book for the first time might be misleading. On its cover is a three-dimensional graph of the modulus of a Hankel function taken from Jahnke and Emde's catalogue of functions (1945).