Ronald S.Calinger: Leonhard Euler: Mathematical genius in the Enlightenment, Princeton University Press, 2016. ISBN:978-0-691-11927-4, GBP 37.95, 669+xvii pp.

REVIEWED BY ANTHONY G. O'FARRELL

This book was published five years ago, so this review is far from timely, and I apologise to the publishers for this abuse of the usual convention about review copies. I also declare my own unsuitability as reviewer. My decision to keep this to review myself was the result of a lifelong fascination with the achievements of Leonhard Euler, and was not motivated by any confidence that I was up to the task. My only excuse for this is my belief that any attempt to grapple with the scope of Euler's work is beyond the reach of anyone but another Euler. The only reasonable attitude that ordinary mortals can adopt in relation to him is profound and abject humility. How else to consider this sober, pious, kindly and generous Swiss family man, who made Newtonian Physics actually useful, whose name came up in every course in Mathematics and Mathematical Physics in my undergraduate days, whose differential equations were just beginning to revolutionise practical weather-forecasting in my youthful days in the Meteorological Service, whose techniques and notation are standard, and whose textbooks are a primary influence on the programme for elementary, secondary, and university mathematical and engineering education?

Francis Horner, in a brief memoir on the life and character of Euler included in Hewlett's 1822 translation to English (of Johann Bernoulli III's translation to French of the St Petersburg German edition) of Euler's Elements of Algebra, had this to say of Euler's mind:

> An object of such magnitude, so far elevated above the ordinary range of human intellect, cannot be approached without reverence, nor nearly inspected, perhaps, without some degree of presumption.

In considering Euler, one is dealing with a man who wrote in German, Latin, French, and Russian and read many more languages, who had an eidetic memory, who could visualise and manipulate arbitrarily complex expressions in his head, who stood for three decades (1745-1775) at the summit of European science, who was interested in everything, who served singlehandedly as the Google Scholar of his day, who touched no subject that he did not adorn, who produced on average a paper every twelve days even after his blindness became total, and who is still cited in the experimental scientific and mathematical research literature hundreds of times per annum.

Ronald Calinger frankly acknowledges the problem, and suggests that a definitive account of Euler's thought would have to be the work of many people, each expert in one of the various relevant areas, and in a position to utilise primary sources in all the languages used by Euler, as well as secondary sources in English, Italian, Spanish, Chinese and Japanese. Calinger tries, in 650 pages, to give a 'comprehensive biography', 'decribing, explaining and summarizing what Euler achieved', and 'by paying more attention to Euler's correspondence and academic records than did earlier concise biographies' to remove some myths and clarify his relationships with other luminaries

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of the Enlightenment. Calinger acknowledges that although the first three series of the *Opera omnia* have at last been published, the work of organising and publishing Euler's correspondence is still in progress — many of Euler's letters are extensive scientific papers, *de facto*.

It is striking that Calinger can say that Euler, whose 'public' life was almost co-extensive with the so-called 'short eighteenth century', receives little or no attention in conventional histories of the period. If it is the business of historians to illuminate the causes of major change in the affairs of men, then it is actually bizarre that they seem unaware of his personal impact. In the last analysis, his effect on our world has been far greater than that of the sovereigns and savants on whom they focus, and the most enduring legacy of Frederick the Great and Catherine the Great is due to their patronage of Euler.

The book follows the chronology of Euler's life (1707–1783), fleshing out and correcting the kind of detail that can be found elsewhere, and providing some background data about the social, political and religious structures of the period. Having read it through in 2016, I've been dipping into it ever since, with profit. Recently I read it through again, in order to conclude this review.

The great strength of this book is its use of the vast Euler correspondence and other contemporary records to piece together the events of Euler's life. It a monumental work of scholarship.

The author's style is rather ponderous. He explains *everything*, and repeats himself. When he discusses an Euler publication, he gives the original title (except when in Russian) and an English translation, and he *may repeat both* when the same publication is discussed in another chapter. This is a bit irritating when the book is read through, but I must admit the advantages: (1) the reader need not understand Latin, German or French, and (2) it is possible to dip into any chapter without reading what went before.

For people of mathematical bent, the act of opening the book at random is liable to provoke an hour, or a day or more, of exploration or calculation, because one is drawn to the questions and controversies mentioned. Euler's enormous range means this can take you in almost any direction. (I should mention that on points of detail this text has very occasional errors, ranging from possible misprints to mere nonsense. The author does not pretend to provide a treatise on the substance of Euler's work, and given the range of topics it is excusable that there are a handful of lapses in the account of technical matters. Anyone who aspired to read all Euler's letters and actually digest the technical content would first need to arrange an antedeluvian lifespan.) Euler was ready to take on any challenge: pensions, annuities and tontines, lotteries, a bridge puzzle in Königsberg and bridge models in St Petersburg, strength of beams and columns, the motion of the Moon, the rings of Saturn, comet trajectories, navigation, the design of ships and sails, alternative means of ship propulsion, surveying the Russian empire, map projections, rigid body dynamics, elasticity, fluid mechanics, pneumatics, hydrostatics, solid mechanics, values of the zeta function, Pell's equation, quadratic, cubic and biquadratic residues, sums of squares, continued fractions, pentagonal numbers, magic squares, the knight's tour, combinatorics, polyhedra, elliptic integrals, tables of logarithms and trigonometric functions, tables for the almanacs whose (monopoly) sale was supposed to generate his academy's funds, telescopes, microsopes, reading glasses, thermometers, tautochrones in various media, music, harmony, geometry of triangles, differential geometry, developable surfaces, agriculture, catechesis, ancient chronologies, and, on his very last day, the differential equation for hot-air balloons.

Calinger does a very good job of painting the world of Euler's day, so different from ours: the domestic arrangements, the mechanics of international travel, the inordinate expense of postage (so vital to Euler), the gulf between nobles and commoners such as

Euler, the spectacle of a Prussian king who preferred to speak French, who appointed a President to his Academy who could not even read German, and who thought it proper to pay Voltaire twenty times as much as Euler. I did not know that Euler was rewarded, not only by his Russian and Prussian employers, but also by the British and the French (from the *secret account of the French navy*) in recognition of his innovations in military science: on navigation, longitude, shipbuilding and handling, masts, sails, speed and stability, ballistics and artillery. Just imagine what would happen to someone, in our age of nation-states, who was known to receive payments and salaries from the authorities on both sides of a major war. Imagine the Russian state employing in a high position of trust someone who had decrypted as needed, and translated to German, Russian military communications intercepted in wartime. People who lost everything in 1945 when the Red Army ground its way to Berlin might have been surprised to hear that when, during the Seven Years War, the Cossacks got out of control and sacked Euler's Charlottenburg estate, Euler was compensated for his loss by the Russians.

I was happy, in the past, that Maynooth's librarians were prepared to invest in the *Opera omnia*, and I recommend that every university librarian do likewise. There is no substitute for holding in your hands those beautifully-produced quarto volumes[1]. For youngsters beginning to read mathematics in German, I've always recommended Edmund Landau's profound texts in his famous telegraphic style, but for Latin it is hard to beat Euler, simple, clear, and beautiful. All the published work listed in the Eneström catalogue is now freely accessible on the internet at `http://eulerarchive.maa.org`, sometimes with links to translations. This should be pointed out to all students of Mathematics. However, they should be told to read critically. Euler published mistakes, cheerfully correcting them later, when detected, in line with his unwavering commitment to the search for truth, and in his applied work he was constantly on the lookout for experimental and observational evidence that might contradict received dogma (such as the inverse-square law of gravitation). Some of his Physics has been completely discarded. His aptitude for philosophy has been derided, perhaps unjustly, because of the influence of Voltaire and other French free-thinkers. I am no judge, but it is worth noting that he was an influence on Kant, was praised by Schopenhauer (and even Goethe), and that a firm Christian faith does not actually disqualify, even today. His willingness to devote serious effort to the education of women is also remarkable, as is his approach to pedagogy, characterized by experiment, attention to feedback, and flexible adaptation.

Calinger's book deserves a place in each library, and the price is reasonable enough to allow its ownership by gainfully-employed professionals and any of their favourite grandchildren who like Mathematics and Physics.

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[1]— except, perhaps, for the experience of holding the original papers. In the wonderful library of the Royal Irish Academy, in Dawson Street, one may read the *Novi Commentarii* of the St Petersburg Academy.