feared anyone stealing his ideas. He refused to reveal them, but Cardano managed to persuade Tartaglia to send him the method. Cardano swore not to reveal it, but then learnt that it had previously been found, independently, by Scipione dal Ferro. Cardano and his pupil Ludovico Ferrari expanded the method to quartics, and, on the basis that the material was very important and that using Scipione's method would not break his oath to Tartaglia, published the whole body of theory in his *Ars magna* (1545), with due acknowledgement to Tartaglia—who was furious.

Even with much original source material to quote, the story is not a long one. Toscano gives eighteen pages to Tartaglia's early life (he was lucky to survive severe head wounds as a twelve-year-old at the Siege of Brescia) and another twenty-three pages to Sumerian and Egyptian methods of solving linear and quadratic equations. The last thirty-one pages are notes, bibliography and index. The original verbal form of the equations, such as "cube and thing equals number", is used throughout, alongside the modern equivalent (in this case $x^3 + ax = c$). On the other hand there is no real sense of how the Italian Renaissance mind-set might have affected the mathematical developments.

The book is plainly aimed at a general readership. Mathematically knowledgeable readers may be frustrated by the lack of detail in such tantalising comments as '[before Tartaglia and Scipione] certain very particular cases of the [cubic] equation could be solved by approximation methods'. Regarding the problem that arises when the method requires the square root of a negative number (called here the 'irreducible' case), all that Toscano says is that Cardano would be able to find all three solutions to such equations 'using some peculiar methods as an alternative to the formula'. What might these have been? Bombelli would solve the problem in 1572 by means of 'a new and rather abstract category of numbers, known today as "complex numbers" '.

The translation from the Italian is correct enough but rather awkward in places ('The Frenchman … was appointed by Otto II, abbot at Bobbio'—it was the Frenchman who was appointed abbot). I imagine that the style would have been more lively in the original. The contexts tend to be Italian-centred (Tartaglia's triangle, not Pascal's); the rhyme known in England as 'As I was going to St Ives' appears here as 'On the road to Camogli'—and worded so as to avoid the trick answer of 1. The diagram on page 40 shows what should be a parabola as having vertical tangents.

The correspondence is a little slow-moving at times, but for a historically-sourced narration of what actually happened this book is well worth reading.

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The flying mathematicians of World War I by Tony Royle, pp. 269, £22.50 (paper), ISBN 978-0-2280-0373-1, McGill-Queen's University Press (2020)

The book opens with the author on the tarmac. He is a younger version of his present self, sitting in the cockpit of a Jet Provost trainer about to take off on his first solo. The date (6 October 1983) is ingrained, a date every flyer remembers. His instructor took the decision to send him off, gave the order 'not to crash' and it was now all down to him. The excitement is palpable and it clouded his mind (as it did for me) but the important procedures had become instinctive as the jet roared down the runway. From this ten-minute flight, one circuit and a bump, the author went on to a career in the Royal Air Force followed by years of commercial flying.

The author thus has an emotional connection with the pilots of WWI, and through a life-long interest in engineering and mathematics he understands and is sympathetic to the role mathematicians played in the design, production and safety of aircraft as war approached. Not that these two groups, mathematicians and pilots, were mutually exclusive, for several of the mathematicians learned to fly, or at least went up as observers in the aircraft they were designing. The author puts his experience at the reader's side, explaining the ins and outs of flying—such things as yaw, pitch and roll, and stalling—all illustrated with helpful diagrams.

The scene is set by reviewing the history of flight in Britain from time immemorial. It begins with monk Elmer, who reputedly launched himself from Malmesbury Abbey in the year 1010, wishfully placing his confidence in a pair of handcrafted wings fixed to his back. Having paid the debt to origins, we move on to the nineteenth century and the well-known story of Sir George Cayley (1773-1857) sending his coachman across his lands at Brompton (near Scarborough) in a home-built glider during the 1850s. Sir George had involved himself with the theory of flight and written a three-volume treatise *On Aerial Navigation* (1809).

Moving on, the author identifies an early mathematical paper that anticipates the later work on instability by Edward Routh and G. H. Bryan. It discussed the motion of a system of particles in terms of differential equations in a paper published in 1847 by one Alexander Quintin Gregan Craufurd (1808-1876). A scion of a Scottish family, he was the son of the commander of the famous Light Division during the Peninsula War. Young Craufurd had graduated a wrangler at Cambridge in 1837; he wrote and published papers on algebra and differential equations. (His varied undergraduate career included being rusticated, though this did not prevent him entering the Church).

The main focus of the book is the period 1880-1920, the real development of flight in Britain, and specifically the emergence of ‘fixed wing powered flight’; dirigibles/airships, used during WWI, are only incidental to the story. There are references to aviation in the United States, France, and Germany in footnotes.

The mathematicians of flight could be found in either the British Admiralty or the Royal Aircraft Factory at Farnborough. The latter were known as the ‘Chudleigh lot’, after Chudleigh House where they were billeted. The main sources for recruitment of mathematicians were either Cambridge, from amongst students of the Mathematics Tripos, the Mechanical Science Tripos, and the Natural Science Tripos, or University College, London. Typical recruits were polymaths by inclination. In the book we make the acquaintance of a range of mathematicians and scientists not normally met in histories of mathematics. While the late nineteenth century is generally seen as a period when pure mathematics was in the doldrums, applied mathematics is seen as a success story, chiefly through leading names such as G. G. Stokes, J. Clerk Maxwell, and Lord Kelvin. In this book we discover another layer—those active in aeronautics.

There is also a chapter on aeronautical literature of the period. This is based on the emergence of magazines, an activity in which the British excel—if you walk into any newsagent's shop you can see magazines that cater for almost every conceivable subject. Such titles as *The Aeroplane* and *The Engineer* were born in the first decade of the twentieth century. *Flight*, a weekly journal, was a leader and notably did not shrink from covering basic mathematics. *The Aero* was a ‘penny weekly’, and *Aerocraft* a monthly. The author describes their two monocled Edwardian editors with restraint, Charles Grey as ‘outspoken and controversial’ and Noel Pemberton Billing as ‘colourful’.

After the success of the Wright brothers in 1903 at Kitty Hawk, North Carolina, it was widely realized that flight had a future, and progress was rapid. However, the theory of flying and the magic of 'lift' were actually little understood. What the pilot of the time feared most was the *instability* of aircraft: when an aircraft is not propelled forward with sufficient speed it loses 'lift' and stalls; it becomes unstable and might be caught in a spin or a dramatic loss of height. Pilots needed more than reliance on 'seat of the pants' manoeuvres to resume straight and level flight. Although advances in instrumentation reduced risk, the lives of pioneers were perilous. Of the young flying mathematicians, Ted Busk, David Pinsent, Keith Lucas, Hugh Renwick and Bertram Hopkinson were all killed in air accidents.

Women made a contribution too. If only the designers had listened to Letitia Chitty who had made calculations in the case of the gigantic tri-plane built in the workshop of the timber merchant W. G. Tarrant. The Tarrant Tabor, all twenty Imperial tons of it, powered by six Napier Lion engines, was originally intended as a long-range bomber but this function was not needed after the end of WWI and it was proposed to use it for commercial transportation. Chitty checked the structural strength of the wooden struts of the Tabor and found it insufficient. But who would listen to a twenty-one-year-old female undergraduate? On the maiden fight in May 1919 the Tabor lumbered along the runway but without gaining height crashed with the loss of life of the two test pilots; the six passengers were seriously injured. However, the project set in train further British activity in the production of large aircraft such as the Bristol Brabazon in the 1950s.

Many mathematicians and aeronautical engineers are introduced in this book: notables such as G. H. Bryan, F. W. Lanchester, L. Bairstow, A. Thurston, G. I. Taylor, F. Lindemann, Hilda Hudson, and Beatrice Cave-Browne-Cave, among many others. One who might be mentioned at greater length is David Hume Pinsent (1891-1918), who in several ways is emblematic of the young mathematicians in at the birth of British aviation. Distantly related to the philosopher David Hume, Pinsent went up to Trinity College Cambridge in 1910 to read mathematics. He became part of an inner circle that included Horace Darwin (son of Charles Darwin), George Paget Thomson (son of J. J. Thomson), and G. I. Taylor (nephew of George Boole). He was a close friend of Ludwig Wittgenstein whom he met in May 1912—Wittgenstein had previously been in Manchester studying aeronautics before replacing this obsession with the study of the foundation of mathematics and philosophy. Pinsent eventually got a job in aeronautics, and was one of the 'Chudleigh lot'. He was a first rate mathematician who investigated the application of differential equations to flight. He was killed in a flying accident; the author judged his reading of the letter Pinsent wrote to his mother just prior to the accident as the most poignant moment in his research.

The book is based on a thesis for a PhD in the history of mathematics with the Open University, but here the author has concentrated on providing the human story. Indeed, he has written a compelling narrative of the way the talents of mathematicians and flying crew were combined in the face of a world war conflict.

There is a Cast of Characters, reference material, and a Glossary consisting of relevant mathematical and flying terms. An Appendix, 'Engineering and Aerodynamic Issues', shows the kind of mathematics used by the Flying Mathematicians. The book is well illustrated with aircraft diagrams, manuscript sources of aeronautical mathematics, and photos of pilots, mathematicians and the actual aircraft. The war in the air in WWI is now an active field of historical research and this book documents the contributions of mathematicians to the story. They were motivated by a strong sense of duty and they made a signal contribution to the national needs of the time. They really were heroes and this book has rightly brought their story to prominence as part of the history of mathematics.

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Africa and mathematics: from colonial findings back to the Ishango Rods by Dirk Huylebrouck, pp. 229, £27.99 (hardback), ISBN 978-3-03004-036-9 Springer Verlag (2019).

This is my first encounter with a book on ethnomathematics. Such books attempt to show the contributions to mathematics that originated from a specific part of the world and in the context of a specific culture. This book, part of the Springer series 'Mathematics, culture and the arts', discusses the origins of several mathematical concepts in the African continent, and it brings to light the rich heritage of African mathematics.

The author, an expert in African ethnomathematics, tells us that several counting methods existed in Africa long before they first appeared in other parts of the world. There is a detailed discussion of the origins and the cultures in which these counting methods originated. Parallels are drawn between the various counting methods that were used in Africa and those used elsewhere, with special mention of the Russian Peasant Algorithm for multiplication. According to the author, this method originated in Africa and was carried to Greece and subsequently to Russia from where it gains its popular name.

Several cultures have little or no written script, so the spoken form of the language is the only way to express and preserve them in historical records. The book gives several compelling reasons for the belief that Africa has been the birthplace of numerous mathematical concepts and activities. However, the author has not blown it out of proportion; for example, he discounts the commonly claimed assertion that detailed mathematical treatments of fractals were known to the Africans.

The book also contains a detailed account of several games popular in the African continent that have deep connections with mathematics. Besides explaining the rules of these games, the author explains the mathematics required to master them.

The most important and the most detailed discussion in the book is that of the Ishango Rod. This bone, excavated at the Ishango site in the Democratic Republic of Congo in 1950 by Professor Jean de Heinzelin, is evidence for the chronological richness of African mathematics. It is estimated to be at least 22,000 years old, which would make Africa a strong candidate for being the place of origin of a plethora of mathematical activities and ideas; indeed, the Ishango Rod is claimed to be the oldest surviving mathematical instrument known. In the words of Vladimir Pletser, who has written the foreword to this book:

> [S]uddenly the history of mathematics shifted from the supposed cradle of civilization around the Mediterranean Sea to the heart of Africa, not far from where, according to the commonly accepted hypothesis, the human race was born.

The book contains a detailed account of the discovery of the rod along with several other important events related to it, including a recent exhibition of the rod in Brussels. Many photographs of the excavation process of the Ishango Rod enhance the narrative through their visual beauty. There has been much discussion of the