Roger Fletcher

29 January 1939 - 15 July 2016

Roger Fletcher was one of the world's leading numerical analysts. He was best known for his work in optimization, where he made many innovative and fundamentally important contributions. He also wrote numerous computer programmes based on methods which he developed, and many of these are widely used. Optimization (also referred to as mathematical programming) is essentially concerned with the calculation of the best or optimal values of a number of variables over a range of possibilities. Therefore it is a field which crosses subject boundaries and has many applications, for example to the improvement of drug design, the minimization of production costs, the maximization of power output, the determination of the lowest energy configuration. As a consequence, Roger's work was known, appreciated and widely used across science, engineering and business.

Roger was born on 29 January, 1939, in Huddersfield. He was an only child. His father was a painter and decorator who was killed in North Africa during the war. His mother remarried (again a painter and decorator) when Roger was about seven years old. Although the family was not well off, they were very supportive of Roger making the most of his opportunities in life. He attended a very good state (grammar) school which encouraged students to progress to University, and he won a state scholarship which enabled him to go to Cambridge. Roger played chess as a schoolboy, and played top board for the England junior side on one occasion.

Roger completed his first degree from Cambridge in 1960, in Natural Sciences, majoring in Theoretical Physics. On the evening of his degree presentation, he sleepwalked out of a third floor window of the College where he was staying, broke his back and suffered paralysis, which fortunately proved to be temporary. Roger was very determined (anyone who knew him would recognise this as a thread running through his whole life), and went on to take up a PhD place at Leeds University, arriving there with the aid of sticks. His supervisor was C M Reeves, and his project involved the development of methods for computing molecular wave functions. At that time Leeds was one of the first universities to have a computer, a Ferranti-Pegasus: he was able to make use of this, and it led to his interest in a branch of mathematics called numerical analysis.

A key moment in his career occurred when Reeves passed him an Argonne National Laboratory technical report, written in 1959 by W C Davidon, on a method for a class of optimization problems. Roger programmed the method and realised its potential. The report (which had limited circulation) also went to M J D Powell at the Atomic Energy Research Establishment at Harwell. By chance, Powell was due to give a seminar in Leeds, and changed his title at the last moment to describe his own experiences with Davidon's method. In particular, Powell was able to extract the essential feature of the method, which was presented by Davidon in a rather unusual way. Powell discovered that Roger was also working on the method, they collaborated, added some theory and the result was a paper published in the Computer Journal in 1963 developing a method which became known as the Davidon-Fletcher-Powell or DFP method. To try to give some indication of how significant this was, problems with around ten variables could present difficulties and this method enabled problems with hundreds of variables to be solved.

Roger completed his PhD in 1963, and stayed at Leeds as a Lecturer. In that year, he also married Mary Taylor, after they met at a friend's wedding. Around that time Reeves was writing lecture notes on a well-known method for solving linear equations, the so-called conjugate gradient method. The solution of quadratic optimization problems leads to a linear system of equations, and he realised that the line search aspect of the DFP method could be used to extend the method to nonquadratic optimization problems. Since Roger had a line search code, this idea was followed up, leading to the Fletcher-Reeves nonlinear conjugate gradient method, published in 1964.

So Roger was already making a name for himself for his contributions to optimization, and he moved from Leeds to a post as Principal Research Fellow at Harwell in 1969. The following year, Roger and three others separately proposed another method generally regarded as superior to DFP, which is now known as the BFGS method after the surnames of the four men involved, the others being C G

Broyden, D Goldfarb and D F Shanno. Each developed the method from a different perspective, Roger's being to achieve it from the Sherman- Morrison formula via a symmetric (duality) argument. In 1971 Roger became a Principal Scientific Officer at Harwell. His job involved research, teaching and consultancy in numerical analysis, and he was responsible for setting up an advisory service in conjunction with the Harwell Subroutine Library.

But Roger felt that Harwell was becoming commercialised, and he took the opportunity to return to academic life in 1973 when he joined the numerical analysis group in Dundee University, led by A R Mitchell, as a Senior Research Fellow. Roger settled in Dundee and continued over the years to do highly original, ground breaking work, primarily in optimization but also in numerical linear algebra. He obviously had a teaching commitment, and wrote two highly respected text books on optimization in the 1980s. He became a Professor in Dundee in 1984, and as is normal, did his share of administration, including acting as Head of Department.

His research remained cutting edge throughout his career. He collaborated widely, and supervised many students and research fellows many of whom went on to make major contributions. As well as unconstrained optimization, he did significant work on linear programming, quadratic programming, and general nonlinear programming. He also contributed to new developments in mixed integer linear and quadratic programming, leading to widely distributed computer programmes. He continued his research into sequential quadratic programming methods for nonlinear programming problems, including contributions on global convergence through the innovative idea of a "filter". Again, as with many of the methods which he developed, code was made available.

As befits a numerical analyst of his standing, he was in great demand to make visits, and to give seminars and talks at conferences. But the quality of his work was also recognised by various honours. He was awarded the George B Dantzig prize in 1997 for "original work, which, by its breadth and scope, constituted an outstanding contribution to the field of mathematical programming" by the Mathematical Programming Society and SIAM (the Society for Industrial and Applied Mathematics, the main US Applied Mathematics organization). He was awarded the Lagrange Prize in 2006, by the same bodies. This prize is awarded for "outstanding work in the field of continuous optimization, based primarily on the mathematical quality, significance and originality"; he was elected a Fellow of the Royal Society of Edinburgh in 1988, a Fellow of the Royal Society of London in 2003, a, SIAM Fellow in 2009 and was awarded a Royal Medal by the Royal Society of Edinburgh in 2008 for "intellectual endeavour which has a profound influence on people's lives, worldwide".

Roger remained active after formal retirement, when he became an Emeritus Professor and Senior Research Fellow at the University of Dundee. He continued to produce innovative work, attending and giving talks at conferences, and giving seminars. Indeed, his research activity continued right up to the time of his death.

Roger was splendid company at all times, with wide interests. His prowess as a schoolboy has already been mentioned, but he gave up chess during his PhD (so he claimed) when he found he was being beaten by players half his age. He took up bridge, and was an accomplished player, and a long-time member of Dundee Bridge Club. He was interested in music, and could play guitar, piano and clarinet, although (he insisted) not very well, and certainly not in public. He enjoyed swimming and hill walking. He said that a familiarity with maps, contours, local maxima and saddle points helped him in visualising optimization techniques. (But he also said that it did not help very much in understanding the complexity of high dimensional space.) He was an enthusiastic member of the Grampian Club, and went out regularly with them to the hills. In later years he slowed down a little, but allowance was made for this.

Roger and Mary enjoyed holidaying in the west of Scotland, and Roger particularly looked forward to long walks in the area surrounding their holiday home. On the first day of their 2016 holiday, Roger went out on his own with an arrangement that he would meet Mary at an agreed time and place. He failed to make the appointment and after some time had elapsed the emergency services were called. Despite numerous searches, he remained missing for a number of weeks. The details of his death are

still unclear. So Roger's life was tragically cut short, but he leaves a legacy of outstanding achievement.

As well as his wife Mary, Roger is survived by his daughters Jane, who works for BAE Systems, and Sarah, who works for Scottish Natural Heritage.

Alistair Watson, FRSE

Roger Fletcher, FRS, FIMA, FSIAM. Born 29 January 1939. Elected FRSE 1988. Died 15 July 2016