Daniel Quillen

Daniel Quillen, who died on 30th April at the age of 70, was among the most creative and influential mathematicians of his time, transforming whole areas of the subject. The most important steps forward in mathematics come less often from solving a particular problem than from finding a new way of looking at a class of problems, a way which suddenly opens paths into previously inaccessible terrain: Quillen's work was of that rare kind. British mathematics can be proud that at the height of his powers he chose to settle in this country.

He was born in Orange, New Jersey, and won scholarships which carried him first to an excellent secondary school in Newark, and then to Harvard, where he was an undergraduate and then a graduate student working under Raoul Bott. On completing his Ph.D. he obtained a post at MIT, where he stayed till he moved to Oxford. He said that Bott — a large outgoing man universally beloved for his warmth and magnetism, outwardly quite the opposite of his shy and reticent student — was a crucial model for him, showing him that one did not have to be quick to be a fine mathematician. Unlike Bott, who always insisted on having everything explained to him many times over, Quillen did not seem slow to others, but he saw himself as a person who had to think things out very slowly and carefully from first principles, and to work hard for every scrap of progress he made. He was truly modest about his abilities — very charmingly so — though at the same time ambitious and driven. Bott was a universal mathematician, who made contributions to many different areas of the subject while always preserving the perspective of a geometer, and Quillen too never confined himself to a 'field'. His most famous achievements were in algebra, but he somehow came at algebra from the outside. He was interested in almost all of mathematics, and in a lot of physics too: when his eldest daughter was studying physics at Harvard he carefully worked through all the problem sheets she was given, and twenty years later he was doing the same when his youngest daughter was studying electrical engineering at Imperial College.

The second great mathematical influence on Quillen — as on many others of his generation — was the towering figure of Alexander Grothendieck, and again the influence had a number of aspects. Grothendieck is famous for his mystical conviction that a mathematical problem will solve itself when one has found by sufficient humble attentiveness exactly its right context and formulation. However that may be, he opened up one of the most magical panoramas of modern mathematics, connecting number theory and geometry. His influence, as well as that of the MIT topologist Daniel Kan, showed in Quillen's first lastingly famous work, published in 1967 soon after he had finished his Ph.D. thesis on partial differential equations but on a quite different subject. In the previous two decades it had been discovered that 'shapes' — the technical term is 'homotopy types' — could be attributed to many algebraic and combinatorial structures with, at first sight, nothing geometrical about them. The way this had been done, however, remained piecemeal and ad hoc. Quillen produced a systematic theory of what kinds of structures have homotopy types, and how they can be studied. At the time these ideas attracted little attention except from a small band of enthusiasts: most mathematicians thought he was carrying abstraction too far. But thirty years later the theory was beginning to be widely used, and it remains central on the mathematical stage today.

Quillen's work, though much influenced by Grothendieck's, has a different flavour. Though both aimed for simplicity, Grothendieck found it in generality, while Quillen's guiding conviction was that to understand a mathematical phenomenon one must seek out its very simplest concrete manifestation. He felt he was not good with words, but his mathematical writings, produced by long agonized struggles to devise an account that others would understand, are models of lucid, accurate, concise prose. Throughout his life he kept a beautifully-written record of the mathematical thoughts he had each day, and they form an extraordinary archive.

He spent the year 1968/9 as a Sloan Fellow in Paris, where Grothendieck was based, and the following year at the Institute for Advanced Study in Princeton, where he produced a torrent of new and exciting work, which can only be touched upon here. One spectacular item was his proof of the Adams conjecture in topology, relating to the classification of mappings of one sphere on to another. The proof made crucial use of Grothendieck's work in algebraic geometry. It led on to Quillen's development of algebraic K-theory, now a very established subfield of algebra and number theory far from its roots in topology, and the contribution he is most remembered for. The Adams conjecture was proved almost simultaneously by Dennis Sullivan, again using Grothendieck's theory, but in a completely different way. Sullivan's work also gave birth to a new, unrelated, area of mathematics. By a fascinating quirk of mathematical history, a few years later a much more elementary proof of the Adams conjecture was found which did not use Grothendieck's theory: if this had happened earlier one can wonder whether a number of active areas of current mathematics would have come into being.

In 1978 Quillen was awarded a Fields Medal, the highest honour in the mathematical world. By then his interests had shifted back towards global geometry and analysis, and also towards the noncommutative geometry and cyclic homology theory of Connes which he aimed to understand in terms of more classical geometry and topology. This held his interest in many different guises ever after. In the 1980s he made at the very least three outstanding contributions which will continue to shape mathematics: the concept of a 'superconnection' in differential geometry and analysis, the invention of the 'determinant line' as a tool in index theory, and the Loday-Quillen theorem relating cyclic homology to algebraic K-theory.

Early in 1982 he decided that the place he wanted to be was Oxford, attracted especially by its leading mathematician Michael Atiyah. He spent the year 1982/3 there, and in 1984 moved permanently from MIT to Oxford as Waynflete Professor. (The joke surged irresistibly around the mathematical world of a dean at MIT rushing to Dan with an offer to halve his salary.)

Outside mathematics his great love was music, especially the music of Bach. He always said that he met his wife Jean, whom he married before he was 21, when he was playing the triangle — and she the viola — in the Harvard orchestra. (She, however, says that he was the orchestra's librarian and occasional reserve trumpeter.) The triangle seems just the right instrument to go with his minimalist approach to mathematics. He delighted in 'figuring out' things about how music worked, and in devising tiny compositions of twenty or thirty bars; but he was far too driven mathematically to let himself spend much time on music. He and Jean had two children before he completed his Ph.D., and went on to have six altogether. His family was his whole life apart from mathematics, and, tongue-tied as he was, he never needed much encouragement from those he knew well to talk about his children's adventures and misadventures. Although his hair turned white in his twenties, he never lost the look or the manner of a teenager.

The last decade of his life was tragically blighted by steadily encroaching dementia. He is survived by his wife, his six children, twenty grandchildren, and one great-grandchild.