John Nash, mathematician - obituary

Mathematician whose work informed political strategies and whose life inspired Hollywood

John Nash attending a so-called 'Meeting for Extraordinary Minds' in Brescia, Italy, in 2008 Photo: EPA/FILIPPO VENEZIA

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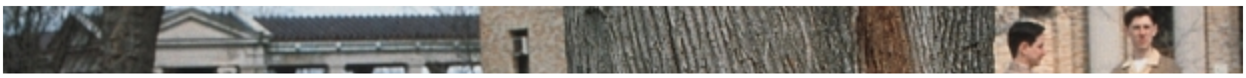
John Nash, the mathematician, who has died aged 86, shared the 1994 Nobel Prize in Economics for what he claimed was his "most trivial work" — a 27-page dissertation, "Non−Cooperative Games", written in 1950 when he was just 21.

By his own estimation – and that of the mathematical world – his contributions in the arcane field of pure mathematics (for which there is no Nobel Prize) were more remarkable still. As an undergraduate, he had inadvertently (and independently) proved Brouwer's fixed point theorem, a problem which had baffled mathematicians since the 19th century.

A few years later he astounded the profession by solving an equally difficult problem involving equations that are used to describe orbits, air flows and similar phenomena. Games of strategy, computer architecture, the shape of the universe, the geometry of imaginary space, the mystery of prime numbers — all engaged his wide-ranging imagination.



But to the public at large Nash became best-known as the subject of A Beautiful Mind (1998), the biography by Sylvia Nasar that was adapted into a Hollywood film, starring Russell Crowe, in 2002. The book revealed how Nash, the brilliant mathematician, had lived in the shadow of a condition diagnosed as paranoid schizophrenia and was virtually incapacitated by the disease for two decades.

Seen from the perspective of pure mathematics, Nash's prize work was an ingenious but not surprising application of well known methods. Yet in terms of application to other branches of human knowledge his thesis on non-cooperative games was nothing short of revolutionary.

The field of game theory emanates from studies of games such as chess or poker, in which players have to devise a strategy based on expected counter-moves from the other player or players. Such strategic interactions also characterise many situations in life, and game theory has therefore proved useful in a variety of fields.

The foundations for the theory were laid in a monumental study by John von Neumann and Oskar Morgenstern called Theory of Games and Economic Behaviour (1944). Nash was the first to emphasise a distinction between cooperative games, as studied by von Neumann and Morgenstern (where the participants negotiate with one another) and non-cooperative games, where there is no such negotiation. He also turned from von Neumann's concept of games of "pure rivalries", in which one side's gain is the other's loss, to games where the interest of the participants is in mutual gain.

Nash suggested an equilibrium point at which no one player can improve his outcome by changing his strategy alone. By clever application of mathematics, he showed that at least one equilibrium point always exists at which no player can do better than the others are doing.

Over the years, Nash's theory led to fundamental changes in economics and political science, affecting a range of fields from nuclear strategy to contract talks in major league sports.

For example, when the American government in 1994 sold off large portions of the electromagnetic spectrum to commercial users, a multiple-round procedure was designed according to Nash's equilibrium theory to maximise both the revenues to the government and the utility of the purchased wavelengths to the respective buyers.

The result was highly successful, bringing more than $10 billion to the government while guaranteeing an efficient allocation of resources. By contrast, however, a similar auction carried out in New Zealand without such a careful design, turned out to be a disaster in which the government only realised about 15 per cent of its expected earnings, and the wavelengths were not efficiently distributed.

Another application of the Nash equilibrium theory has been in the field of population genetics and evolutionary biology, where it has been used to explain and predict competition between different species or within a species, or competition between genes.

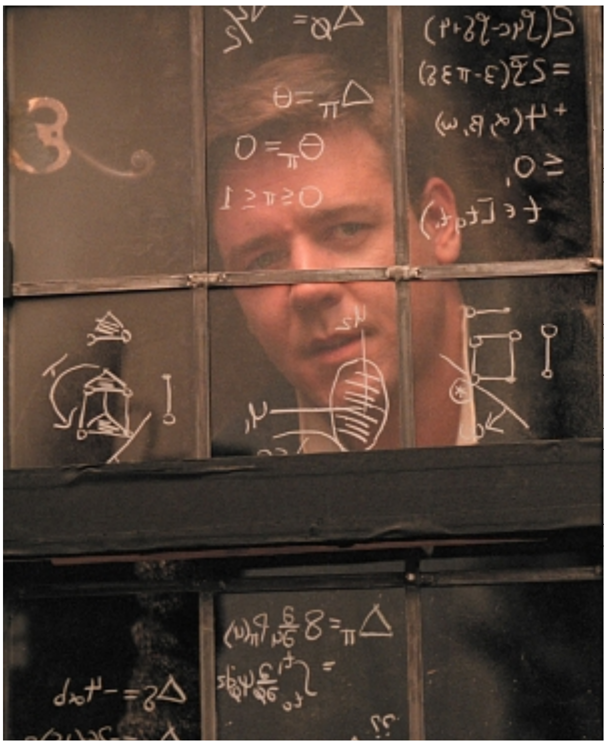
John Forbes Nash was born on June 13 1928 at Bluefield, West Virginia, a booming railroad town in Appalachia. His father was an electrical engineer working for the Appalachian Electric Power Company and his mother was a schoolteacher.

Surrounded by close relations, he had a happy family life, yet John grew up a solitary and awkward little boy who had little interest in playing with other children. His teachers did not recognise his genius – bored by his lessons, he gave them little reason to. They were more conscious of his lack of social skills and, because of this, labelled him as backward. By the age of 12, however, he was showing great interest in carrying out scientific experiments in his room at home.

He entered Bluefield College in 1941 and first showed an interest in mathematics when he was about 14 years old after reading E T Bell's Men of Mathematics. Inspired by the book, he tried, and succeeded, in proving for himself Fermat's theorem. He did not, however, consider a career in mathematics at the time, assuming he would follow his father's footsteps into electrical engineering.

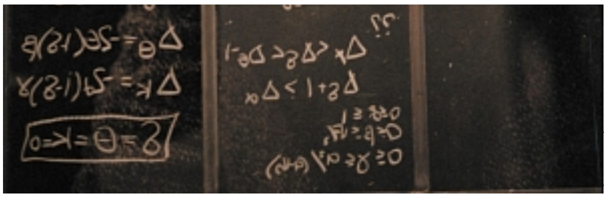
Nash won a scholarship to the Carnegie Institute of Technology, to study Chemical Engineering. Soon, however, his professors recognised his remarkable mathematical talents and persuaded him to specialise in mathematics. He received a BA and an MA in Mathematics in 1948.

When he applied for graduate school, one of his professors wrote only one line on his letter of recommendation: "This man is a genius." He was accepted to study for a doctorate at Harvard, Princeton, Chicago and Michigan; when Princeton offered him the most prestigious fellowship it had, Nash made his decision to study there.



At Princeton, Nash showed an interest in a broad range of pure mathematics, topology, algebraic geometry, game theory and logic, but he avoided attending lectures and seldom read books, preferring not to learn mathematics "second-hand". Instead, he worked things out from first principles, while pacing endlessly, whistling Bach, or riding bicycles in tight concentric circles. In 1950, Nash received his doctorate from Princeton with his thesis, "Non-Cooperative Games".

In the summer of that year he worked for the RAND



Corporation, an ultra-secret nuclear think-tank in Santa Monica, California, where his work on game theory made him a leading expert on Cold War military and diplomatic strategy, which dominated RAND's work.

Back at Princeton in the autumn of 1950, he began to work seriously on pure mathematical problems. In 1952 he published "Real Algebraic Manifolds" in the Annals of Mathematics, a work that established him as one of the world's leading mathematicians. Yet, though he more than qualified to join the Princeton Mathematics Faculty, there was resistance from some mathematicians who objected to his aggressive personality.

Instead, from 1952, Nash taught at the Massachusetts Institute of Technology, but his teaching was unusual (and unpopular with students) and his examining methods highly unorthodox. His mathematical achievements during this period were extraordinary and prolific. Important papers published at this time included "C1 isometric imbeddings" (1954), "The imbedding problem for Riemannian manifolds" (1956) and "Continuity of solutions of parabolic and elliptic equations" (1958).

The outstanding results which Nash obtained in the course of a few years made him a celebrity in the mathematical community and put him into contention for a 1958 Fields' Medal. But his work on parabolic and elliptic equations was still unpublished when the committee made their choice, and he was passed over. Before the next round of awards, Nash's career had been destroyed.

During his time at MIT Nash's personal life became complicated. He met Eleanor Stier and they had a son, born in June 1953. Nash did not want to marry Eleanor although she tried hard to persuade him. Then, in the summer of 1954, while working for RAND, Nash was arrested in a police operation to trap homosexuals. He was dismissed from RAND.

One of Nash's students at MIT, Alicia Larde, became friendly with him and by the summer of 1955 they were seeing each other regularly. In 1956 Nash's parents found out about his affair with Eleanor and about his illegitimate son, and his father died soon after. In February 1957 Nash married Alicia and by the autumn of 1958 she was pregnant. But Nash's behaviour was becoming increasingly eccentric. On New Year's Eve 1958 he appeared at a fancy dress party wearing a nappy and spent the night sitting on Alicia's lap, alternately sucking a dummy and taking swigs from a baby's bottle of milk laced with bourbon.

One morning, he walked into the MIT common room carrying a copy of The New York Times which he declared, to no one in particular, contained encrypted messages from another galaxy that only he could decipher. The chairman of Chicago University's Mathematics Department, eager to woo Nash to his faculty, was surprised to be informed that Nash would be unable to accept because he was "scheduled to become the Emperor of Antarctica".

Then, in February 1959, he gave a lecture which degenerated into a disjointed series of non sequiturs, and it became clear that something was horribly wrong. As psychiatrists later determined, he was suffering his first episode of paranoid schizophrenia, the most devastating of all mental illnesses, and one which is generally seen as an unremitting life sentence.

Nash recalled thinking that "the staff at my university, the Massachusetts Institute of Technology, and later all of Boston, were behaving strangely towards me. I started to see crypto-communists everywhere. I started to think I was a man of great religious importance, and to hear voices all the time. I began to hear something like telephone calls in my head, from people opposed to my ideas. The delirium was like a dream from which I seemed never to awake."

As a consequence of these delusions, he resigned his position at MIT and, after spending 50 days under "observation" in hospital, travelled to Europe where he "attempted to gain status as a refugee". For the next two decades or so, he was virtually incapacitated by the disease, believing himself, at various times, to be the foot of God, a Japanese shogun, Job, a Palestinian refugee named Corpse, and Saturn.

Alicia finally divorced Nash in 1963, though she continued to help him. In 1970, when he wrote to her begging her to save him from further spells in hospital, she agreed to shelter him.

She became convinced that his only hope lay in living a quiet life in the heart of the mathematical community, and with the help of some of his former colleagues, she arranged for him to be given access to the mathematics department at Princeton. There, he became a sad, ghostly character shuffling about on the campus in purple trainers and occasionally writing numerology treatises on blackboards. He became known to students as “The Phantom of Fine Hall”.

Then, miraculously, in the early 1970s the disease began to wear off, and Nash was able to return to his work. He resumed his studies on game theory and lectured at mathematics and economics meetings.

When members of the Swedish Academy of Science sat down to consider the candidates for the 1994 Nobel Prize in Economics, Nash was almost voted down, hours before it was announced, by members who could not bear the notion of bestowing the honour on a “madman”. In the event, though, Nash won the day, sharing the Nobel Prize for work he had done some 45 years previously.

In 1996, he delivered a paper at the 10th World Congress of Psychiatry, in which he claimed that there was a conspicuous link between madness and mathematical genius. Rationality, he believed, often interfered with the ultra-logical thinking necessary for pure mathematics. If being “cured” meant he could no longer do any original work at that level, then, Nash argued, a remission might not be worthwhile.

When working on the film A Beautiful Mind, the actor Russell Crowe invited Nash to tea. “Do you want coffee or tea?” the actor asked, innocently. “If I have a cup of tea,” replied Nash, “how can I be sure it is going to be of the density and fullness of flavour that I actually enjoy, because Sri Lankan teas, south Indian teas, are not necessarily to my palate. I prefer north Indian teas.” The exchange found its way into the film almost verbatim. Nash professed to enjoy the film, although he commented: “It’s not me.”

John and Alicia Nash remarried in 2001. They were both killed in a car accident in New Jersey. He is survived by his two sons.

John Nash, born June 13 1928, died May 23 2015.