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The legacy of John Nash

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Reuters
Nobel Prize winner John Forbes Nash, in this March 24, 2002 file photo.

"You can't write a paper in game theory without mentioning the Nash equilibrium."

In the 2001 film 'A Beautiful Mind,' a biographical work based on the life of the brilliant mathematician John Nash, Director Ron Howard sets up a memorable scene set in a bar to simplify his subject's ground-breaking work on decision-making in a social setting, one that got him a Nobel Prize in 1994.

Nash, who died in a car accident along with his wife on May 23, was a mathematical genius whose extremely fruitful research career was cut short in its prime by paranoid schizophrenia, which he overcame many decades later.

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In a 1999 paper, Roger Myerson, who went to bag the Nobel Prize for economics in 2007, termed Nash's work as "one of the great breakthroughs in the history of social science.

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Russell Crowe, who plays Nash, is in a bar along with his college mates when a group of girls, including an attractive blonde, walk in. Mr. Crowe and his mates wonder who could successfully pursue the blonde. Each one of them should try, one of his friends suggests. Didn't Adam Smith, the 'father of modern economics,' believe that self-interest in a competitive environment leads to the greater good?

It's then time for Mr. Crowe's lightning bolt moment. "Adam Smith needs revision," he says. "If we all go for the blonde and block each other, not a single one of us is going to get her. So then we go for her friends, but they will all give us the cold shoulder because no one likes to be second choice. But what if none of us goes for the blonde? We won't get in each other's way and we won't insult the other girls. It's the only way to win."

The "only way to win" is also supposed to lead to what is popular as the Nash equilibrium, a state where one participant in a situation finds there is nothing to be gained by changing his or her strategy given that other participants are holding on to theirs. Like, continuing to drive in your lane because the car coming on the opposite side, thankfully, isn't in your lane. The idea is more real-worldly than Adam Smith's view — because you need to consider the impact of your action and also your opponent's likely counter. (Howard's bar scene has been criticised by those who know their economics for being overly simplistic and, worse, not representing a Nash equilibrium at all. Why so? Because, when no one goes for the blonde, it makes sense for any of the boys to change tack and indeed pursue her.)

Nash, who died in a car accident along with his wife on May 23, was a mathematical genius whose prolific research career was cut short in its prime by paranoid schizophrenia, which he overcame many decades later. He revolutionised economic theory. Roger Myerson, who went to bag the Nobel Prize in 2007, termed Nash's work as "one of the great breakthroughs in the history of social science" in a 1999 paper.

Arunava Sen, Professor, Planning Unit, Indian Statistical Institute, says, "You can't write a paper in game theory without mentioning the Nash equilibrium." Nash wasn't the founder of game theory; Hungarian polymath John von Neumann, born 25 years earlier than Nash and considered as the 'father of the computer,' was.

To understand Nash's contributions, one has to first understand what game theory did to economics, and then what Nash did to it.

Mr. Sen says, "Game theory isn't some esoteric sub-branch of economics. It is at the heart of modern economic theory." Before von Neumann and his collaborator Oskar Morgenstern, however, no one looked at economics from the lens of games – where each move has a counter move and so on. Early economics theories on markets largely assumed the unrealistic extremes of perfect competition (characterised by a large number of buyers and sellers with perfect knowledge of the market) and a single seller or monopoly. In both of these cases, knowing about the effects of one's actions is superfluous. It doesn't matter.

But then it gradually dawned that the real world of business is filled not with perfectly competitive firms or monopolies but with oligopolies, or where a few firms dominate each industry. "Everything in between (perfect competition and monopoly) is the domain of game theory," says Mr. Sen.

In the early 1940s, von Neumann and Morgenstern analysed the strategies which come about when there are two participants in a situation and where one's gain is the other's loss (zero-sum games). And they aren't colluding. This, while being a significant first for analysing such situations, wasn't going to be useful outside of extreme situations such as conflicts. In the real-world, such situations are rare, and win-win possibilities abound.

It was Nash who extended this idea dramatically in the early 1950s. His model mirrored reality even more, not just because it had space for more than two players or participants. It was applicable to all classes of games or situations, not just the zero-sum ones, says Amit RK, who teaches at IIT Madras' Department of Management Studies. "Equilibrium is an answer that's not enforced but converged by players themselves," says he. "Nash's idea was easily saleable."

Nash figured out that the players can, even when they aren't co-operating, settle at an equilibrium which, however, need not be the best outcome they can attain. (They might not get the blonde, but they won't go single either!) What can help achieve the best is co-operation. Doesn't it sound sufficiently real when one analyses how two firms will price others products? Or, how countries frame their climate change strategies? Its uses are many.

Prof Y Narahari, who runs the Game Theory Lab at the Indian Institute of Science, points to how economists have built upon this framework. His examples include William Vickrey (known for his Vicrey auctions, according to which the highest bidder wins but needs to only pay the price quoted by the second highest-bidder), Roger Myerson, Leonid Hurwicz and Eric Maskin (whose mechanism design theory work helps structure auctions better), Thomas Schelling (who showed how players who need to co-ordinate but are unable to communicate choose the most obvious options) and Lloyd Shapley (who showed how the needs of market players can be matched best). They all won Nobel Prizes. "All this work couldn't have been made without Nash's contribution," says Mr. Narahari.

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