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HOT TYPE

A Mathematical Method for Assessing Whether a Terrorist Cell Has Been Broken; the Perversity of the U.S. Electoral College

By DAVID GLENN

GEOMETRY FOR G-MEN: When FBI agents arrest a few members of a terrorist cell, how can they know if the cell has been disabled?

Several scholars have brought mathematical tools to bear on that crucial question. Social scientists have imagined individual terrorists as nodes on a graph, most of whom are connected to only one or two other nodes. Using such cellular graphs, the scholars have proposed ways of estimating whether a chain of relationships has been effectively shattered, even when some of its members elude capture.

But those models are too simple and too optimistic, according to **Jonathan David Farley,** a visiting associate professor of mathematics at the Massachusetts Institute of Technology. In the November-December issue of *Studies in Conflict and Terrorism,* Mr. Farley proposes an alternative method. We should imagine terrorist cells not as graphs but as ordered sets, he says. "Lattice theory, my field, is the abstract study of order and hierarchy. In terrorist organizations, hierarchy appears to matter."

Such hierarchy complicates the project of destroying a cell. "People have been interested in simply splitting terrorist cells apart," says Mr. Farley. "That would be like blocking various intersections around D.C. so that it was impossible to get from, say, the northwest to the southeast. That might seem like a good model, but one can quickly see that you could break a terror cell apart and still have two functioning terrorist cells, even if they could not speak to one another. Whereas if you take the perspective of the ordered set, you see that what you want to do is cut the leaders off from the followers."

Mr. Farley offers an equation for calculating the probability that a given cell has been disrupted. His formula is gloomier than the "graphic" models offered recently by other scholars. In an example in which four members of a 15-member cell have been captured, he says, the standard graphic model would suggest a 93-percent probability that the cell had been broken; Mr. Farley's equation yields only a 33-percent probability. "I'm not selling mathematical snake oil, suggesting that we can actually make exact predictions," he says. The point is instead to give law-enforcement agencies a rough idea of how to allocate their resources.

"It all started when I saw the movie *A Beautiful Mind,*" says Mr. Farley, who was struck by the line, "Mathematicians won the war." "And I started thinking, Could lattice theory actually save lives?" Mr. Farley and two colleagues have started a small company, Phoenix Mathematical Systems Modeling, that offers advice on the terrorist-cell model and other practical applications of lattice theory.

"G.H. Hardy, the Cambridge mathematician, said that he liked mathematics because it was useless," says Mr. Farley. "I am a pure mathematician myself, but

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it's nice to be useful once in a while."

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ALGEBRA FOR ELECTORS: Meanwhile, in Los Angeles, two other math scholars with aspirations to usefulness have analyzed the perverse mechanics of the U.S. Electoral College. In the October issue of *PS: Political Science and Politics*, **Michael G. Neubauer** and **Joel Zeitlin,** professors of mathematics at California State University at Northridge, ask how the 2000 election might have ended if the size of the U.S. House of Representatives had not been capped at 435 in 1941. If the 1941 ratio of representatives-to-citizens had been maintained, the House would have had roughly 830 members in 2000.

The Electoral College today has 538 members. Each state sends one delegate for each of its House members and senators. Mr. Neubauer and Mr. Zeitlin ran scenarios imagining what would have happened in 2000 if the House size had been 436, or 437, and so on, up to 830. (At each step, they awarded the "new" House seat to the state whose district sizes were proportionally largest relative to the national mean.)

They found, not surprisingly, that relatively small Electoral College sizes benefited **George W. Bush,** who won almost all of the smallest states. (The extra weight of the "senator" delegates gives small states a disproportionate power in the Electoral College; that effect has been amplified by the 1941 decision to freeze the size of the House.) Mr. Bush won every scenario with a House size smaller than 491. Larger House sizes, on the other hand, would have aided **Al Gore,** who won every scenario with a House size larger than 655.

What surprised the scholars was the range of outcomes for House sizes between 491 and 655. In that zone, the winner oscillated wildly; at 25 different points, the outcome would have been a tie.

"The winner changes, and really there's no way to predict the outcome, in a range of House sizes that seems quite reasonable to imagine," says Mr. Neubauer. "We started to see all of this chaotic -- though not in the technical mathematical sense, just speaking metaphorically -- this chaotic behavior, where the winner changes repeatedly over small intervals, without any rhyme or reason."

The authors emphasize, however, that they do not advocate any particular electoral reform. They note that every apportionment scheme used in U.S. history has been fraught with mathematical trouble, because a small whole number of House members must be awarded across a wide range of population variance. If a state could be awarded 2.83 or some other fractional number of representatives, some of the difficulty would vanish.

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