

Terror and Beauty - The European Institute for Mathematical Methods in Counterterrorism

by Jonathan David Farley

Abstract:

Concepts and techniques from mathematics – specifically, from Lattice Theory and Reflexive Theory – have already been applied to counterterrorism and computer security problems. The following is a partial list of such problems:

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1. Strategies for disrupting terrorist cells
2. Data analysis of terrorist activity
3. Border penetration and security
4. Terrorist cell formation
5. Information security

We propose the creation of a European Institute for Mathematical Methods in Counterterrorism (IMMC), to be based in Austria. Such an Institute would require minimal investment but could serve as a catalyst to draw several million euros in research grants and contracts to Austria. This influx of funding would benefit not merely scientists and firms working in Homeland Security, but other aspects of Austrian science as well.

Shadows strike

It was a Tuesday morning, and I awoke into a nightmare. The phone rang; a friend spoke. "Turn on the television," she said.

You couldn't see it at first. This was before anyone knew it had been caught on camera. All you could see was a plane disappearing behind a building, and a burst of hellfire.

Terrorism is the watchword of the day, and the fear – regardless of whether the threat is real or imagined – requires an antidote: security. Callous or not, "[t]he first reaction of many companies to 9/11 was to reorganize around the emerging opportunity." (1) Of the \$40.2 billion requested by the US Department of Homeland Security for 2005, \$1.039 billion will go toward the Science and Technology Directorate, whose mandate is to "lead a national research effort to harness science and technology, in coordination and partnership with universities, research institutes and laboratories, private sector companies, and ensuring research entities, to counter high-consequence [terrorist attacks]." (2) In July 2004, a bill was introduced in the US Senate to require the Department of Homeland Security to conduct a survey of "existing products or services within the United States or other countries, such as Israel, focused on homeland security. Grants would fund joint ventures among businesses, academic institutions or nonprofit groups and other entities that have demonstrated counterterrorism or homeland security capabilities. The bill authorizes \$25 million for fiscal 2005." (3) In 2003, Boston University won a \$120 million grant to build a National Bioterrorism Laboratory. (4) Homeland Security is Big Business.

As Austria assumes the presidency of the EU, one important way to build bridges with the US will be for Austria to move into the area of Homeland Security. Funds that could be drawn to Austria would foster Austrian science in an unprecedented manner. A country in the heart of Europe would suddenly be, in both politics and the world of science, the center of attention.

Of course, everyone is competing for his or her piece of the pie. To win it, you have to have something different – such as the European Institute for Mathematical Methods in Counterterrorism.

"Mathematicians Won the War"

How do you stop a terrorist?

You can work hard: Post men and equipment at every street corner, every port, every bay, every slip of beach, every straight stretch of asphalt long enough to land a plane.

You will spend billions, and your lines will be thin. All you've done is build the "impregnable" Atlantic Sea Wall – which the Allies punched through in hours on D-Day.

You've got to work smarter, not harder.

The opening line of the Oscar-winning movie *A Beautiful Mind* is "Mathematicians won the war." During World War II, the mathematics underlying cryptography played an important role in military planning. Churchill admired Alan Turing, the Cambridge mathematician who had mastered the Nazi codes, recognizing him as the man who had perhaps made the single greatest individual contribution to defeating Hitler.

Thereafter came a new kind of war. After the first frosts descended in the Soviet East, approximately \$2 billion were spent in the development of "Game Theory." The names of mathematicians who worked for the US government – Russell Crowe's John Nash among them – became legend.

Now again we face a new kind of war. And we need a new kind of mathematics to fight it.

The Thinking Man's Game

At first it seems absurd. How could mathematics, the science of logic and reason, possibly help us understand madmen?

At Los Alamos National Laboratory, the lab that built The Bomb, they understand. Cliff Joslyn uses "Lattice Theory" to mine data drawn from thousands of reports of terrorist-related activity, to discover patterns and relationships that were previously in shadow.

And listen to George Habash, leader of the Popular Front for the Liberation of Palestine, who in 2002 said that terrorism "is a thinking man's game." According to terrorism expert Gordon Woo, terrorists are not irrational. They are former chess champions, men who studied mathematics at institutions like the London School of Economics. The terrorists are using rational strategies to attack; rational strategies are needed for defense. Consider four examples:

In 2003, US Defense Secretary Donald Rumsfeld asked, "Today, we lack metrics to know if we are winning or losing the global war on terror. Are we capturing, killing or deterring and dissuading more terrorists every day than the madrassas and the radical clerics are recruiting, training and deploying against us?" To model the growth of a terrorist network, we could use the same "differential equations" that govern the spread of an infection like SARS. Such models could be used to help us

understand, and eventually contain, the Al Qaeda Virus in Europe.

In March 2003, US Vice President Dick Cheney falsely predicted that Americans would be “greeted as liberators” in Iraq. Harvard University’s Tony Harkin has used ideas from statistical physics to model the battle for the hearts and minds in Iraq. Just as a magnetic pole may be north or south, a person could be either for the occupation or against it. Harkin’s model shows that there can be a tipping point in the evolution of public opinion: It may seem as if much of the population is with you but then, dramatically, a wave of hostility sweeps down, and one witnesses the birth of an insurgency.

In early June 2005, the Pentagon announced plans to revise its strategy in the war on terror. While Bush repeatedly cites that 75 percent of Al Qaeda’s leadership has been killed or captured, Al Qaeda is, quite clearly, still active. Now the Pentagon wants to target mid-level captains and foot soldiers. How effective will that be?

Lattice theoretical methods developed at the Massachusetts Institute of Technology tell us the probability that we have disabled a terrorist cell, based on how many men we have captured and what rank they hold in the organization. It can even account for gaps in our knowledge of the structure of a terrorist cell by making assumptions about how the “perfect” terrorist cell must be organized. Boston student Lauren McGough experimentally tested the accuracy of this model, essentially confirming what the theory predicts.

Finally, there is the ever-present threat of a dirty bomb being carried across the borders of the US or Europe. Which border do you guard? Which border do you want the terrorist to think is weak? You want to funnel him toward your snare, thinking it’s an open field. Reflexive Theory – a branch of mathematical psychology used by the Soviet defense establishment – gives us a quantitative way to do so. Stefan Schmidt of Phoenix Mathematical Systems Modeling, Inc. is developing software tools to help border patrols allocate personnel, and spread disinformation to the adversary.

The European Institute for Mathematical Methods in Counterterrorism

Since 2001, tremendous amounts of information have been gathered regarding terrorist cells and individuals potentially planning future attacks. There is now a pressing need to develop new mathematical and computational techniques to assist in the analysis of this information, both to quantify future threats and to quantify the effectiveness of counterterrorism operations and strategies.

Progress on these problems requires the efforts of researchers from various disciplines such as mathematics, computer science, political science, and psychology. By having researchers from diverse disciplines come to one place to conduct their research, greater progress will be

made in developing scientific and analytical tools to deal with the problem of terrorism. Hence, to facilitate the invention of new tools, the exchange of new ideas, and the dissemination of new results to users in the intelligence and law enforcement communities, we propose the creation of an Institute for Mathematical Methods in Counterterrorism.

Benefits to European Security

The Institute will spur research on mathematical methods in counterterrorism in two ways. First, individual researchers from disciplines not normally applied to counterterrorism will dive into their pool of knowledge to find novel uses to which their areas of expertise could be put. Second, since the Institute will host workshops, support visiting researchers, and train students, researchers from diverse disciplines will hear about the problems and approaches of others, and form collaborations to solve each other's problems, thus advancing the state of the art.

Benefits to Austria

The Mathematical Sciences Research Institute in Berkeley, California was started in 1980 with a budget of \$9,096,873 over 84 months. The IMMC would require much less: it could initially be created as a "virtual institute" connected with the Johann Radon Institute for Computational and Applied Mathematics in Linz or the Technical University of Vienna. This minimal investment could possibly give Austria the opportunity to secure, from the US or EU, several hundred million euros in Homeland Security funding for use in other areas.

This is not about politics. As a neutral country, Austria can (and should) reject Bush's call to be "with him or against him," and soberly get on with the business of supporting Austrian science and pursuing better methods to save civilian lives, whether it be in London, Bali, Nairobi, New York – or Vienna.

The author, Jonathan Farley, is a Science Fellow at Stanford University's Center for International Security and Cooperation and the co-founder of Phoenix Mathematical Systems Modeling, Inc., a company that develops mathematical approaches to Homeland Security.

Further Reading

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The Economist Magazine

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<http://www.sciencenews.org/articles/20040110/mathtrek.asp>

MIT News Office

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Chronicle of Higher Education

<http://dimacs.rutgers.edu/Workshops/Defense/article5.pdf>

DIMACS Workshop on Applications of Order Theory to Homeland Defense and Computer Security

<http://dimacs.rutgers.edu/Workshops/Defense>

DIMACS Working Group on Applications of Order Theory to Homeland Defense and Computer Security

<http://dimacs.rutgers.edu/Workshops/DefenseWG/index.html>

Second Conference on Mathematical Methods in Counterterrorism (November 1-3, 2005)

www.cmmc2005.org

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<http://cisac.stanford.edu/>

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Footnotes:

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