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Strategic Science

Philadelphia-area researchers have enlisted in a broad national security effort, working to detect terrorist threats, protect the food supply, and deal with other disasters.

By Faye Flam, Inquirer Staff Writer

With the attacks of Sept. 11 in the recent past and an assault on Iraq possible in the near future, many scientists are turning their talents and research to national defense.

This beating of plowshares into swords takes many forms. Medical researchers are creating ways to protect citizens against attacks with anthrax and smallpox. Computer scientists are designing systems to block cyberterrorists. Veterinarians are studying the safety of the food supply. Chemists are building detectors to sniff out a poison agent in the air or water.

At some area universities, researchers are getting military funding as they realize their work can be applied to national security. At Temple University, for example, chemist Robert Levis is working on a technology for controlling chemical reactions and for detecting minute traces of substances in a mixture.

At the University of Pennsylvania, more than 100 faculty members from many fields of study have formed a loose alliance called the Institute for Strategic Threat Analysis and Response.

Microbiologist and information specialist Harvey Rubin, who helped organize the group, says, "What sets us apart is we've taken a broad approach to strategic threats - not just terrorist threats but issues of natural resources, cybersecurity, network security, issues in risk communication."

The group also is concerned about threats to civil liberties and privacy that can come as a side effect of beefed-up security, Rubin said.

The main goal is to bring diverse researchers together to brainstorm on tactics for dealing with an unstable world. The Penn institute brought in social scientists such as Susan Wachter of the Wharton School, who had been studying ways that maps and satellite photos - geographical information systems - could be used to address social problems such as poverty and joblessness.

Before Sept. 11, she developed a method for overlaying high-resolution satellite photos with maps showing public transportation, power distribution, census data, or other geographical information.

But after Sept. 11, she said, she realized how valuable geographical information could be in emergency relief. New York City authorities used a combination of satellite photos overlaid with hundreds of maps, she said, to identify natural-gas lines, electrical lines, smoke plumes, tunnels, and other features needed to help rescue workers get access to the ground zero site while avoiding hazards.

"New York City was a leader in putting together this kind of information," she said, but Philadelphia does not have the same information ready. "There's so much that needs to be done to bring Philadelphia and Pennsylvania up to the cutting edge."

Another result of Penn's academic cross-pollination was that Michael Kearns, a computer scientist and artificial intelligence expert, realized he had something to contribute to the work of Wharton School risk specialist Howard Kunreuther.

Kunreuther had been working in "game theory," a technique that uses mathematics to predict behavior of individuals or groups in competitive situations - anything from the cold war arms buildup to business investment strategies to poker games.

Kearns saw how he could apply game theory to the now-vital issue of airline baggage screening. Airlines generally screen checked baggage but are reluctant to invest in screening baggage transferred from other airlines.

Society benefits most if all the airlines invest in screening at all points, but airlines are not motivated to do so. "Somebody has to go first and that person would be making an economically irrational decision," Kearns said.

A solution might involve government subsidies to a few of the biggest airlines, which would motivate smaller ones to follow suit without fear that the investment would cost them their competitive edge.

Kearns said he realized that game theory worked best when taking into account the fact that not all players are equal. Some airlines don't get any transferred bags, while others get thousands.

If you take into account this added complexity, he said, game theory becomes useful for real-world problems.

Smallpox vaccinations offer another example, he said. It's not necessary to vaccinate everyone in the population to stop an epidemic from spreading, he said. With limited time and supplies, it makes sense to concentrate on those people with the most potential infectious contacts, such as children attending school, over those who are more isolated.

To apply the game theory to these real-world scenarios, Kearns is trying to get data on baggage transfers. He also is seeking census data and numbers on day-care-center populations for the smallpox question. "This is not just a theoretical project," he said, noting it eventually could be used to make policy decisions.

Meanwhile, Penn veterinary school researcher Gary Smith is devising strategies for vaccinating farm animals to protect them against natural or intentionally caused diseases. Massive infection among livestock could threaten the economy and cause food shortages.

Smith said he began to realize the vulnerability of the nation's livestock industry several years ago when Britain lost billions of dollars worth of cattle to foot-and-mouth disease. "It caused tremendous alarm among the general population," he said. That was a natural outbreak, but the same devastation could occur if someone deliberately set off a wave of disease among livestock, he said.

At Temple, Levis' chemical-detection research involves blasting a sample of a suspicious substance with ultrafast laser pulses. The pulses can be tuned for any particular type of molecule - for instance, the nerve toxin called sarin gas.

Get the laser tuned to the right frequency, he said, and the molecules of the sarin will break apart in a particular way.

The fragments are then weighed in an instrument called a time-of-flight mass spectrometer, and the identity of a compound or biological agent can be read from the weights of the different parts.

"All I need are 100 molecules in a sample," Levis said. Beyond that, the instrument can pick up traces from a complicated mixture. After a chemical weapons scare, he said, "if I have a bottle of New York air, it won't just contain sarin gas - there will be 10,000 other things." And no technique currently available could sift through such a mix.

Theoretically, the detector could immediately identify a dangerous compound to prompt evacuation or guide later treatment.

Penn's Rubin said that he didn't expect all the scientists in the school's newly formed institute to dwell on the threat of terrorist attacks. It's too hard to predict what will next disrupt public safety and security. He hopes that the work spawned by the institute also can address threats from natural disasters, epidemics, and the city's crumbling infrastructure.

"Hopefully, there won't be any more terrorist attacks," he said. "But the kinds of problems we might face can be analyzed using this high-level approach."

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