

▶ the best interests of our infectious-disease community”.

While the organizers of future conferences reviewed their plans, other meetings were disrupted by last week's interruptions to air travel. The Cardiovascular Research Foundation cut short a meeting in Washington that opened on the day of the attacks, and the American Association of Cardiovascular and Pulmonary Rehabilitation's annual meeting in Minneapolis, which was due to start on 12 September, was abandoned. Across Europe and Asia, many meetings went ahead without American participants.

As concerns grow about escalating global instability and the likelihood of the United States launching a military response, the ramifications for science could run much deeper than the disruption of conferences.

An increased focus on security seems inevitable. Last week, for instance, the US Senate Committee on Governmental Affairs was told that federal agencies, including those responsible for research, have given inadequate thought to protecting their computer infrastructure against terrorist and other threats.



Research agencies may now be asked to tighten their security procedures across the board. It is also possible that policies on the exchange of scientific data will be reviewed. “At present, we distribute and share scientific information without regard to where it's going,” says Graham Cameron, joint head of

the European Bioinformatics Institute in Hinxton, near Cambridge, UK. But he speculates that the US government and its allies could demand that certain countries are excluded from access to a range of scientific data — such as the genome sequences of pathogenic microorganisms.

Technology will assist the fight against terrorism



William Triplett, Washington

In the immediate aftermath of last week's attacks, attention has focused on the importance of beefing up the human element in counter-terrorism. The need for better-trained security

personnel and a stronger emphasis on the human aspects of intelligence-gathering have been cited repeatedly. But experts stress that science and technology will also be fundamental.

Take airport security, for example. US airlines have been heavily criticized for using poorly trained employees to screen passengers and baggage. But aviation specialists say that, even with outstanding staff, improved technologies are needed to maximize security. “With excellent people you can build an aviation-security system that can be very good,” says Billie Vincent, a security consultant based near Washington's Dulles airport, who is a former director of civil aviation security for the US Federal Aviation Administration (FAA). “But you can build a better security system if you have excellent people and then integrate the right technology.”

Many of these technologies are already available, at least in prototype form, and their application could now be seriously

considered. They include ‘biometrics’ for confirming the identity of passengers, computerized pattern recognition to identify weapons hidden in baggage or under clothing, and even an extension of auto-pilot technologies to prevent hijackers from assuming manual control of airliners.

“The strategy used to be keeping bombs and weapons off airplanes,” says Rick Charles, a specialist in aviation security at Georgia State University in Atlanta. But facing a new breed of terrorist prepared to take their own lives by turning airliners themselves into weapons, “now we need to look at how to keep the wrong people off airplanes”.

The field of biometrics — which recognizes individuals by fingerprints, iris patterns and so on — has a role to play, argues Charles. “If you had sophisticated identification devices at ticket counters, and they were linked to FBI, Interpol and CIA databases, it would certainly help.” A more comprehensive system would require all passengers to carry biometric identity cards, which could be checked and verified.

Some technologies, such as enhanced X-ray machines that can detect objects hidden under clothing, may now win public acceptance that was previously elusive on grounds of privacy. American Science & Engineering, based in Cambridge, Massachusetts, has a device called a Z Backscatter X-ray, which, when used in

conjunction with conventional X-rays, offers sharper image resolution and can discriminate between different materials — pinpointing explosives, for example. The equipment is used by US prisons, but the FAA has yet to certify it.

Experts argue that such machines, allied with computer-image-recognition systems, are needed to tighten airport security, however well-trained security personnel may be. People simply cannot maintain the levels of concentration to reliably spot suspicious objects on the screens of X-ray scanners, says Douglas Harris, chairman of Anacapa Sciences, a security-systems-analysis company in Santa Barbara, California. “Vigilance drops within minutes,” he says.

A software package called Threat Image Projection, developed by PerkinElmer Instruments of Boston, Massachusetts, is capable of identifying weapons of various shapes from X-ray images. It has been tested at Atlantic City airport in New Jersey and is being deployed elsewhere. But its pattern-recognition algorithms would need to be modified to identify the knives and box-cutters reportedly used by the terrorists responsible for last week's atrocities.

There is also scope to improve security on board aircraft. Strengthening cockpit doors with Kevlar, a lightweight, bulletproof substance, for example, would cost only \$2,000 per aircraft — and could be combined



Science officials in the regional neighbours of Afghanistan — the most likely target of US military action — are acutely aware of the potential for a security clamp-down to affect international scientific collaboration. “It is too early to say in what form restriction will come,” says Ragunath

Mashelkar, secretary to India’s Department of Scientific and Industrial Research. “But there is bound to be some restriction on the freedom that non-Americans currently enjoy in the United States.”

More generally, the crisis could have a profound effect on the resources that are

made available for research. The US federal budget will come under pressure as money is released for the immediate relief effort, for eventual rebuilding at the sites of the attacks and to finance the expected military action. Already, the US Congress has authorized the spending of \$40 billion for rebuilding and to step up security. “The money has to come from somewhere,” observes Robert Eisenstein, assistant director of the mathematical and physical sciences directorate of the National Science Foundation.

Although officials such as Eisenstein are duty-bound to consider the potential implications of the crisis for their agencies’ budgets, such concerns are not foremost among the scientists who spoke to *Nature* over the past week. “There are thousands of widows, widowers and orphans,” says Princeton University physicist William Happer, director of the Office of Energy Research in the US Department of Energy during the early 1990s. Under the circumstances, he says, most scientists will accept that fundamental research is not going to be the US government’s top priority. ■

Reported by Alison Abbott, David Adam, Josette Chen, Rex Dalton, K. S. Jayaraman and Paul Smaglik.



Detection aids: could an experimental explosives-detection portal (left) augment existing X-ray screening equipment at airports?

Charles also believes that auto-pilot technology could be further developed to prevent hijackers seizing control of aircraft. “We’ve had fully automatic landing capability for a long time.” With current technology, he says, “it wouldn’t take great additional effort to implement a system that would activate fully automatic flight and landing and disable all manual control inputs”.

But the system could create problems if it malfunctioned, and denied control to legitimate pilots. Developing telemetry to override manual inputs and assume control from the ground in the event of hijacking would help. But that, in turn, might be vulnerable to someone hacking into the system. Such complications illustrate how, in combating terrorism, securing one area of vulnerability often creates another.

Some researchers complain that the FAA’s lengthy certification process has delayed the adoption of promising security techniques. A

team at Sandia National Laboratories in Albuquerque, New Mexico, for example, developed a screening portal in 1997 that can detect explosives carried by passengers. After two years of tests at Albuquerque’s airport, a New Jersey company, Barringer Technologies, bought rights to the technology, but the FAA has yet to certify it.

The FAA will now come under pressure to expedite its certification procedures. Its research priorities may also be reviewed. The administration spends around \$50 million a year on research and development, about \$40 million of it on explosives detection.

However, the events of 11 September suggest that, whatever technologies become available, they cannot provide watertight security. There is no “magic bullet”, warns John Hansman, a physicist and director of the International Center for Air Transportation at the Massachusetts Institute of Technology. “Any technical solution for security will be highly vulnerable to a well-planned attack.”

As the US authorities investigate the vulnerabilities that allowed last week’s attacks to occur, a top priority will be providing better intelligence on terrorist activities. “Intelligence tells you what the threat scenario is,” says Harris, “but intelligence on terrorism is a severe weakness of the system right now.” Addressing that weakness may require vast reforms of both human spying and the use of technologies such as electronic communications interception. ■

Additional reporting by Rex Dalton.

with procedures to keep cabin doors locked during flight. US officials are also discussing a major expansion to the Air Marshal programme, to put armed guards on many more scheduled flights. Discharging a firearm during pressurized flight is dangerous — but Israel’s airline, El Al, equips its guards with nylon composite bullets that can disable hijackers without threatening cabin walls.