THE ROLE OF PHYSICISTS IN COUNTERTERRORISM:

Tony Fainberg

Background

I began my interest in the role of technology in counterterrorism in the late 1980's while working at the Congressional Office of Technology Assessment (OTA), which had a good run of twenty years before being closed by Congress in 1995. It had occurred to me that science and technology could do a lot to help in this area. Although some research and development projects had appeared here and there in various government agencies, I was not convinced that the overall effort was as large or as coordinated as it should be. This still may be the case.

Following the destruction of PanAm Flight103 over Lockerbie, Scotland in December 1988, I was able to persuade my colleagues at OTA that technology and counterterrorism was a fertile field for study, and, within a couple of years, we produced a couple of volumes on the federal effort to apply technology to counterterrorism. The areas covered included not only aviation security, but also chemical and biological terrorism (which had been insignificant up to that point), communication and organizational issues, explosives detection technologies and a number of other areas. Up to that point, not too much work had been done to survey what needed doing and what was being done to apply technology in the war on terrorism: a war that did not begin in 2001, but that was ongoing even in the late eighties. Some of the suggestions made in the work were acted upon. Many findings and conclusions are still applicable.[1]

In the nearly fifteen years since, terrorist attacks have increased in effectiveness and scope, if not in raw numbers. The federal reaction, most easily measured in dollars, has also ramped up, although usually in stuttering steps, or perhaps I should say, the federal effort has evolved in a mode approximating punctuated equilibrium. There were quantum leaps in funding immediately following major events, such as Lockerbie, the (non-terrorist) crash of TWA flight 800 in 1996, and, most obviously during these past months. In between, funding stays stagnant, more or less constant, until the next event.

As fiscal points of reference, I offer the following: the budget of the Aviation Security Research Laboratory in Atlantic City, which had a budget of less than $10 million per year in 1988, now is envisioning a funding level well in excess of $50 million for fiscal year 2003. Similarly, the Technical Support Working Group, which is an interagency group that funds counterterrorist technology applications that might otherwise fall between agency cracks, was staggering at a level of around $2 million per year in the late 1980's and was in danger of extinction. It now has a budget in excess of $80 million.

Of course, in the acquisition mode, things are even clearer. For years, the federal government was not in the business of buying security equipment for airports, and air carriers flatly refused to put money into this unproductive activity, since, as was frequently asserted, there was no domestic terrorist threat to civil aviation in this country. After TWA 800 in 1996, with the appearance of yet another Presidential Commission, this one headed by Vice-President

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[1] U.S. Congress, Office of Technology Assessment, *Technology Against Terrorism: The Federal Effort*, OTA-ISC-481 (Washington, DC: U.S. Government Printing Office, July 1991) and U. S. Congress, Office of Technology Assessment, *Technology Against Terrorism: Structuring Security*, OTA-ISC-511 (Washington, DC: U.S. Government Printing Office, January 1992).

Gore, the government decided for the first time to pay for the deployment of massive amounts of security equipment at airports. The majority of these devices were of two basic types: a CAT-scan-based explosive detector that cost about $1 million each (exclusive of installation), and trace chemical detectors, costing about $40,000 each, that were usually placed at passenger checkpoints to test carry-on items for explosives residues. For the first few years after TWA 800, over $100 million/year was applied to these acquisitions. Each year, however, it became more and more difficult to sell the idea of this deployment, since there had been no real evidence of a major terrorist act against domestic civil aviation for quite a while. The resident memory time of many decisionmakers was not all that long.

Now, of course, things are much different. In the wake of much discussion over many years, the terrorist events of 2001 impelled the Congress to federalize the security screening force at airports (it had been mostly in the hands of private contractors to the air carriers), and to deploy enough explosive detectors to check everyone's luggage in the United States, by the end of the year. Hundreds of CAT-scan-type units and several thousand trace detectors will likely be deployed. For comparison, since 1996 until 9/11, given the fiscal ceilings, only about 150 of the former and about 1000 of the latter had been deployed. The total bill for aviation security for the current fiscal year will be somewhere between $2 billion and $6 billion, depending on how one counts. Much of this will be a one-time capital expenditure, but one may expect yearly bills at least of the order of a billion dollars or more for the indefinite future, especially considering the large numbers of additional screening personnel now on the federal payroll for the first time.

All this may give you an idea of where the public interest is now in the field of transportation security. There are other topics within transportation security that I have not yet touched upon, including future threats in the realm of weapons of mass destruction, which we have to anticipate and deter. There will be a major effort to focus on other modes of transportation in addition to the obvious major target, aviation. There are operations research issues in designing security systems that need serious and inventive work. And there are a host of new communications and cyber-based issues that also require innovation and creativity.

This brings me to the major topic of the discussion: namely what can physicists do to help? And, as a point of reference, I would like to mention that my colleague Fred Roder, a physicist now at the TSA, was responsible for the conception, development and initial production of the CAT-scan explosive detectors: a (nearly) lifetime project that for many years no one thought would succeed.

Technical Tasks

It might be useful to describe some of the research and development tasks that remain in transportation security. Some of these are well-known and obvious, others have been less discussed and less worked on. The list is not all-inclusive, but will give you a flavor of the main directions of effort.

- Improve explosive detection for
  - Baggage
  - Carry-on
  - Cargo
  - Persons

The issues here are the canonical ones: detectors that are faster, cheaper, smaller, and, above all, have higher efficiency and lower false alarm rates. With regard to detection on people, in particular, there are also issues of privacy and civil liberties, which are not to be discarded for the convenience of the engineer or security designer. While we may have more latitude than before the terrorism of last year, there are still limits of intrusion, beyond which we are not allowed to go without serious cause.

- Improve access control at airports.

For years, there has been a problem in maintaining the proper control to access to the "sterile area" of an airport. A related issue is the confidence we may have in the background checks now to be performed on those with access to aircraft.

- Investigate chemical and biological detection.
- Investigate detection of nuclear and radioactive material in all modes of transportation.

The reasons for the above are obvious and have been much reported in the press. Whereas the nuclear threat may be less immediate, one cannot completely dismiss it in the longer term. The radiological threat, whereas rather less serious than other weapons of mass destruction (WMDs), is probably more immediate: virtually any effective organization can obtain highly radioactive material. Other areas of technical interest:

- Perform vulnerability analyses of systems and subsystems that form part of aviation security, both domestically and internationally.
- Work on integrating security systems at each site.
- Continue to apply human factors science to transportation security issues.
- Improve security communications, including between aircraft and ground.

I think most of these are self-explanatory: they involve more systems engineering and psychology than hard science, but are no less vital.

There are additional technical studies of aviation security technologies that are easily accessible, many of them authored by panels of the National Academy of Sciences, under contract to the Federal Aviation Administration.[2] These provide many details on a wide variety of technical approaches to the issue.

Potential Roles for Physicists

The above list, although not exhaustive, clearly implies many opportunities for physicists in their direct areas of expertise but also in analytical areas that may not be related to physics, but where the sort of logical analysis and understanding that physicists do well, can be applied. There is at least as much use for a physics background, for example, in doing a systems analysis of a complex security entity as there is in attempting to predict stock options behavior, to cite just one area in which physicists have been quite active lately.

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[2] There are several reports since 1993 that may be found at http://www.nationalacademies.org. *Detection of Explosives for Commercial Aviation Security* in 1993 was the first; *Assessment of Technologies Deployed to Improve Aviation Security* in 1999 is the most recent broad review from the Academy. Additional studies that cover security issues in other transportation modes as well as aviation can be found at the site of the Academy's Transportation Research Board at http://www4.trb.org/trb/homepage.nsf/web/security.

The area about which I am most familiar is aviation security. I have worked in this field from without and within, on and off, for some 13 years. Here, the bulk of the technical work has been done by a technical center in Atlantic City that does some lab work and some contracting. At the Center, which will probably be expanding, there is a staff of some 70 people, of whom about 15 are Ph.D. scientists and engineers. Disciplines run from physics to industrial psychology. The quality of the staff is high; remarkably so, for a small center that is almost unknown outside the limited scope of actors in the field. At the TSA headquarters, there is an additional staff of competent scientists and technology integrators.

One point: there is a need for expertise in biology, since awareness of the biothreat to civil aviation is recent. The anthrax letters reminded many that civil aviation could become a target of bioterror as well. Indeed, in the Aviation and Transportation Security Act of 2001, there is a provision requiring the TSA to consider putting bioterror countermeasures in place. I can imagine a potential role for biophysicists, of course, particularly in the area of improving biodetectors.

What are the other technical elements in the Department of Transportation that may be dealing with technical issues related to counterterrorism? Two important ones are the Volpe Transportation Systems Center and the Coast Guard. Neither has done too much work in the terrorism area to date, but this is changing now. Volpe has, in fact, worked in the explosives detection area for a number of years. Additionally, it has worked on vulnerability analyses of transportation facilities and nodes, but the main emphasis in the past has been on innovation in transportation and safety, health and environmental issues related to transportation. Now, Volpe is extending its efforts to responses to chem and bio terror, preparing information and courses for first responders in areas related to transportation. Volpe is also developing expertise in biometrics, and perimeter security. The Coast Guard has focussed primarily on smuggling and occasionally on specific military requests, but is now turning to vulnerability analysis and the threats from weapons of mass destruction. Both entities, clearly more concerned with counterterrorism now, may be expected to contribute significantly to R&D in this field.

In summary, there are physics and physics-related problems in transportation security that are crying for innovative ideas and new sets of eyes and brains. In addition, there are engineering and systems problems that can benefit from physicist-like techniques of analysis and study. Further, counterterrorism and technical responses are likely to be growth areas for a while. Moreover, work in this field can yield the satisfaction that one is doing work that is relevant (remember the 60s?), important, and that may save many lives, as well as enhance the national security. I commend this sort of work to your consideration, either as a newly-minted PhD, a mid-career physicist, or a senior physicist. Work can be done in many modes: as a government employee, as a consultant to government, as an employee of a private corporation, or even as a constructive and informed outsider. Academics can participate under grants or contracts, so the effort devoted to this endeavor can be part time. Or, one can immerse oneself entirely. The range of options is open.

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