Cabin Baggage Screening:

any improvement?

It's been a little over 4 years since the 11 September terrorist attacks refocused the world's governments on improving aviation security. When looking at what has changed at the checkpoint, comparisons are often made with the advances in hold baggage screening, yet it's important to recognise that checkpoint challenges far exceed those of hold baggage screening. Both bags and passengers must be screened for a broader, and smaller, range of threat items. Improvised explosive devices and firearms, in the control of a passenger, may be assembled or disassembled at will, whilst bladed weapons may be made of different, perhaps non-metallic, materials. ***Steve Wolff*** *reports on the technological advances achieved at the checkpoint - the most critical part of the airport security system - and highlights the roadblocks that have impeded further progress.*

There's no doubt about it. Improving security at the checkpoint is a major challenge, yet critically important. Baggage and passenger screening must have the same detection capability. There is no point screening one for explosives without having a similar capability for the other. At the same time, all stakeholders need to remember that customer service is key to avoid turning away the passengers that the industry needs to grow and in some cases, survive. To date, multiple $ billions have been spent worldwide on hold baggage screening (HBS); given the checkpoint's complexities and challenges, it is likely that even larger expenditures will be needed to effectively counter the multitude of threats and ensure passenger throughput.

Has There Been Progress?

Sadly, we are not very far along in deploying a checkpoint system capable of finding the breadth of threats required. The technology "workhorses" are still operator-staffed X-ray systems and metal detectors, which were designed to find the high contrast objects, such as guns and metallic knives, that were

used in the ransom hijackings of the 1970s. Most experts admit that even the newer upgrades to these systems are not able to reliably reveal cleverly concealed bombs or the components of explosive devices.

Though the Lockerbie incident focused improvements on hold baggage screening, some checkpoint enhancements were made. These included improved dual energy X-ray systems, which were more recently replaced with higher resolution X-rays incorporating Threat Image Projection (TIP) to test operators while they worked. Another "improvement", that of operator-assisted explosives detection derived from hold baggage screening, did not fare well in tests. Governments improved their understanding of Human Factors issues, leading to better hiring, training and on-the-job monitoring capabilities using TIP. Indeed, the UK government played a leading role in this effort, and its "New Screening Methodology" eliminated a high percentage of random bag searches. However, the underlying weakness – the reliable detection of explosives – remained.

On September 11th 2001, terrorists demonstrated a, sadly, remarkable understanding of the end-to-end security process by penetrating several US checkpoints using "legal" weapons. Richard Reid later demonstrated a similar understanding, this time with explosives in shoes. The US responded with a massive reorganisation of FAA security first into the new Transportation Security Administration (TSA), first under the US Department of Transportation and then moving to the brand-new Department of Homeland Security (DHS). In spite of several reorganisations over the past few years, restructuring continues today within this new bureaucracy. US R&D funding for new cabin baggage screening systems dropped precipitously in the years following 911. Even 4 ½ years later, checkpoint progress continues to be hampered by organisational and funding problems within the DHS and TSA.

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Despite the fact that the 911 terrorists and Richard Reid targeted the checkpoint, US Congressional mandates and funding primarily focused the new TSA on deploying explosives screening equipment for hold baggage rather than at the checkpoint. The primary checkpoint initiatives were to replace contracted screeners with US government employees and to implement operational changes such as asking passengers to remove shoes and coats, and, from their baggage, laptops and camcorders. Certain passengers were targeted for secondary search and the TSA placed, sometimes, bizarre restrictions on passenger carry-on items such as nail clippers. Secondary search was enhanced with more prevalent and thorough hand-searches. Many procedures attempted to

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compensate for fundamental technology deficiencies and they required extensive passenger management efforts to alleviate excessive queuing at US airports. They often created confusion and long lines at the checkpoint, coupled with some embarrassing searches and travel restrictions (which even snared a US Senator). Some of these changes filtered overseas, especially for flights heading to the US, but outside the US procedural changes were more modest.

Technology upgrades included tough new metal detector standards leading to the replacement of all US metal detectors. TIP was added to X-ray systems; French authorities developed extensive TIP libraries for the major X-ray systems, available throughout the European Union. However, human factors studies and blind tests in the UK showed that even TIP - which was hailed as a major improvement - requires more extensive libraries and frequent changes to avoid operators doing well on TIP images but missing other threat configurations. The US deployed trace detectors for some secondary bag searches (currently the only routine use of explosives detection technology) and while small X-rays were purchased for screening shoes – a boon for manufacturers – they largely sit idle.

In spite of these changes US DHS Inspector General studies showed minimal actual security improvements, especially in the detection of explosives, both during a 2004 audit[1] and in a follow-on audit in March 2005[2]. A key conclusion of the report: "Despite the fact that the majority of screeners with whom our testers came in contact were diligent in the performance of their duties and conscious of the responsibility those duties carry, the lack of improvement since our last audit indicates that significant improvement in performance may not be possible without greater use of new technology". TSA responded with better procedures and both the UK and US have trialed trace portals and backscatter X-rays for passengers. There are still no trials of bag explosives detectors; operator inspection of every portion of every bag's X-ray image is still a cornerstone of our defence system.

New technology – preferably automated – is needed. Even before the

35 years on and the archway metal detector is still the primary method of screening passengers

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DHS Inspector General audits, several manufacturers took the initiative (and risk) to develop novel multi-view automated X-ray and CT systems without government funding or direction. In Russia, airports are trialing compact thermal neutron activation systems to inspect bags rejected by X-ray operators for explosives. In 2002, several US companies joined forces to integrate new prototype devices into an advanced screening system. The companies contracted the National Safe Skies Alliance (which performs tests for the TSA) to conduct a thorough, independent test, which showed dramatically improved performance over a conventional checkpoint for explosives, guns, metallic and non-metallic knives on passengers and in bags[3]. However, the system was slow, occupied about 25% more space than a current checkpoint lane and likely would be usable only for selected passengers. In spite of excellent detection results, regulators showed no significant interest, possibly because there were no government mandates or funding to do so. Several individual devices used for passengers in the advanced checkpoint have recently been trialed in the US and the UK. However, there are no baggage-screening system trials underway.

The Remaining Challenges

As the US provides the bulk of the funding for technology development, it is important to realise that TSA technology development activities also affect the rest of the world. Addressing the following several factors should ensure expedient progress.

A. Embrace Spiral Development: While the UK is more pragmatic, the TSA remains focused on the "perfect" solution: one system for bags, one for passengers. Both will be

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highly automated to minimise the use of operators. "Perfect" implies extremely high performance, which has several drawbacks. First, it institutionalises the problem of "letting the excellent be the enemy of the good". The promise of an excellent system dissuades officials from deploying existing technologies that, while improving security in the interim, might become obsolete in a few years. Second, waiting for the "perfect system" prevents both governments and industry from gaining valuable operational experience needed to improve equipment and the inspection process. Third, even though an all-in-one system is desirable longer-term, it needs to incorporate the lessons learned from interim, independent systems, so-called "spiral development".

The UK recognises this with its "best available" approach, though the focus to date has been on passengers, not cabin bags. Several passenger-screening systems have been trialed at government test sites and at both London and Manchester airports with the aim of revising the "New Screening Methodology" currently in place.

B. Improve the product development process: With its large R&D budget, the US remains the leader in funding the development of new technologies that could offer substantial detection improvements. These systems are adopted overseas– often more rapidly than in the US. However, the current serial method that TSA uses is slow and inefficient. It consists of funding development followed by extensive lab tests, a pass/fail qualification process leading to small-scale operational trials followed by limited - and finally widespread - deployment. For example, even though trace portal evaluations in the US started in 2002, the transition to operational deployment remains slow and is far from widespread.

To be fair, the government is inundated with systems from manufacturers, of which "up to 50% do not work", according to a TSA official interviewed for this article. No government should prematurely deploy faulty technology into real operations, which would confuse operators and reduce their effectiveness. However, the product acceptance process could be fast-tracked in several ways.

i. By bringing operational personnel into the development process early on to help manufacturers understand their needs and avoid mistakes that otherwise would appear later, requiring time-consuming redesigns.

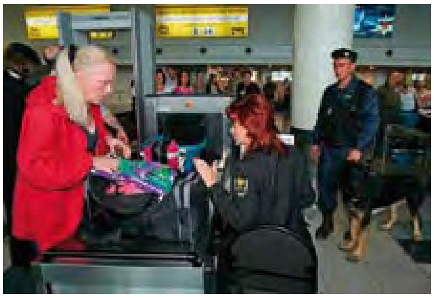
ii. When presented with a new system, governments could conduct short, limited, low-cost tests to ensure the system has a chance of meeting realistic requirements. If not, the system is returned to the manufacturer.

iii. If so, governments would then complete more extensive lab tests and operational trials in parallel. At the end of these tests, everyone would have an excellent idea of what (if any) changes are needed to achieve performance and operational goals, along with how to configure and optimally integrate the system at checkpoints. This would save time and development costs. Even though many new systems come from US development funding, it is imperative for all countries to streamline and fast track their product development and introduction cycles.

C. Ensure stability and direction: Ongoing reorganisation, changes in leadership, a poorly defined strategy coupled with lack of funding will doom any effort – whether private or public. Unfortunately, the TSA has been embroiled in all of these since its inception. Private companies (and their investors) need a stable regulator able to communicate and commit to a mid and long term strategy. This would spur and optimise technological developments.

D. Understand overall process effectiveness: All devices have weaknesses, but a layered, systems-oriented approach would mitigate many of these. Checkpoint designers need to focus on overall system performance early on, rather than merely evaluating each individual sensor's capability. Performance includes contributions to passenger handling, operator use, information transfer, and passenger selection. An example is the US's (and, more recently, the European Community's) requirement to remove shoes and laptops. This has slowed the passenger throughput from roughly 350 passengers per hour before 9/11 to between 175 and 200 passengers/hour, causing long queues, which will get longer as passenger traffic increases, even without new technology. Studying the process reveals that the main bottleneck is the time required for passengers to place bags and other objects on the X-ray belts. As metal detectors (currently deployed in a 1:1 ratio with X-ray systems) are idle most of the time, replacing every other metal detector with an X-ray system would dramatically increase throughput with at most minimal effect on space requirements.

Another process improvement is Secondary Search. Rarely does primary search information reach secondary search personnel so they largely "start from scratch". Providing them with primary search information, such as X-ray images, ticket information and metal detector results would help focus the searcher on suspicious items, improving efficiency and effectiveness. This could be supplemented with new technology to improve detection confidence. While trace detection systems are used at secondary search, some countries (for example, Russia) are already trialing and using new technologies such as neutron-based techniques or quadrupole resonance systems. Several late-prototypes based on new technology could already provide improved explosives detection at Secondary Search. These could later become more widely deployed as confidence increases and the challenges (space, cost, manpower, etc.) are resolved. Also, improving Secondary Search first is critical to ensure that any false alarms from new technology used for Primary Search does not cause bottlenecks at Secondary Search.



What Technologies are Available?

No single technology can provide comprehensive detection at the checkpoint; it will take a combination of techniques. The table shows a list of technologies that are at various stages of development for screening bags at the checkpoint. While many systems are scaled-down versions of their hold baggage counterparts, it is important to recognise that success in screening hold baggage does not necessarily translate into success at the checkpoint.

References

1 "Audit of Passenger and Baggage Screening Procedures At Domestic Airports, September 2004", OIG-04-37 September 2004

2 "Follow-Up Audit of Passenger and Baggage Screening Procedures at Domestic Airports (Unclassified Summary)", OIG-05-16, March 2005.

3 "Test Report for the Threat Detection Demonstration of the Advanced Technology Screening Checkpoint Equipment", Tim Hollifield, Mary Hawkins, and Lori Anderson, National Safe Skies Alliance, April 2003

Technology	Benefits	Liabilities	Status
Multi-view X-ray	• Some ability to find explosives, • High speed • Relatively low cost	• Higher cost than X-ray • Unable to detect some explosives types, configurations • Unable to penetrate some shields	Production Prototype
Quadrupole Resonance (QR) with X-ray	• Enhances X-ray's explosives detection capabilities • Automatic systems • Cheaper than CT • Some detection advantages over CT	• Requires more items to be separated from bags, possibly inspected separately to minimise false positives • Higher cost than X-ray • Likely to be slightly slower than X-ray • Unable to penetrate some shields	Engineering Prototype
CT	• Automatic explosives detection • Automatic gun detection (not validated)	• Slow compared to X-ray • Large, heavy, complex • Much higher cost than X-ray • High false positive rates • Some explosive configurations not detected.	Engineering Prototype
Thermal Neutron Activation	• Able to find most explosives • Excellent penetration of shield objects • Low false alarm likely if used as secondary search	• Some homemade explosives not detected • Best suited for secondary search as it is slow, relatively heavy and large • Neutron generator maintenance needed	Engineering Prototype in trials (Russia)
Trace	• Automatic explosives detection • Able to find most explosives	• Time consuming, procedure intensive • Labour intensive and subject to error • May be defeated by good cleanliness	Product (deployed in US, overseas)
Magnetic Resonance or Electrostatic	• Detects explosives in bottles/ beverages	• Time consuming, procedure intensive: need to open bag, remove bottle • Costly • Won't work on cans	Lab and engineering prototypes

Conclusion

Most industry experts are convinced that new checkpoint technology is needed to detect the broad range of threat items. Available systems and approaches can significantly enhance checkpoint detection, even if deployed today. However, a stable government organisation structure, ongoing funding and a comprehensive multi-year plan are all essential to encourage, and focus, private investment in new systems. This is especially true in the US, where government funding has traditionally been the driving force behind the technologies ultimately deployed, even overseas. Devising and implementing a fast-track process, where performance and operational evaluations of late-stage prototypes are performed in parallel (instead of in series), would speed up, improve and reduce the cost of developing and deploying effective systems. Unfortunately, many people believe that it may take another act of terrorism to adopt the necessary steps and focus sufficient attention on accelerating security improvements at the world's checkpoints. Let's hope not…

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