Modern Airports Offer No Easy Way Out for Panicking Crowds

By Jeremy Hsu
Posted 6 Sep 2016 | 17:00 GMT

Photo: Wang Ying/Xinhua/Getty Images

People wait for the reopening of the security checkpoint at the JFK International Airport in New York, on 15 August 2016. All flights from the airport were suspended due to reports of shooting inside a terminal.

False reports of shooters at two of the busiest U.S. airports—one in New York City and one in Los Angeles—left many passengers swept along by surging crowds of panicked people searching for the closest exits. The chaos was perhaps all too predictable, because computer simulations suggest that many major airports are terribly designed for emergency evacuations.

Many airports are designed as long, narrow “pier” buildings with aircraft parked at gates running along both sides. That’s relatively efficient for getting large numbers of people loaded onto as many planes as possible—even if delayed passengers sometimes have to sprint to catch their flights at the far end of a terminal building. But the pier design presents huge problems for people who are trying to get to traditional exits during emergencies. During a

15 August incident, crowds panicked by false reports of a shooter at John F. Kennedy International Airport (http://nymag.com/daily/intelligencer/2016/08/the-terrifying-jfk-airport-shooting-that-wasnt.html) in New York, ran out onto the tarmac where planes are typically parked.

"Airports are built that way to get passengers through security and bag check and everything as quickly as possible, so that they have best customer service experience," says Matthew Manley (http://mays.tamu.edu/field-trips/meet-the-professors-2/matthew-manley-information-technology/), clinical assistant professor in information and operations management at the Mays Business School of Texas A&M University. "But from an evacuation standpoint, it's problematic because passengers might be at the end of a pier and would be required to evacuate across a very long distance and through hazards."

Busy airports usually cannot afford to conduct emergency drills with huge crowds of real paying passengers. That means real-life disasters or even false alarms can often leave airport crowds scrambling to figure out the safest course of action on their own. Still, computer simulations may provide some answers by showing how airport layouts and certain security measures impact crowd movements during emergency evacuations.

Manley worked with several colleagues at Utah State University to develop a crowd simulation, called Exitus, that showed how an especially vulnerable population—say, disabled individuals—would fare in emergency evacuations. They used Exitus to simulate several scenarios involving dirty bombs at Salt Lake City International Airport in Utah and published the results in the 20 November 2015 issue of the journal *IEEE Transactions on Systems, Man, and Cybernetics: Systems* (http://ieeexplore.ieee.org/document/7332972/).

The dozens of Exitus simulations, run with as many as six thousand simulated people, assumed a best-case situation with an orderly, controlled evacuation through the normal airport exits. But these "best-case" evacuation scenarios—where the crowds, even without guidance, didn't panic—still revealed big flaws in the traditional airport pier design found at Salt Lake City International Airport and most major airports.

For example, the long corridors inevitably led to pile-ups at escape routes such as stairways or narrow passageways leading back to the central airport hub and main exits. The evacuation became even slower when the researchers added a small group of disabled individuals to the simulated crowds. (Exitus may be the first "agent-based" simulation to show how the presence of disabled individuals impacts emergency evacuations at an airport.)

Disabled people in wheelchairs, those with impaired eyesight, or elderly folks with lower stamina tended to move the slowest and were at greatest risk. Just imagine your elderly grandparent trying to sprint down a long, crowded airport terminal, and you can get the idea. In addition, the slower progress of disabled individuals also slowed the overall crowd evacuation.

One major impetus behind Manley and his colleagues' decision to study this issue was the desire to find potential evacuation alternatives for the elderly and those with disabilities. The typical evacuation policy usually requires disabled individuals to "shelter in place" by staying in a designated refuge area until rescue personnel arrive.

It may be a sign of how terrible airport designs are for mass evacuations that some airport security experts actually recommend the "shelter in place" strategy for everyone. Part of the advice to wait out the danger in a quiet restroom or similar area makes sense, at least from the standpoint of avoiding being swept up in panicking crowds running here and there. But it's perhaps also symbolic of how modern airport design has failed passengers when it comes to providing escape routes from danger.

The researchers introduced another problem that set the airports' design flaw in relief: a simulated a dirty bomb placed in locations that blocked some of the stairwells and passageways. That meant evacuating passengers had no choice but to cross through a potential danger zone as they exited on their way to the central airport terminal.

Such a scenario is not very different from a real-life incident that occurred at the Salt Lake City airport on 14 October 1989. A Boeing 727 parked at a gate near the intersection of a long concourse building and the central terminal caught fire. Passengers were forced to walk through smoke billowing from the fire as they exited toward the main airport terminal.

Again, keep in mind that these simulations represented best-case scenarios with no panicked crowds. The researchers talked with Salt Lake City International Airport officials to discover the established procedures for controlled evacuations, which do not usually call for passengers to run out onto busy airport tarmacs where planes and other potentially dangerous vehicles operate. But as the recent incidents at JFK Airport and LAX Airport (http://www.nbcnews.com/news/us-news/lax-scare-police-say-loud-noises-not-gunshots-caused-panic-n639191) have shown, people will flee perceived danger by any means necessary.

"Airports, unlike hotels, don't have evacuation points, because they are supposed to be secure, so it's not like you can easily get out," Mike Ackerman, a travel security expert, told the *New York Times* (http://www.nytimes.com/2016/08/30/travel/how-to-stay-safe-at-the-airport-jfk-lax.html?_r=1).

So what can be done to improve this sad state of affairs? Additional crowd simulation studies may point to better layouts for future airport designs. They could also help security officials map out better plans for dealing with crowd behavior during a crisis.

For example, a 2011 study (http://teamcore.usc.edu/papers/2011/Tsai-IVA.pdf) by researchers at the University of Southern California in Los Angeles simulated how "emotional contagion" could spread fear or panic through a crowd. Their research was presented at the 11th International Conference on (http://link.springer.com/chapter/10.1007%2F978-3-642-23974-8_42#page-1)Intelligent Virtual Agents (http://link.springer.com/chapter/10.1007%2F978-3-642-23974-8_42#page-1) held in Reykjavik, Iceland from Sept. 15-17 in 2011. It did not specifically study airport environments, but such emotional contagion effects in a simulation could help better understand chaotic airport evacuations such as those that took place at JFK and LAX.

The USC researchers compared the results from their ESCAPES simulation with video of real-life panicked crowds in order to tweak their models until they came up with the most realistic results. They found that their simulation best mimicked real life when it showed emotions spreading like temperature. An individual agent's fear would go up or down based on the mood of the surrounding crowd. By comparison, a model that assumed fear spread like an infectious disease did not work as well.

The simulation also included other factors that helped it better mimic a chaotic situation, says Milind Tambe (http://teamcore.usc.edu/tambe/), professor of computer science and industrial and systems engineering at the University of Southern California. Tambe is also co-founder and co-director of the Center on Artificial Intelligence for Social Solutions and a coauthor of the 2011 study.

"ESCAPES was the first to include families and children and first-time visitors," Tambe says. "This meant evacuation became messy and agents in the simulation did not march out in perfect order when the evacuation started. Children would wander from their families and parents wouldn't follow evacuation orders until they found their children; and children wouldn't move fast, so the evacuation became messy."

Meanwhile, Manley at Texas A&M hopes to continue using crowd simulations to study how emergency evacuations from airports and other buildings could be made smoother and safer—especially for elderly and disabled people. He thinks that simulations could also begin directly illustrating the safety benefits of airport designs other than the traditional pier design.

“The bottom line is the cost and safety concerns…at an airport are just too high to conduct a live safety exercise like a fire drill or anything,” Manley says. “Simulation is the only recourse for understanding what would happen during these situations.”