Emerging Active and Passive Safety Systems for Reducing Risk in Airport Operations

Air travel has been by far the safest mode of travel both in absolute and relative terms, despite a few high-profile incidents in the last 12 months in the US and around the world. Here, we will discuss a few emerging active and passive safety systems in airport operations. We believe an analysis of these systems illustrates the requirement of systems thinking in risk management.

First, a few words are in order to distinguish the active and passive safety systems. Designing and integrating active and passive systems usually requires tradeoffs and optimization. An active safety system usually involves at least two different sub-systems of sensing and responding. A common burglar alarm is perhaps the most common example of an active system. When it senses movement, most commonly by optical means, it triggers a loud and repeated alarm.

The active systems are very common and effective; however, their limitation is usually the sensing sub-system which is subject to reliability, accuracy, and repeatability challenges. The passive systems are usually less complex, more reliable, and more accurate due to lack of opto-electronic or mechanical components. They either do not require a sensing sub-system or the extent of required sensing is very limited. The movie cliché of a hidden trapdoor is perhaps the best-known example of a passive system. On the other hand, the lack of significant sensing capabilities may reduce the responsiveness, accuracy, and effectiveness of passive systems. Thus, in vast majority of applications, a combination of active and passive systems is required.


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Perhaps the most crucial emerging technology today in active airport safety, especially in ground traffic safety, is ASSC (Airport Surface Surveillance Capability). ASSC is the upgraded successor to legacy ASDE-X (Airport Surface Detection Equipment, Model X). It provides similar surface surveillance of aircraft and vehicles but with an additional all-weather capability due to input from ADS-B (Automatic Dependent Surveillance-Broadcast). ADS-B leverages satellites and thus, is mostly independent of the adverse weather events. Besides ADS-B, ASSC typically receive inputs from ASDE-3 surface movement radar, multilateration remote units, Airport Surveillance Radars (ASR), which are then combined with the flight plan information from terminal automation systems like STARS (Standard Terminal Automation Replacement System). ASSC provides a high level of situational awareness to air traffic controllers (ATCSs) and it alerts them to act when necessary.

The most recent incident which highlighted the value of ASSC was the near-miss incident in August 2023 in San Diego International Airport, per the NTSB's final report. ASSC also received significant attention after January 2025 Potomac River mid-air collision. ASSC is a high-cost and complex system currently operational at only nine U.S. airports. The FAA is actively working to expand the deployment of ASSC to enhance ground safety.

A good example of passive airport safety systems which has been receiving increased attention is the Engineered Materials Arrestor System (EMAS). EMAS is built at the end of a runway and made of easily collapsable materials. It reduces the severity of the consequences of an aircraft running off the end of a runway. It is important to emphasize that a runway excursion is a very low probability incident. However, as the Jeju Air Flight 2216 incident illustrated, its consequences may be extremely hazardous and EMAS may reduce this risk.

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EMAS is also a good example to illustrate the promises and limitations of a passive safety system. It does not require any sensing sub-systems, and it does not have any mechanical or electrical components. On the other hand, it will neither prevent runway excursions nor function beyond the design envelope. For example, FAA notes that EMAS may not be effective for aircraft of less than 25,000 pounds.

The most recent incident which highlighted the value of EMAS was the long landing of CommuteAir Flight 4339 at Roanoke-Blacksburg Regional Airport in September 2025. The Embraer 145 was safely stopped by EMAS without any injuries and only minor damage to the landing gear.

More than 120 EMAS systems are operational today in 70 US airports and the adoption around the world is accelerating.

The emergence of new active and passive safety technologies, combined with greater extent of automation powered by AI will increase the safety of the airline industry and airports. If you are interested in learning more about our work in risk management and AI and about how we can help you, please contact us at **sei-partners.com**

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