

# AVIATION RESEARCH GRANTS PROGRAM

## "Highly Successful Research" InVision Technologies, Incorporated

*Through the Aviation Research Grants Program, the Federal Aviation Administration (FAA) and InVision Technologies of Newark, California have partnered to increase aviation security for the traveling public. This partnership has addressed a critical Government need to produce an explosive detection system (EDS) that reliably detects concealed explosives in airport luggage and to train and monitor operators in the usage of those systems. It has contributed to InVision's efforts to enhance the capabilities of its CTX 5000 series EDS, the only EDS to have met the FAA's stringent certification criteria, which are now recognized as the standard of excellence around the world. The FAA's Aviation Research Grant Program has also been instrumental in InVision's program to develop its next-generation EDS.*

### THE NEED FOR ENHANCED AVIATION SECURITY

In the 1970's, the FAA responded to the increasing frequency of terrorist aircraft hijackings by requiring all airlines to screen passengers and carry-on baggage for hidden weapons. The policy became a model for all airports worldwide, spawning the x-ray screening industry and resulting in the use today of more than 7,000 x-ray scanners worldwide for the screening of passenger carry-on baggage. As a result, the threat of aircraft hijackings was significantly reduced, leading terrorists to seek other options for their high-profile, destructive activities.

Despite the use of x-ray scanners, civilian aviation security still has weaknesses. Enhanced x-ray technology can detect high contrast items such as guns and knives, but it can not reliably reveal bomb materials, since they are comprised primarily of low-contrast materials that resemble many items commonly found in luggage. This makes bombs particularly hard to find when concealed inside other items within a suitcase.

On December 21, 1988, a small amount of plastic explosive - a substance that was undetectable by any x-ray screening system in use at the time -- tragically downed Pan American Flight 103. The crash killed all 259 passengers and 11 people on the ground in Lockerbie, Scotland, and brought the total death toll from acts



*InVision Technologies Headquarters Newark, California*

of aviation terrorism in 1998 to 550 people. Careful investigation of Flight 103's wreckage found that terrorists had hidden the bomb within a tape recorder tucked inside an unaccompanied suitcase.

This tragedy served as a wake-up call to the flying public worldwide, signaling the urgent need to increase aviation security in response to the heightened risk of on-board aircraft explosives. While this tragic loss of life is the most compelling reason to perfect detection, the hard currency costs associated with airplane bombings

are staggering. For Pan Am Flight 103, they have been estimated at more than \$650 million.

Following the Pan Am bombing, Congress passed the Aviation Security Improvement Act of 1990 to accelerate research and development of technologies and procedures to counteract terrorism. The Act authorized the FAA to fund the development of EDS and to establish standard criteria for certification of such equipment.

The FAA worked with the National Academy of Sciences, in collaboration with the Federal Bureau of Investigation (FBI) and the Central Intelligence Agency (CIA), to create scientifically valid certification protocols. The standards developed are used today to certify explosive detection equipment that, alone or as part of an integrated system and under realistic air carrier operating conditions, can detect the amounts, configurations, and types of explosive materials which would likely cause catastrophic damage to commercial aircraft. The resulting certification protocol focuses on:

- ✦ Quantities and categories of explosives to be detected.
- ✦ Probability of detection by explosive category.
- ✦ Number of bags processed per hour.
- ✦ Maximum acceptable false alarm rates.

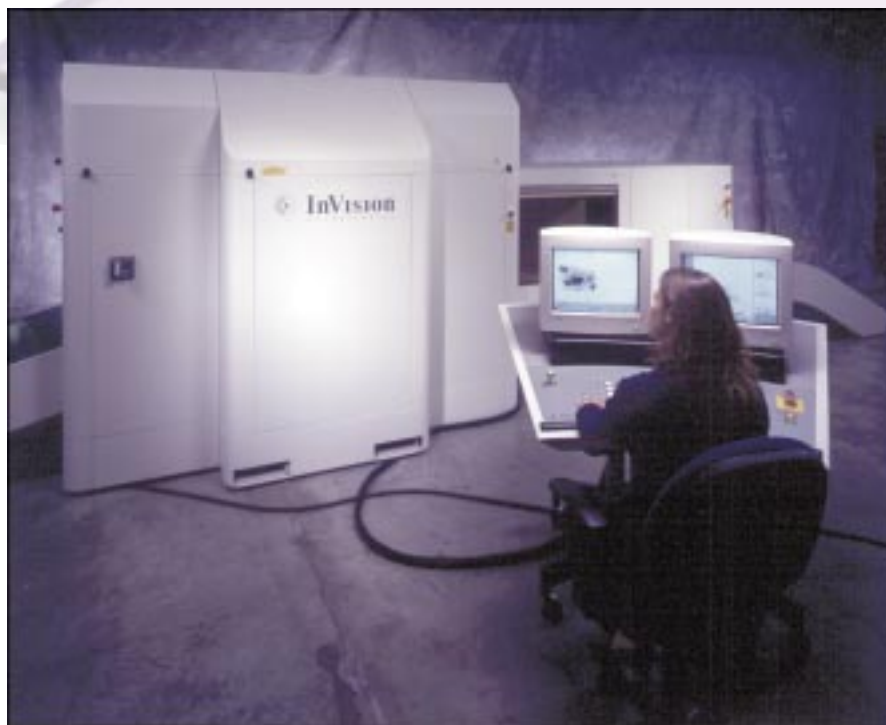


*The FAA's Aviation Security Research and Development facility, at the William J. Hughes Technical Center, includes laboratories used for certifying InVision's EDS.*

## **DEVELOPMENT OF INVISION TECHNOLOGIES' CTX 5000 SERIES EDS**

InVision Technologies was founded in 1990 with the objective of adapting sophisticated Computed Tomography (CT) technology, previously used in the medical field in the form of the CAT scan, to detect explosives. The company worked with the FAA through funding and guidance to develop a scanner that could reliably detect the wide variety of explosives in the quantities that are a threat to the security of civil aviation. In early trials, InVision demonstrated that CT technology was capable of distinguishing explosives from other innocuous items in checked baggage.

In 1994, following 5 years of development, the CTX 5000 became the first EDS to be certified by the FAA. The second-generation CTX 5500, offering a 50 percent increase in baggage throughput with one-half the rate of false alarms, obtained FAA-certification 4 years later. By mid-1998, more than 130 CTX 5000 series systems were sold for installation in airports throughout the world providing the traveling public



*InVision's CTX 5000 examines luggage with both X-rays and computed tomography. Operators are automatically warned when potential explosives are found and they use the interface (foreground) to examine images of the area of concern.*

with the best available security against terrorism. Some of these airports were in countries such as Belgium, France, Hong Kong, Israel, Japan, Malaysia, Netherlands, Philippines, Saudi Arabia, Taiwan, United Kingdom, as well as the United States.

CT's detection capabilities stem from its three-dimensional image analysis techniques combined with powerful automatic detection software. CT technology uses a source of x-rays, rotating around an object, coupled with InVision's proprietary software, to create multiple cross-sectional images. These images, called slices, allow the measurement of each object's density without being influenced by the shape, concealment or proximity of other objects in the

suitcase. Superimposing materials on top of one another, such as layers of clothing and toiletry items, does not hamper its capabilities to detect objects. A concealed explosive will look the same to the CTX 5000 detection software no matter how it is layered among other objects in the suitcase.

The total data from several CT slices are then compiled to create a three-dimensional representation of any threat object, which is then compared to an extensive database of known explosives characteristics. If a bag triggers an alarm, the operator undergoes a "threat resolution" process and is presented with x-ray and CT images, along with threat analysis tools to identify the item.

## TRAINING AND OPERATOR TESTING TOOLS FOR CTX 5000 SERIES EDS

CTX 5000 series operators must be adequately trained and their performance monitored to ensure that the system's capabilities are fully utilized and that acceptable security standards are met. Through the FAA's Aviation Research Grants Program, InVision obtained funding in 1995 to augment its classroom-style training programs. Enhancements included a Computer Based Training (CBT) module and an operational testing program, complete with safeguards to monitor an operator's performance on the job and to correctly link the measured performance to the appropriate operator.

There were three phases to the project. Phase I encompassed the design and development of a multi-media CBT program for CTX 5000 system operators. It culminated in the construction of a Macintosh-based training kiosk comprised of lessons and tests for operators being trained to use the CTX 5000 series. This phase was accomplished through a subcontract with SafePassage, Limited, a leading manufacturer of CBT products for the security industry.

Users of the CTX 5000 series also needed operational drills to ensure peak performance under realistic working conditions. In response, Phase II of the program involved adaptation of CTX 5000 software to display stored images. Threat Image Projection (TIP) software periodically performs this function on screen while the operator scans baggage during the normal course of the day. The operator's response to TIP is monitored and the performance data stored for review and instruction by a supervisor.

In Phase III, X-ray and CT images of baggage packed with explosives were created to provide accurate simulation drills for the operators being trained and tested. The FAA William J. Hughes Technical Center collected over 300 bags containing realistically configured explosive devices, which were then used by the Computer Based Training and the Threat Image Projection operational training programs.



*The Aviation Security Human Factors Program participated in the development of computer-based training for the CTX 5000. Instruction includes both how to operate the CTX 5000 as well as resolving automatic machine 'alarms' to determine whether a potential explosive is actually a concern.*



## CREATING THE NEXT-GENERATION EDS

With the success of CT-based technology to produce FAA-certified explosive detection systems, InVision Technologies and the FAA have continued their partnership to the next logical step: the development of the next-generation EDS. The FAA's Aviation Research Grants Program is contributing funding to develop an evolutionary CTX system that will provide numerous state-of-the-art improvements. These improvements include a larger opening to accommodate larger baggage, even higher detection capabilities and extremely low false alarm rates while operating at a 50-100 percent higher speed than the CTX 5000 system. Not only will this new system improve aviation security, it will also greatly increase the flow of checked baggage onto airplanes, thereby aiding the on-time performance of air carriers.

The new system is scheduled to be field tested at an international airport and to enter certification testing by the FAA in the fall of 1998.

## MEASURABLE SUCCESSES

The partnership between the FAA and InVision Technologies has generated very visible obvious improvements in aviation security. In addition, this partnership is creating further benefits outside the FAA's domain.

Today, InVision continues to be the world's premier manufacturer of explosive and contraband detection systems. It is the only company to offer products that are both FAA-certified and that reflect the knowledge gained from actual day-to-day use in airports throughout the world since 1995. It is translating the knowledge gleaned from its field experience into heightened security for the traveling public and into new applications to satisfy broader security needs -- a testimony to the tangible benefits of the FAA's Aviation Research Grants Program.

### SUMMARY:

*As you can see the Aviation Research Grants Program is focused on the mission of the FAA in continuing to strive for safety, security, and system efficiency for the flying public.*

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