



# DHS SCIENCE AND TECHNOLOGY

## Behavioral Science Research Informing Next Generation Shoe Screening Technology

November 5, 2019

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**Homeland  
Security**

Science and Technology

# Technology Acceptance Evaluation

**Mission:** Aid DHS S&T programs to bridge the technology “valley of death” by providing analysis to understand how organizations adopt (or do not adopt) new technologies.

- Understand how new solutions impact customers and their missions.
- Consider the environment and culture in which technology will be used, including public perceptions.

**Problems Needing Solutions:** Increase the probability of successful technology transition and implementation

**Methods to work with DHS S&T:**

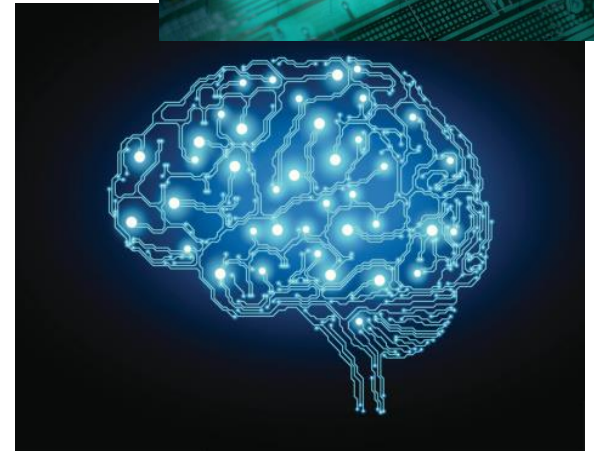
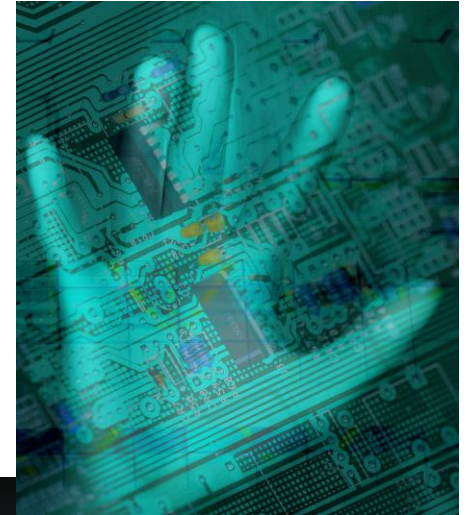
- LRBA <https://baa2.st.dhs.gov/portal/BAA/>
- RFI will be released soon

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# Public Agency Technology Adoption

“It is rarely the complexity of the science that is at the heart of implementation failures, but the lack of understanding as to how organizations operate and interact both internally and with constituents that leads to failure to successfully transition a technology into the organizational context.” Hedge et al. 2015

- Developed a theory
- Organizational Assessments
- Public Perceptions



# Apex Screening at Speed

## Secure, High-Throughput Checkpoint Screening for TSA

**Program Vision:** Apex Screening at Speed is pursuing transformative R&D activities that support a future vision for increasing security effectiveness from curb to gate while dramatically reducing wait times and improving the passenger experience.

### Requirements

- Detect threats at TSA's highest security standards
- Double passenger checkpoint throughput <sup>[1]</sup>
- Extend security architecture beyond the checkpoint
- Reduce number of personal items separated for scanning
  - ✓ No divestiture of outerwear / clothing
  - ✓ No removal of liquids, aerosols, gels, or electronics from carry-on bags

### Results

- Efficiently detect more advanced aviation threats while outpacing the growing population of travelers
- Reduce crowding at checkpoints, lower soft target risk
- Redeploy checkpoint staff to support other critical tasks
- Develop technology applicable to other missions (stadium security, mass transit, etc.)



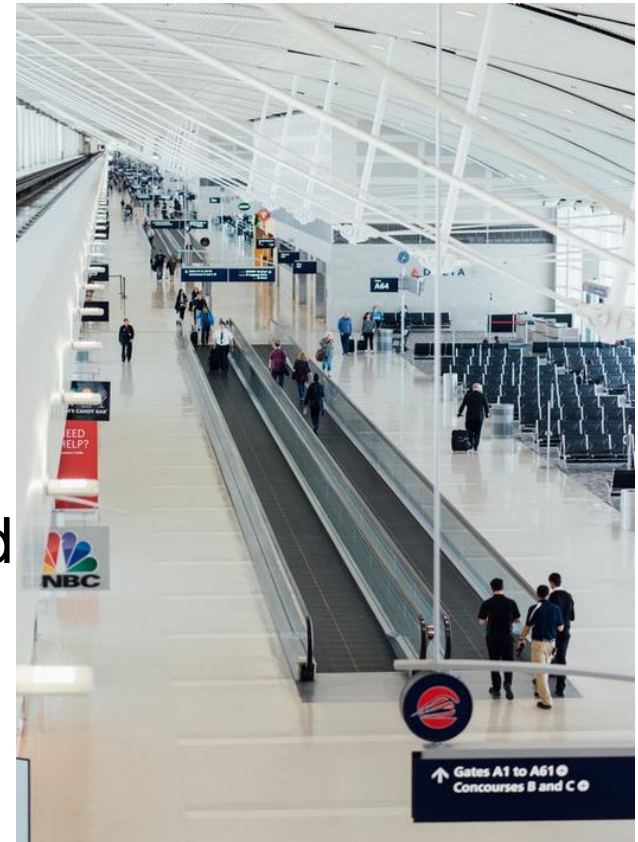
*Artist's concept of future passenger checkpoint*

Security, Speed, and Passenger  
Convenience

# SS-TC Shoe Study

## Desired Outcomes of the Study

- Observational data to support further refinement of a millimeter wave shoe scanner
- Data from TSA and the air traveling public to better understand design, end user requirements, and integration considerations for using a shoe scanning technology at passenger checkpoints



# Instrument Design

## Data Collection Template

### Shoe Observation Sheet

<u>Shoe Style</u>	
Men's Dress Shoes	<input type="checkbox"/>
Women's Dress Shoes	<input type="checkbox"/>
Boat shoes	<input type="checkbox"/>
Boots	<input type="checkbox"/>
Sandals	<input type="checkbox"/>
Flip-flops	<input type="checkbox"/>
Clogs	<input type="checkbox"/>
Slip-on/Loafer	<input type="checkbox"/>
Sneaker	<input type="checkbox"/>

<u>Casual/Dress</u>	
Casual	<input type="checkbox"/>
Dress	<input type="checkbox"/>

<u>Lace-Up/Slip-On</u>	
Lace-Up	<input type="checkbox"/>
Slip-On	<input type="checkbox"/>

<u>Thickness of Sole</u>	
Thin	<input type="checkbox"/>
Medium	<input type="checkbox"/>
Thick	<input type="checkbox"/>

<u>Sole Material</u>	
Leather	<input type="checkbox"/>
Rubber	<input type="checkbox"/>
Other	<input type="checkbox"/>
Don't know	<input type="checkbox"/>

<u>Heel</u>	
Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

<u>Heel Thickness</u>	
Thin	<input type="checkbox"/>
Medium	<input type="checkbox"/>
Thick	<input type="checkbox"/>

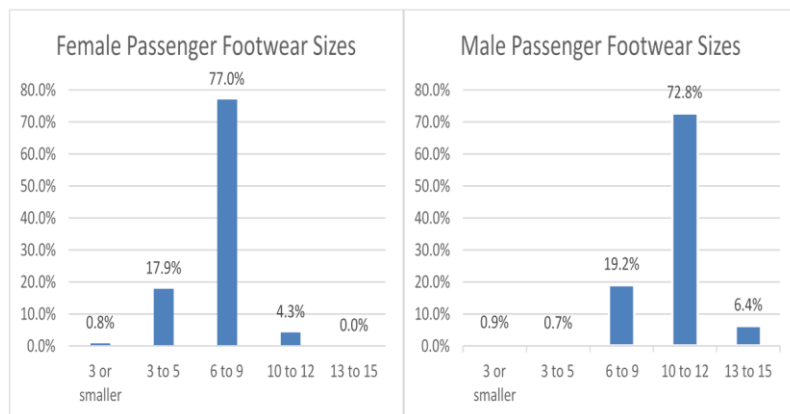
<u>Upper Material</u>	
Leather/Suede	<input type="checkbox"/>
Canvas	<input type="checkbox"/>
Cloth	<input type="checkbox"/>
Plastic/Rubber	<input type="checkbox"/>

<u>SexGender</u>	
Male	<input type="checkbox"/>
Female	<input type="checkbox"/>

<u>Estimated Shoe Size</u>	
< 5	<input type="checkbox"/>
5-7	<input type="checkbox"/>
7-9	<input type="checkbox"/>
10-12	<input type="checkbox"/>
> 12	<input type="checkbox"/>

# Design Considerations

Figure 1. Footwear Size Frequency by Gender



## Footwear Choices and Characteristics

83% -- casual

Style: 35% sneakers; 19% boots; 17% loafers

Closure style: 45% lace-up; 42% slip-on

Upper material: 44% leather/suede;  
24% canvas/cloth

## Sole Characteristics

### Sole thickness:

thin (< .5 in)	72%
medium (.5-1.5 in)	27%
thick (> 1.5 in)	1%

Sole material: Rubber 90%

### Heel Characteristics

77% of shoes had a distinct heel

### Heel thickness:

thin (<.5 in)	24%
medium (.5-1.5 in)	58%
thick (> 1.5 in)	18%

Sole material: Rubber 84%

# Implementation Considerations

- Communication and education/training is critical to gain buy-in from the traveling public and TSA officers
- Traveler/officer trust in the technology is crucial for technology acceptance
- TSA staff need to receive thorough training on the technology before implementation
- Operational testing prior to adoption/implementation is essential; the technology must be easy to use and durable
- Implementation plans must be unique for each airport
- Efficient throughput is biggest consideration for placement
- If the new technology does not improve safety and security, and make the process more efficient and effective then it is not worth the time, effort, and expense.



# Outcomes and Impact

## Outcomes of the Study

- Provided data to support further development and testing of a prototype millimeter wave shoe scanner
- Provided data from TSA and the traveling public to better understand design, end user requirements, and public integration considerations for integrating the shoe screener into passenger checkpoints
- Provided a final report detailing study design, outcomes, and recommendations



# Impact

**SS-TC** provides programs with actionable recommendations based on measures of short and long term success in process, impacts, outcomes, and unintended consequences of technology implementation. This research increases the likelihood of successful technology transition.

