Research on Aviation Security*

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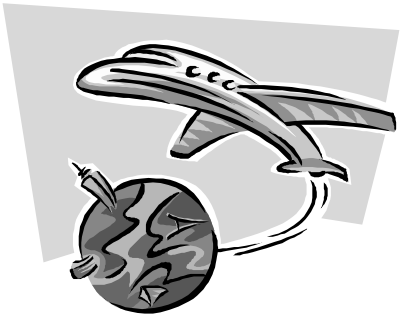

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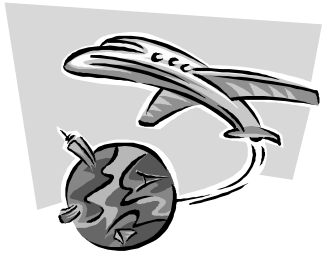

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Project Participants

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Background

¥ Over the past several years, Congress has funded the SEIPT to purchase and install security devices in the nation s airports.

¥ The FAA has deployed these security devices based on experience.

¥ There is a need for a system-wide quantitative approach for making security device deployment decisions.

Background Information on Aviation Security Equipment Deployment

- Airports have several baggage screening security devices.
- Each security device has a capacity limitation.
- Passengers are designated as selectees or non-selectees (determined by CAPPS).
- Each flight has a mix of selectee and non-selectee passengers (i.e., a selectee rate).
- Bags are screened or unscreened.
- Flights are covered or uncovered.

Research Areas

- ¥ Develop performance measures to assess the effectiveness of baggage screening security device deployment strategies.

- ¥ Analyze baggage screening security device deployment strategies using these performance measures.

- ¥ Assess the impact on cost and risk of fully using currently available baggage screening security device capacity.

Aviation Security Performance Measures

Performance Measures quantify the level of effectiveness for a given security system.

Objectives

- Determine when and how different performance measures can be optimized.
- Analyze the relationships between these measures.

Aviation Security Performance Measures (cont d)

Uncovered Baggage Segments (UBS)

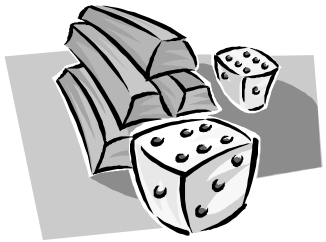
— Number of unscreened selectee bags on each flight

Uncovered Flight Segments (UFS)

— Number of flights carrying unscreened selectee baggage

Uncovered Passenger Segments (UPS)

— Number of passengers on flights carrying unscreened selectee baggage (i.e., number of passengers at risk)



Properties of Performance Measures

- **UBS** captures the overall proportion of unscreened selectee baggage.
- **UFS** and **UPS** measure the effectiveness of the screening choices in terms of uncovered flights and passengers (i.e., at risk), respectively.
- The **UFS** measure generally favors screening selectee baggage from a large number of smaller flights, while the **UPS** measure favors screening selectee baggage from a small number of larger flights.
- **UPS** increases with **UFS**.

Deploying Aviation Security Equipment

¥ Single Airport Problem (Common Selectee Rates)

- ¥ Determine which selectee bags to screen to optimize **UFS** or **UPS** subject to capacity constraints.

¥ Multiple Airport Problems (Common Selectee Rates)

- ¥ Allocate devices among multiple airports.
- ¥ Determine which selectee bags within each airport to screen to optimize **UFS** or **UPS** subject to capacity constraints.

¥ Selectee Rate Analysis

- ¥ Measure the impact of different selectee rates on the single and multiple airport problems.

Deploying Aviation Security Equipment (cont d)

Using the **UFS** and **UPS** measures, a given security system can be modeled in two ways

1) **Integer Program Models** — Each measure is reformulated as an objective function with integer decision variables. The objective is to determine which selectee bags to screen optimize **UFS** or **UPS** subject to capacity constraints.

2) **Knapsack Problem Models** — Each flight is assigned a size (i.e., number of selectee bags on flight) and a value (i.e., number of passengers on flight). The objective is to identify a set of flights so that **UFS** or **UPS** is optimized, while system constraints are satisfied.

Note:

- Knapsack problem models are special cases of integer program models.
- Knapsack problem models provide a suitable framework in which to devise methods for optimizing **UFS** or **UPS** .

Analysis of Fully Utilizing Existing Baggage Screening Security Devices

- Assess the impact on cost and risk of fully using currently available baggage screening security device capacity (e.g., CTX 5500)

- Screening more bags should make the system safer.

- However, screening isn t free;
  - machines wear out sooner,
  - higher operational costs,
  - queueing delays.

Annual Total Cost

$$(C_F/N_{eff}) + C_O + C_I (S_1 + \alpha S_2) + C_{FA}P_{FA} [(1- P_{T|S})S_1 + (1- P_{T|NS})\alpha S_2] \quad 1.2.3.4$$

$$+ C_{FC}P_{FC}[P_{T|S} S_1 + \alpha P_{T|NS}S_2] + C_{TA}(1-P_{FC}) [P_{T|S} S_1 + \alpha P_{T|NS}S_2] \quad 5.6$$

$$+ C_{TC}(1-P_{FA}) [(1- P_{T|S})S_1 + (1- P_{T|NS})\alpha S_2] + C_{FC} P_{T|NS}(1-\alpha)S_2 \quad 7.8$$

1st component :	annual cost of purchasing the device
2nd component:	expected annual cost of operating and maintaining screening device
3rd component:	expected annual inspection cost for the device
4th component:	expected annual cost of false alarms
5th component:	expected annual cost of false clears
6th component:	expected annual cost of true alarms
7th component:	expected annual cost of true clears
8th component:	expected annual cost associated with not screening non-selectee baggage containing a threat (the equivalent of a false clear cost).

Annual Total Cost Decomposition

Payers:

Air Carriers (Direct cost to an airline)	AC
Aviation Industry	AI
Government (Both FAA and non-FAA)	GV
Society	SO

Decomposition:

C_{FA}	3% AC 97% AI
C_{FC}	52% SO 12.8% AC 1% GV 34.2% AI
C_{TA}	3% AC 97% AI
C_F	100% GV
C_O , C_I	100% AC

Probabilistic Analysis

Use the annual total cost function and the distributions of the parameters to compute

- expected annual total cost,
- expected annual total cost per bag screened,
- expected annual total cost per expected number of bags containing a threat detected,
- expected number of threats not detected per expected recurring cost,
- sensitivity (correlations) of total cost to model parameters.

Results

Given current system performance parameters, the marginal improvement in risk does not justify the increased cost of using remaining baggage screening device capacity to screen non-selectee baggage.

Questions?