Aviation Baggage Screening Strategies:
To Screen or Not to Screen, that is the Question

You are an analysis team in the Office of Security Operations for the Transportation Security Administration (TSA), responsible for the Midwest Region of the United States. New laws will soon mandate 100% screening of all checked bags at the 429 passenger airports throughout the nation by explosive detection systems (EDSs; see Figure 1). EDSs use computed tomography (CT) technology to scan checked bags, similar to how CAT scans are used in hospitals. Using multiple x-rays of each bag, EDSs create three-dimensional images of a bag's content, showing the density of each item. This information is utilized to determine whether an explosive device is present. Experimentation with EDSs indicate that each device is operational about 92% of the time and each device can examine between 160 and 210 bags per hour.

The TSA has been actively purchasing EDSs and deploying them at airports throughout the nation. Given that these devices cost nearly $1 million each, weigh as much as eight tons, and cost several thousand dollars to install in an airport, determining the correct number of devices to deploy at each airport and how to best use them (once operational) are important problems.

Currently, manufacturers are not able to produce the expected number of EDSs required to meet the federal mandate of 100% screening of checked luggage. Because of the limited number of EDS machines available, the Director of Airport Security for the Midwest Region (Mr. Sheldon) is not surprised that the TSA is requesting a detailed analysis on the estimated number of EDSs required at all airports. In addition, given the limited space and funds available for each airport, Mr. Sheldon believes that at some point a detailed analysis of emerging technologies will be needed. Promising technologies with more modest space and labor costs will emerge in the coming decade (e.g. x-ray diffraction; neutron-based detection; quadropole resonance; millimeter wave imaging; and microwave imaging).

Task 1: You have been tasked by your Director, Mr. Sheldon, to develop a model to determine the number of EDSs required at two of the largest facilities in the region, Airports A & B, which are described in the Technical Information Sheet (TIS)–Appendix A. Carefully describe the assumptions that you make in designing the model, then use your model to recommend the number of EDSs required using the data provided in Table 1 of the TIS.

Task 2: Prepare a short (one page) position paper to accompany your model that describes the security-related objectives of the airlines and the constraints that the airlines must work within for the sets of flights described in Table 1 of the TIS.

Task 3: Since security screening takes time and might delay passengers, the airport managers at Airports A & B request that you develop a model that can help the airlines determine how to schedule the departure of different types of flights within the peak hour. Carefully describe all the assumptions that you make in designing the model and use your model to produce a schedule for the two airports with the data provided in Table 1.

Task 4: Based on your analysis, what can you recommend to Mr. Sheldon and the airlines about checked baggage screening for the flights during the peak hours at your two airports?

Task 5: Mr. Sheldon realizes that your work may have national impact and requests that you write a memo explaining how your models can be adapted to determine the number of EDSs and airline scheduling for all 193 airports in the Midwest Region. He will send the memo along with the models and the analysis to the Director of the Office of Security Operations (his boss) at the TSA and to all security directors of other airports in the region for their comment and possible implementation.

Additional security measures associated with higher risks may require that up to 20% of the passengers will need to have all their checked bags screened through both an EDS and an explosive trace detection (ETD) machine, even though an EDS is 98.5% accurate in identifying explosive devices in checked bags. ETD machines use mass spectrometry technology to detect minute particles of explosive compounds. Each ETD machine costs $45,000 to purchase, however, the labor cost to operate the ETD machine is approximately 10 times that of the EDS. ETD can process 40 to 50 bags per hour; they are operational 98% of the time, and they are 99.7% accurate in identifying explosive materials on checked bags. At this time, ETD machines have not been federally certified, but Mr. Sheldon believes that they will soon be an integral part of national airport security systems.

Task 6: Modify your EDS models to incorporate the use of ETD machines and determine how many ETD machines are needed for Airports A & B and if the schedules need to be changed. Since this information may affect national level decisions, write a memo to the Director of Homeland Security and the Director of TSA with a technical analysis of this enhanced screening policy. Is the cost of such a policy justified in light of the value that it provides? Should the ETDs replace any of the EDS devices?

Task 7: The Director of Homeland Security must also decide how to best fund future scientific research programs. Use your EDS/ETD model to examine the possible effect of changes in the device technology, cost, accuracy, speed, and operational reliability. Include recommendations for the science, technology, engineering, and mathematics (STEM) research areas that will have the biggest impact on security system performance. Add your recommendation to the memo prepared in Task 7.

Appendix A

Technical Information Sheet (TIS)

Table 1

Peak Hour Flight Departures for Airports A and B

Note: On average, 2% of flights are cancelled each day

Flight Type	Number of Seats on Each Flight	Airport A Number of Flights of Each Type	Airport B Number of Flights of Each Type
1	34	10	8
2	46	4	6
3	85	3	7
4	128	3	5
5	142	19	9
6	194	5	10
7	215	1	2
8	350	1	1

Although all the flights in Table 1 depart during a peak hour, their actual departure times are set by the airline when designing their flight schedule. A flight cannot depart until all its checked bags are screened using an EDS. The airline has the flexibility to schedule their flights during the peak hour to avoid undesirable flight delays due to unscreened bags.

Historical data indicates that flights with 85 or fewer seats typically fly with between 70% and 100% of their seats occupied. Flights with between 128 and 215 seats typically fly with between 60% and 100% of their seats occupied. Flights with 350 seats typically fly with between 50% and 100% of their seats occupied. Passengers typically arrive for their flight between forty-five minutes and two hours prior to their scheduled departure time. For flights other than “shuttle” service, airlines claim that 20% of the passengers do not check any luggage, 20% check one bag, and the remaining passengers check two bags.

Preliminary estimates indicate that it will cost $100,000 to modify existing infrastructure (reinforced flooring, etc.) to install each EDS at Airport A and $80,000 to install each EDS at Airport B.

Figure 1: Explosive Detection System (EDS)