Thirteenth Annual IIE/Rockwell Automation Simulation Contest

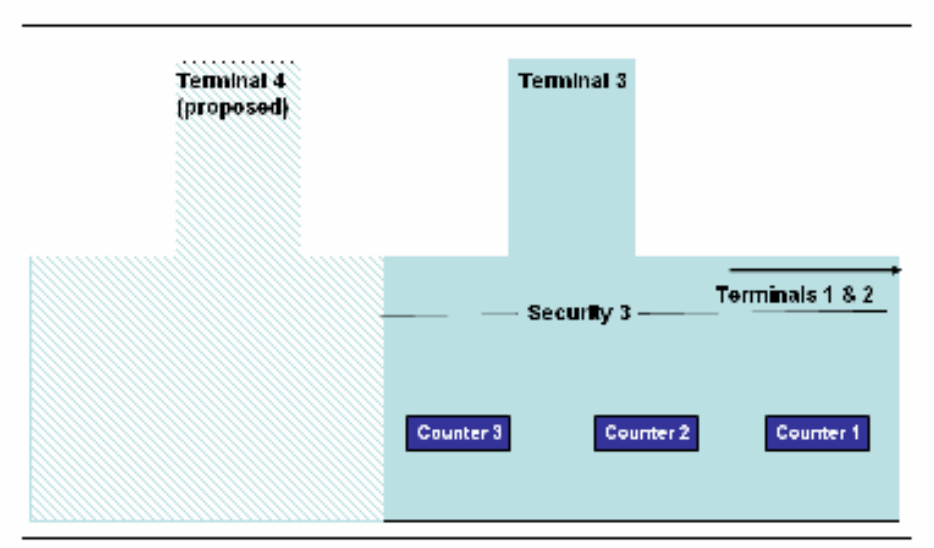
Airport Security by Rockitecture Architects

Background

Rockitecture Architects (RA) is a well known architecture firm with a focus on designing efficient and customer friendly airport structures. In order to thoroughly test their designs, they use Arena simulation software to analyze the flow of travelers through their proposed systems. They learned early on that an exquisite structure can fail miserably from an operational standpoint if the layout is not properly tested. A week ago, they won a bid for the expansion of a major Chicago airport. The project manager for the expansion has assigned your team the task of designing the check-in and security areas.

Current Airport Layout and Expansion Space

A new terminal is being added to the existing airport design. There is just enough space to develop the new terminal adjacent to Terminal 3 (T3). The diagram below depicts the proposed Terminal 4 (T4). A major concern for the airport operations team is the design of the security check-point(s). The security check-points have become major bottlenecks in the system due to increased mandatory security procedures. Currently, each terminal in the airport has its own security check-point. Travelers frequently complain of long lines and congestion in this area. A primary question that RA must answer is whether the new terminal should have an independent security check-point, or a single shared security check-point for T4 and T3. Currently, T3 caters to three major airlines; Fabulous Flights, Premium Planes and Jolly Jets. T4 will service two additional airlines; Wild Wings and Airborne Airlines.



Check-In Process

There are several different types of travelers based on their check-in requirements. Standard customers must go through ticketing and then security. Some airlines designate frequent travelers and first class customers as elite, for expedited treatment. Some airlines allow express passengers without checked luggage to obtain boarding passes early, enabling them to skip the ticketing process.

The ticketing information by airline is as follows:

	Fabulous Flights	Premium Planes	Jolly Jets	Airborne Airlines	Wild Wings
Standard ticketing time*	1,15,45	1,10,30	2,17,35	3,15,30	1,10,35
Elite ticketing time*	1,10,20	1,5,20	NA	1,20,25	NA
Percentage of elite passengers	25%	20%	0%	23%	0%
Percentage of "express" passengers who bypass ticketing	15%	10%	0%	10%	15%
Arrival time recommendation	120 minutes before departure	120 minutes before departure	120 minutes before departure	120 minutes before departure	120 minutes before departure

* Numbers represent minimum, mode, and maximum times in minutes.

Assuming that passengers arrive the prescribed 2 hours before their flights, typical passenger arrival times (passengers per hour) would be as follows:

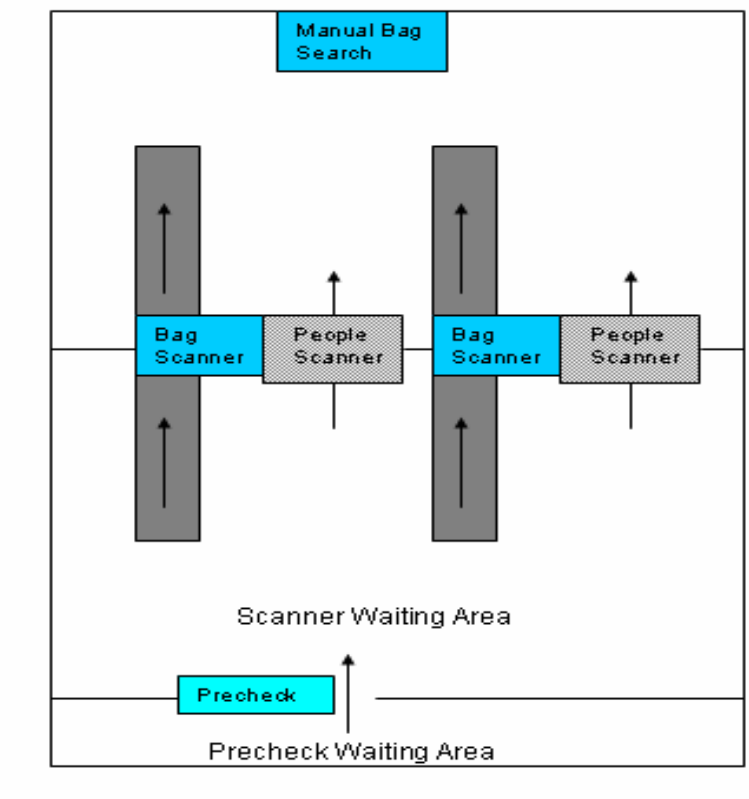
Time of day	Fabulous Flights	Premium Planes	Jolly Jets	Airborne Airlines	Wild Wings
0:00-4:00	0	0	0	0	0
4:00-6:00	393	129	175	0	198
6:00-9:00	375	135	354	150	195
9:00-12:00	156	174	150	144	330
12:00-15:00	156	183	138	153	339
15:00-18:00	153	327	183	345	156
18:00-21:00	165	318	150	303	141
21:00-24:00	90	135	123	0	161

Most airlines have 40% fewer passengers on Saturdays and Sundays, however Jolly Jets specializes in weekend excursions that cause their typical arrivals to double on Fridays through

Mondays. Fabulous Flights and Premium Planes have a 35% and 27% increase (respectively) in their Monday and Friday passenger volume.

Security Process

Before travelers can get to their gate, they have to pass through security. An example of a typical security check-point layout is below. Each security check-point has a single waiting area for precheck, staffed by one or more precheck agents. Each security check-point contains one or more baggage scan machines and one or more people scan machines – usually these are in pairs, but other configurations may be possible. Each security check-point also contains one or more manual bag search stations.



The security process is as follows:

- First, a security officer must check the passenger's boarding pass and identification (Precheck). If these two items are in compliance, the traveler can proceed to the next step. Studies have shown that 96% of travelers have adequate boarding pass and identification. Of the travelers who do not have this information 90% must return to the ticket area to get or fix their boarding pass and 10% of these passengers will have insufficient ID, miss their flight and leave the airport.
- After precheck, the precheck officer will direct the passenger to the scanner with the smallest line. There is limited room for passengers to wait in line for open security lanes. If a passenger does not have room to move into the scanning area, they must wait with the pre-check security until there is room to move into this space. RA must also determine how much space to allocate to the scanner area. Although there is some leeway in the space available, security concerns dictate that each scanner line have no more than 8 people waiting. The current scanner area at T3 security has space for 20 people.
- Next, the traveler must send all their security items through a bag scanner. When it is available, passengers place their hand luggage and loose clothing on the designated bag scanner conveyor. There is room on this conveyor for the bags of 3 people.

- Once their baggage is on the bag scanner conveyor, the passenger can proceed on to the adjacent people scanner. The two scanning processes may occur in parallel. After baggage items have passed through the bag scanner, they move to the delivery conveyor which has room for the luggage of 2 people. If the delivery conveyor becomes full, the bag scanner is delayed. When the bag scanner is occupied, the input conveyor is blocked.
- 8% of bags that pass through the bag scanner machine must be searched manually. There is a separate staff (1 person per machine) that performs all manual baggage inspection. Items waiting for a manual check remain on the delivery conveyor.
- 10% of travelers do not pass the people scanner the first time. These travelers are re-scanned. Typically, all disruptive objects are found after the first re-scan.
- After both scans (passenger and bags) are complete, the passengers are reunited with their bags and passengers can collect their belongings and remove them from the conveyor.
- About 7% of bags are identified as requiring a manual search conducted by a security officer. Passenger and bags move to the manual search area and wait for the search to be completed before being allowed to continue to their gate.
- Once the security process is complete, passengers proceed to their gate.

The security process is pretty standard among airports and some very accurate data has already been collected. It has also been found that adding an extra (standard) security person to a precheck line or scanner to help expedite passengers can reduce the time on that operation by 13%. An extra person added to the precheck line can also expedite selected late passengers to the beginning of the line (a single security person can expedite no more than 30 passengers per hour).

Process	**Process Time (seconds)**
1. Precheck	Min: 7, Mode: 15, Max : 45
2. Place Items on bag scanner conveyor	Min: 15, Mode: 70, Max : 240
3 Bag scanner processing time	Min: 10, Mode: 15, Max : 45
4 People scanner processing time (each pass)	Min: 3, Mode: 5, Max : 7
5. Pick-up bags from bag scanner	Min: 3, Max : 9
6. Manual baggage search	Min: 15, Mode: 90, Max : 120

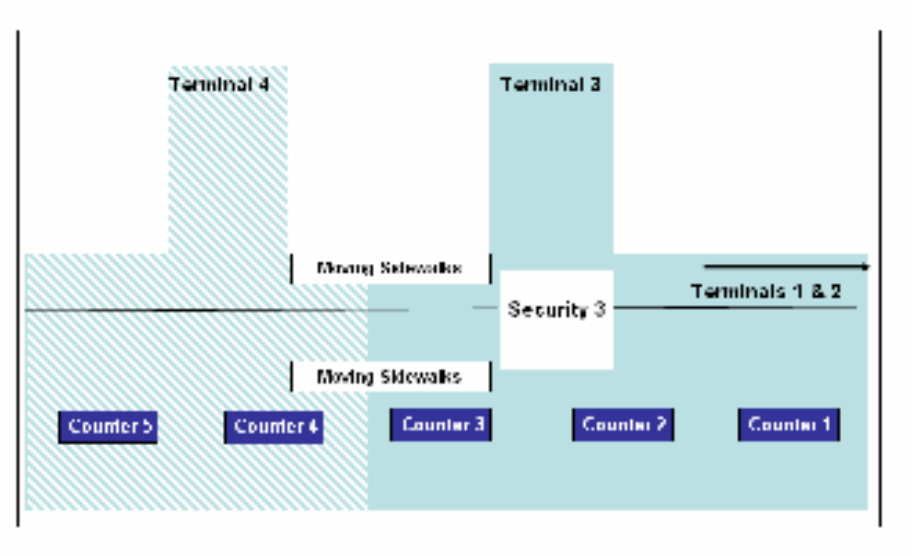
The present security system has the following resources:

Resource	**Constraints**	**Cost**
Standard Security	These people are qualified to do all tasks except staffing the bag scanner.	$18/hr incl overhead
Bag Scan Security	These people are qualified to do all tasks including staffing the bag scanner.	$28/hr incl overhead
Bag scanner	This is the full bag scan system including the conveyors. Scanner must be staffed by at least two qualified people during operation.	$45,000 plus $0.17/scan
People scanner	People scanner must be staffed by at least one qualified person during operation.	$34,500 plus $0.23/scan
Manual bag search	Manual bag search must be staffed by one qualified person per station, but only while a search is in process. Personnel may do other things when not needed for a search.	$800/station

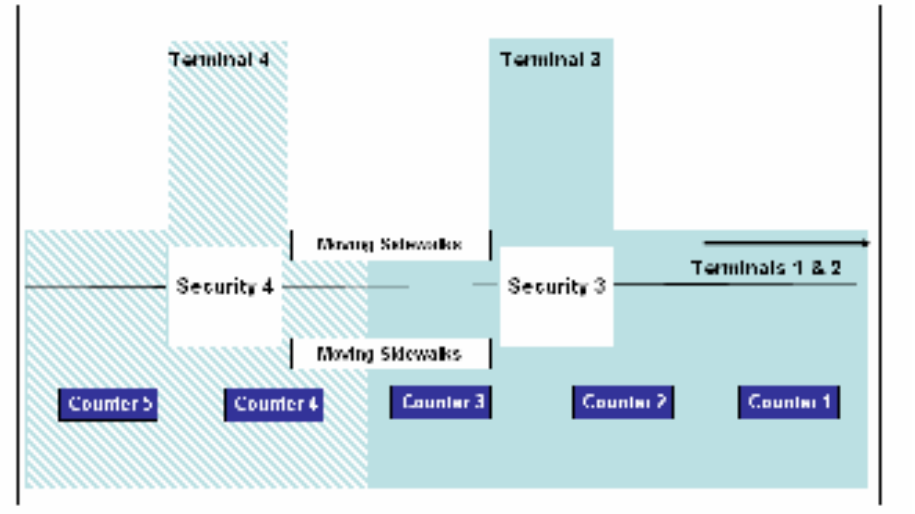
Layout Scenarios

Based on the structure of the expansion space, there are two different layout scenarios that are feasible. In scenario 1, we would expand the current security check-point (Security 3) as needed to accommodate the additional traffic. In the second scenario, we would create a second security check-point (Security 4) dedicated to Terminal 4.

Scenario 1



Scenario 2



Each counter is 50 meters long and 40 meters apart. The entrance to the security checkpoints would be approximately 50 meters directly behind the counters in addition to the lateral travel distance. Passengers generally walk at 40 to 110 meters/minute. The bi-directional moving sidewalks are 110 meters long moves at 40 meters/minute. About 45% of people on the sidewalk stand stationary, while the remaining walk on the sidewalk at 75% of their normal speed. After clearing security, it requires passengers 5 to 16 minutes to travel to their gates. Note that people who are in danger of missing their flights will travel 50% faster.

Project Objectives

You have been asked to assist in the facility design by suggesting alternatives and using simulation to evaluate them. The airport is particularly interested cost effectiveness and customer satisfaction. In addition, they are concerned about the flexibility of the system, because new security regulations and technology are introduced frequently.

Passenger satisfaction is primarily measured by **Security Time** - the time passengers are "inconvenienced" by security. This is measured as the time from when they leave the ticket counter to when they leave security. The standard for Security Time is less than 45 minutes for 90% of passengers and the average for all passengers at less than 24 minutes.

A secondary measure of passenger satisfaction is **Missed Flights** - the percentage of passengers who miss their flights. The airlines would like to ensure that 99% of people who follow the prescribed arrival guidelines will reach their flights the required 15 minutes before scheduled departure.

Cost effectiveness is measured by **Average Cost per Passenger**. Due to wear and technological obsolescence, you can assume that all equipment must be replaced every two years, and that all existing equipment is being immediately replaced.

In order to evaluate the design, you must answer the following questions for both the present system (e.g. Terminal 3 servicing the existing three airlines) and the proposed system (e.g Terminals 3 and 4 jointly servicing 5 airlines).

1. What is the optimal equipment layout and staffing for the present system?
2. How much waiting area should be allocated at each location?
3. Which airline should be located at each counter (does it make a difference)?
4. What is the cost difference if we raise or lower the Security Time standards by 20%?
5. What should the airlines be charged for the service?
6. If we created a priority line through security precheck for elite passengers, how would that impact the performance measures? If we designed that line to attain Security Times that are 20% better than our standards for normal customers, how does that impact cost?
7. What is your recommended arrival time before their flight? Should this vary by airline?
8. Assume that 70% of passengers will respect a recommended early arrival time; the other 30% will cut that time interval by 20-40% (e.g. if you recommend arriving 120 minutes early, 30 percent will arrive only 72-96 minutes before their flight). How does that impact Missed Flights?