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Improving the Passenger Journey

A Systems Approach for Louisville Muhammad Ali International Airport

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LOUISVILLE CASE STUDY

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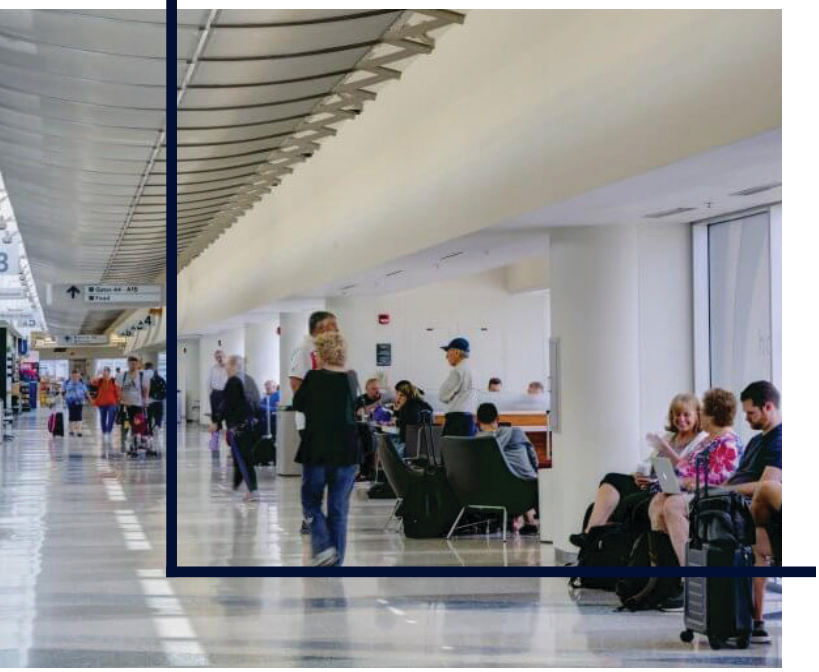
The passenger journey is critical. Despite increasing challenges, passengers expect (and deserve) a stress-less travel experience without sacrificing safety or security.



Passenger Journey Simulations

In 2019, Swanson Rink analyzed the Passenger Security Screening Checkpoint (SSCP) at Louisville Muhammad Ali International Airport (SDF) to determine the right number of checkpoint lanes for passenger load and if additional space would be needed. The study revealed interesting possibilities, but then the pandemic hit.

With the advent of the Covid pandemic, touchless processes and social distancing became pressing concerns, so we returned to the original study and expanded our analysis to encompass the entire passenger journey from curbside to boarding. We investigated new technologies and protocols to identify the most effective means of establishing a safe, secure, journey that is not only touchless and seamless but also cost effective for stakeholders and passengers.

The expanded study focused on reducing queues and time-in-system throughout the passenger journey. We captured metrics that included the percent of passengers processed in less than ten minutes, number of passengers in queue, number of passengers that missed their flights, and the number of lanes or pieces of equipment required to process passengers at each stage in the travel journey.

As the study evolved, we noticed that changes to one subsystem had a material effect on the next stage or subsystem in the passenger journey. Though improvements can be made separately to the ticketing/bag drop area, security screening and ultimately to hold rooms and boarding, the impact to each subsequent stage was undeniable. The entire passenger journey is a singular process made up of many sub-processes.

Managing the Passenger Journey

There are four essential and distinct touch points in the outbound domestic passenger journey where serious queues often arise, and each touch point has several tasks and subtasks as described below.

1. **Departures Hall.** The departures or check-in/ticketing hall is the first place passengers encounter transit processing. Our first improvement was to add free-standing kiosks and automated self-bag drops at existing counter positions.

2. **Security Checkpoint.** While there have been several recent changes at TSA Security Checkpoints, we employed a comprehensive approach that includes: automated screen lanes (ASL) where several passengers can divest and recompose at the same time; CT scan of property; Advanced Imaging Technology (AIT) for passenger scans; and biometric validation.

3. **Lounge/Concessions.** This is the conventional hold-room space. It may not seem like a process, but it is necessary to provide a space where passengers are staged for boarding. We considered concessions, full-service restaurants, restrooms, and dedicated lounge space; the challenge is providing a suitable level of service within the allocated space. Passenger experience and safety are dependent on having sufficient room for waiting.

4. **Boarding.** The final step is actual boarding, which includes boarding pass validation and using the Passenger Board Bridge with queues for each. Improvements include using auto boarding gates with biometric validation and virtual queueing.

Challenges to Simulating How People Move

People are constantly in motion, and human behavior is hugely unpredictable. The natural environment of the passenger journey is also constantly changing. People react to crowds, weather, bad information, etc., which makes conventional discrete fixed metrics useless.

We can document the number of people in queue at the security checkpoint but that says nothing about the actual capacity of the checkpoint. What about such impacts as how fast can passengers divest, or what are the analysis capabilities of the TSA agent at this station? Further, how do situations at the checkpoint affect what happens at restaurants and hold-rooms on the concourse? Queue size is only one metric, and it doesn't begin to describe the dynamic nature of the process.

In statistical terms, all events making up the passenger journey are time-dependent, non-linear, pathdependent, and unpredictable. Spreadsheet analysis doesn't work even using Monte Carlo techniques where random variables are inserted in static models and run multiple times. While Monte Carlo simulations can help investigate the impact of risk and uncertainty, the dynamic nature of the passenger journey flow can only be captured effectively using robust simulation tools.

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The Passenger Journey Simulation Study

This study was structured to improve an existing baseline condition. The first step was to establish the baseline to represent existing conditions and validate that configuration and assumptions. The steps that followed added improvements that make the passenger journey better.

BASELINE: EXISTING CONDITIONS

The baseline for our study was the average day peak month (ADPM) 2019 flight schedule for SDF. The operating environment assessed includes the number of gates, airlines, checkpoint lanes, and ticketing/bag drop positions. Assessment of the pre-pandemic arrangement is a credible baseline.

In 2019, the SDF check-in process included conventional ticket agent positions, with bag drop performed manually by an airline attendant. All passengers using the check-in hall are currently processed separately by each airline at their dedicated ticket counter. Passengers who do not check bags can check in online and proceed directly to security screening. American Airlines passengers have the option of using ticket counter kiosks, though Southwest and Delta Air Lines passengers can also use two curbside check-in positions.

TSA checkpoint in 2019 included three Travel Document Checker (TDC) podiums, two dedicated to non-pre-check passengers, and one for pre-check passengers. The pre-check position can also process non-pre-check passengers when no pre-check passengers are present. There are four screening lanes for non-pre-check passengers and one dedicated pre-check lane. Non-pre-check passengers are screened using an Advanced Imaging Technology (AIT) body imager for full body scanning. Pre-check passengers use a walk-through metal detector. There are five stations to conduct secondary screening of passengers and their belongings.

Gate hold rooms are a conventional configuration with rows of seating and a boarding podium. There are 11 gates on each of the two concourses with center corridor walkways with gates on each side.

Promising Technologies

We investigated several encouraging technology and protocol improvements:

1. Add freestanding ticketing and bag tagging kiosks.
2. Replace baggage induction with automated self-bag drops.
3. Replace existing Security Checkpoint lanes with full TSA Checkpoint Property Screening System (CPSS) including biometric validation capabilities, CT scan of carry-on baggage and automate lanes (ASL).
4. Provide Common Use assignment technology for bag drop/ticketing.
5. Provide Common Use for gate assignment.
6. Use virtual queuing with self-boarding gates, which means metering passenger flow to the passenger boarding bridge and then to the plane.
7. Use biometric recognition throughout the passenger journey.

Each technology offers significant improvement by expediting the process, making the process touchless, or both. We gathered data for the entire journey for each alternative, and metrics included dwell time, percent of passengers processed in 10 minutes or less, maximum number of people gathering at each gate-hold, number of passengers who missed flights, size of queues, and total time from curbside to gate. Ultimately, we identified five improvements having the greatest potential impact on the overall passenger journey at SDF and identified the number of touch points or lanes required.

The study combined the five promising improvements by sequentially adding them as they would appear along the path of the passenger journey. The first set of improvements are retained, and others are added. The first three improvements affect the areas with the most congestion: ticketing/bag-drop and TSA passenger screening. The last two address passenger congestion at gate hold-rooms and boarding.

1. Add freestanding check-in kiosks for all airlines and bag drops at ticket counters, replacing one-half of ticket counter positions.
2. Convert TSA checkpoint into full Checkpoint Property Screening System (CPSS) using the same number of lanes.
3. Add Virtual Queueing ("just-in-time" boarding notification) with auto boarding gates. This results in smaller gate hold areas and more open area for passenger services.
4. Add Common Use at departures hall counters.
5. Add Common Use airline gate assignments.

THE IMPACT OF THESE IMPROVEMENTS ON BOTH PROCESSING TIME AND PASSENGER DENSITY:

	Time at Checkin			Time at Checkpoint			
	Mean	Max	% in 10 Min or Less	Mean	% in 10 Min or Less	Max Pax in Queue	% Pax Miss Flights
Baseline (Existing Conditions)	3.9 min	40.8 min	92.0%	10.4 min	61.7%	160	3.0%
Check-in: Add Self-Service Kiosks & Auto Bag Drop	1.7 min	31.6 min	98.7%	11.2 min	62.7%	227	2.3%
Check-in + CPSS	1.7 min	32.3 min	98.4%	4.3 min	96.3%	60	0.4%

RESULTS

*By improving check-in/bag drop, the **mean time per passenger is cut by more than half** and the maximum time reduced by 10 minutes. Furthermore, almost all passengers that need to check bags or need assistance are through within 10 minutes. Security screening statistics are equally striking: the **queue at the checkpoint goes up over 40%** from 160 passengers to 227!*

*Also notable is that as the check-in/bag drop improved, the **queue at the checkpoint is reduced by 62%** and **passengers missing flights is reduced by over 86%**. Clearly, the passenger journey from check-in to the gate has improved significantly.*

Improvements at the Concourse and Gate Hold Areas

It is obvious that fixing one problem in isolation only pushes the problem down the line; with improvements at only check-in queues, security screening queues only get worse. When security screening and check-in operations are improved, gates get more crowded. In this case the area available for passengers at the gates on average is reduced by 7.6% and the concourse by 5.5%. Certain gates already packed at peak times, are worse.

	PAX Density - Gateholds		PAX Density - Concourses Overall	
	Max PAX	SF / PAX	Max PAX	SF / PAX
Baseline (Existing Conditions)	824	36.4	1020	79.9
Check-in: Add Self-Service Kiosks & Auto Bag Drop	856	35.0	1033	78.9
Check-in + CPSS	894	33.6	1079	75.5

VIRTUAL QUEUING

One encouraging option is to employ virtual queuing at the boarding gates. This option assumes using auto boarding gates and density measurement in the boarding bridge tunnel. By adding virtual queuing the area per passenger more than doubles (36.4 to 73.7 sf/passenger) and improves more when common use at check-in is employed, as shown in the following table.

	PAX Density - Gateholds		PAX Density - Concourses Overall	
	Max PAX	SF / PAX	Max PAX	SF / PAX
Check-in + CPSS + Virtual Queuing	407	73.7	1085	75.1
Check-in + CPSS + Virtual Queuing + Common-Use Check-in	405	74.1	1073	76.0

Virtual queuing for boarding has significant potential and needs further exploration to effectively reduce passenger density at the gate hold and on the boarding bridge.

COMMON USE GATE ASSIGNMENTS

Another option is to employ common use for gate assignments. Though not popular with airlines, this strategy could free up gates and balance loads, which would further reduce density at the gates and concourses.

	PAX Density - Gateholds		PAX Density - Concourses Overall	
	Max PAX	SF / PAX	Max PAX	SF / PAX
Check-in + CPSS + Virtual Queuing +Common-use Gate Assignment	421	71.3	1082	75.3

These improvements could make it possible for passengers to spend more of their post-Security time comfortably waiting for their flight. The wait does not have to be stressful.

Observations that Impact the Passenger Journey

AUTO BAG DROP AND COMMON USE CHECK-IN

It may also be possible to reduce the total number of bag drop positions and checkpoint lanes, which frees up space for other functions. Replacing ticket counter positions by using auto bag drops reduces the number of check-in positions required and common-use check-in reduces the requirements even more.

	Number of Positions		
	Koisks	Auto Bag Drop	Ticket Counter
Baseline (Existing Conditions)	6	n/a	24
Check-in: Add Self-Service Kiosks & Auto Bag Drop	8	12	5
Check-in: Kiosks & Bag Drops + Common-use	6	10	4

CPSS CHECKPOINT

In the CPSS checkpoint, we see increase throughput for the day shown in the table below. It also substantially reduces the need for the fifth checkpoint lane and is only used during the morning peak with CPSS improvements in place. This means fewer full-time or even part-time employees are needed and shows that the passenger journey can be improved without adding floor space to handle large queueing demands. Note that the fifth lane usage drops by two-thirds with CPSS while the other lanes are more effective in their processing.

	% of Total PAX per Checkpoint Lane				
	1	2	3	4	5
Baseline (Existing Conditions)	19%	27%	24%	22%	9%
Checkpoint: Add CPSS (all lanes)	21%	32%	25%	20%	3%

Summary of Findings

Our study shows that queues at check-in and checkpoint are virtually eliminated. Future passengers will not need to arrive two to three hours before flight time to avoid missing their flight. The time spent by passengers at the airport means less standing in line and more actively using airport services. It does not necessarily mean less concessions revenue.

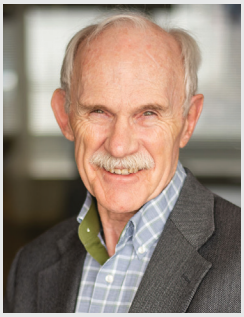
The Recommendation

This innovative systems approach creates a roadmap for future capital expenditures. When the entire passenger journey is analyzed, priorities can be established that identify which improvements have the best return on investment (ROI). The roadmap can also be updated as flight information and technologies change, which makes responses to future improvements nimble and cost effective.

By right-sizing the process, the passenger journey can be made safer, more efficient, and more attractive to passengers while reducing airport resource costs and avoiding unnecessary capital investments for the airport and its stakeholder airlines.

** Notes: Andrew Weigel, PE (Swanson Rink) was responsible for designing, developing, and executing the simulations used in this study. Louisville Muhammad Ali International Airport graciously provided data and consultation throughout the study and is currently evaluating options as they proceed with terminal wide improvements. Alliiance, the Architect working with SDF provided consultation throughout the simulation process. Materna IPS provided operational information on auto bag drop, self-boarding, biometrics, and common use applications. Point.FWD, a security and checkpoint consultant from the Netherlands provided data on checkpoint operations. Additional information was provided by Vanderlande and Analogic on the CPSS operation.*

CONTACT THE AUTHOR



Airlines and airport operators need to look beyond conventional data to embrace a systems approach that transforms and improves the passenger journey. Stephen W. Bennett, PE, Senior Vice President Aviation Services, has more than 40 years of experience in airport systems, and regularly shares his expertise to improve the aviation industry. Contact him at 303-832-2666 or sbennett@swansonrink.com.

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