BOS Terminal C Flow Optimization

Design Team
Patrick James, Caitlin Kenney, Nicole Labo
Alex-Kathryn Reeh, Christopher Wishon

Design Advisor
Professor Beverly Jaeger

Abstract
jetBlue Airlines, one of the largest domestic carrier providers, is located within Terminal C at Boston Logan International Airport and is currently expanding the number of daily flights offered. As a result, increased customer traffic throughout Terminal C has led to congestion, impeded flow, and customer movement issues for Massport, the organization responsible for airport traffic management. Through a sponsor-based needs assessment, multiple observations and interviews, review of literature search topics, data collection and analysis, the development of a simulation model, and sensitivity analyses, three multifaceted solution stages have been developed. jetBlue currently shares Terminal C with United Airlines, AirTran and Cape Air; however that occupancy profile is preparing to undergo significant modifications according to a set of multi-phase reconfiguration proposals. The first stage is the state of Terminal C in June 2011, with the addition of 14 self-service kiosks and 15 ft in front of the jetBlue ticket counters, as well as a new security checkpoint. The second stage relocates AirTran and Cape Air, allowing jetBlue to utilize this existing counter space. Finally, the third stage relocates United Airlines, allowing jetBlue to fully occupy the terminal. Each solution includes recommendations for crew member staffing, adjustments to the physical layouts of the jetBlue bag drop and full service counters and queues, the reorganization of the self service kiosk system, as well as the reallocation of existing counter space within the terminal. Additionally, from studying the effectiveness of existing terminal signage, a wayfinding component has been developed to ensure the efficient flow of customers.

The Need for Project

(For additional information, please contact Prof. Jaeger, bkjaeger@coe.neu.edu)
Massport needs multiple layout and system redesign solutions to address the congestion issues within BOS Logan Terminal C. In late 2010, jetBlue announced and began the progressive expansion of daily Boston flights, increasing the volume of customers traveling throughout Terminal C. Consequently, the increased volume of customers has created queuing and congestion issues for Massport. Customer volume surpasses the bag drop queue capacity and intersects with kiosk queues, blocking the full service queue entrance. These intersecting paths result in hot spots (areas of extreme congestion), decreased flow, and unnecessary confusion for customers as they try to navigate the terminal. Massport requested that the project address the potential effects of relocating United, Cape Air, and AirTran out of Terminal C, resulting in a multi-stage solution set. Each stage includes crew member staffing recommendations, redesign of jetBlue service layouts, and the review of existing wayfinding signage.

The Design Project Objectives and Requirements

**Design Objectives**

The objective of this project is to develop multifaceted solution sets that reduce congestion and confusion of customers for each of the three stages. For all stages, the solution layouts were developed by creating a simulation, performing sensitivity analyses, determining optimum crew member staffing, and then creating layouts and applying wayfinding techniques.

**Design Requirements**

Each stage must alleviate queuing congestion and hot spots (areas of customer flow congestion) within Terminal C, not create additional congestion, and conform to the current space available. Therefore, customer check-in queues must not create fire hazards by blocking exits, nor can they block surrounding businesses or other airline queues. Additionally, customers must be able to enter and exit the queue with up to two bags per customer without blocking the queue.

Finally, the misorientation factor, how often a customer experiences a delay due to lack of direction or signage, will also be addressed in each solution. Way-finding techniques will be used to reduce the number and amount of times customers are forced to stop and ask for directions or to locate a sign.

**Design Concepts Considered**
The design team considered spreadsheet modeling, queuing theory, simulation, various wayfinding techniques, levels of service, and different types of queuing to alleviate congestion within Terminal C.

Through extensive research, several engineering techniques for the development of multifaceted solution sets were considered.

**Terminal Planning**

Designing an airport terminal requires buildings to handle peak loads of passengers, while maintaining a specified level of service and alleviating terminal hot spots. Data collection, simulation, and queuing theory are used to design terminal layouts to meet these requirements.

While construction and design of the terminal from the ground up was impossible for this project, the team conducted extensive data collection and analysis, identified terminal bottlenecks through the use of Flow Planner and AutoCAD, and created a simulation model to design the multifaceted layout solutions for each stage. Massport and jetBlue did not provide levels of service and, therefore, the solutions do not include this metric.

**Visual Factory/ Wayfinding**

A variety of visual instructions and techniques are used in airports to direct traveling customers to their desired destinations. Customers rely on the spatial organization of terminal services, landmarks, signage, directories and maps to guide them through the terminal. Therefore, properties of signage, such as content, font size, color, spacing, location, and orientation, influence effectiveness of the information and the usability by the customer. These elements were incorporated in the redesign and placement of Terminal C signage.

**Existing Airport Data Distributions**

_Earliness of arrival_ distributions describe the temporal pattern and percentage of passengers that arrive at various time intervals prior to scheduled flights. This data, combined with flight schedule, aircraft type, and load factor data, is used to estimate the number of customers within the terminal at a given time interval. Spreadsheet modeling, queuing theory, and simulation can then be used to evaluate the system. An Arena simulation model was developed to evaluate this system.

Additionally, two types of queues are used within airports. The first involves one queue which serves all servers of one resource. This is the current queuing system for the bag drop and the full service counters. The second has a dedicated queue for each server position. This is the current queuing system for kiosks.

**Recommended Design Concept**
Three different solution phases were developed to accommodate the airline relocation options. (1) Design Description

Solutions for each stage have been developed using data that has been collected, analyzed, and validated, a comprehensive simulation model, and a series of sensitivity analyses. The identification and evaluation of layout hot spots was also conducted to determine points of congestion. Finally, a review of wayfinding signage design and placement was performed to identify needed changes with regard to minimizing customer confusion and fostering efficient passage through the terminal.

The first phase addresses the state of the terminal as of June 2011 with the following approved modification: The jetBlue counters will be pushed back 15 ft, creating additional queuing space in front of the counters, and six new server stations will be added. Further, 14 kiosks will be added to manage the expanded flight schedule and alleviate kiosk queues. Finally, a new security checkpoint will open behind the jetBlue counter area. The solution set for phase one includes the redesign of the bag drop and full service queues to incorporate the additional space, staffing optimization and server allocations, redesign of the kiosk layout, and wayfinding solutions.

The second phase involves AirTran and Cape Air relocating to another terminal. These counters would be reassigned to full service, while the existing jetBlue counters would be assigned to bag drop. Redesigns of the queues would occur, as well as reconfiguration of the kiosks in front of the bag drop queue. Further, an optimized staffing plan and wayfinding solutions will be provided.

The third phase involves the relocation of United to another terminal, allowing jetBlue to occupy all existing terminal counters. Full service would move to the United counter area, as it has the most up-to-date baggage handling system. Bag drop would remain on the back wall with the same queue and kiosk configuration as phase two. The AirTran and Cape Air counters would be dedicated to international check-in services. An optimized staffing plan and wayfinding solutions will also be provided.

(2) Analytical Investigations

Data for the simulation scenarios, including earliness of arrival, service times, transfer times, path distributions, and group sizes, was collected over various observations. The flight schedule was provided
by Massport and used to predict demand during critical time intervals. Data was collected through surveying, measuring, and tracking customers as they moved throughout the system.

(3) Experimental Investigations

The team was able to run multiple simulation scenarios with regards to number of servers at bag drop and full service, as well as number of kiosks to determine the effects on queue size and customer wait time. As a result, an optimal staffing schedule and server allocation was devised for each phase.

(4) Key Advantages of Recommended Concept

The three solution phases provide Massport with viable alternative layouts that alleviate customer congestion and confusion as the terminal transitions and changes. All phases can be easily implemented without changing the physical integrity of the building.

Financial Issues

The cost of airlines relocating from Terminal C and of new terminal signage is dependent on the contracting firm hired by Massport for the job. The relocation of airlines within the terminal and the cost of redesigning the signage are immediate costs that Massport will need to address. All airlines within the terminal lease the space from Massport and, as result, Massport must negotiate with the airlines if they wish to change the contract. For proprietary reasons, this information is unavailable at this time. Further, the cost of overhauling the signage is unknown at this time, as Massport contracts this work to a third party. The cost is dependent on the rates charged by independent contractors and could vary dramatically depending on the firm selected for the job.

Recommended Improvements

The system will continue to change as jetBlue grows and will need to be adjusted accordingly to accommodate customer demand. The improvements for this project are part of an ongoing, iterative process, as outlined by the multiple stages presented. Based on these stages and recommended improvements, the results of our study show that the bag drop maximum queue will reduce by 75%, while full service will reduce by 33% overall. Additionally, the total feet squared allotted per customer doubled from 23.6 ft² to 49.9 ft².