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Using Simulation to Evaluate Impacts of Airport Security

2003 Simulation Workshop

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TRB website:
www.trb.org

Transportation Research Board
500 Fifth Street NW
Washington, DC 20001

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Introduction

This TRB E-Circular documents the proceedings of the workshop, Using Simulation to Evaluate Impacts of Airport Security, held on January 12, 2003. The workshop organized jointly by the TRB Committee on Critical Transportation Infrastructure Protection–Subcommittee on System Integration and Management/Architecture (A5021-2), and the Committee on Airfield and Airspace Capacity and Delay (A1J05), and co-sponsored by the Committee on Airport Terminals and Ground Transportation (A1J04). The primary objective of this workshop was to present, demonstrate, and discuss the passenger and baggage screening simulation techniques used to comply with the Transportation Security Administration's (TSA) congressional mandate to implement the new airport security measures stipulated by the Transportation Security Act of 2001 to all U.S. commercial airports.

The workshop was a hands-on, two-way discussion, interactive activity aimed at providing a better understanding of how simulation techniques could be employed to evaluate impacts of the TSA security requirements for passenger and baggage screening on airport operations performance and terminal space requirements. Presentations and ensuing discussions facilitated the coverage of the scenarios, constraints, techniques, performance measures, data requirements, and other intricacies encountered in adopting the simulation approach to evaluate the impacts of the new TSA security mandates on airports. Technical details, data requirements, analysis methods and results from case studies were discussed and demonstrated, highlighting the pros and cons, as well as constraints and cost-effectiveness of utilizing simulation in this critical aspect of air transportation.

The workshop was truly interactive where a panel of experts comprised of government security experts, architects and airport planners, software developers, simulation analysts, airport managers and airport consultants presented their collective experience. Ensuing discussions covered assumptions, simulation logic, data requirements, management of databases, modeling approaches and analytical techniques, practical considerations of airport terminal space planning, and findings and conclusions vis-à-vis utilization and implementation of simulation for such a critical and sensitive task.

Saleh A Mumayiz, Editor
Chair, Subcommittee on System Integration and Management/Architectures–Critical Transportation Infrastructure Protection (A5021-2)

James M. Crites
Chair, Committee on Airfield and Airspace Capacity and Delay (A1J05)

Jody Yamanaka Clovis
Chair, Committee on Airport Terminal and Ground Access (A1J04)

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Airport Operations Perspective

JAMES M. CRITES
Dallas/Fort Worth International Airport

The ATSA Public Law 107-71 that was passed in November 2001 identified a series of security requirements for all modes of transportation. To comply with ATSA requirements for airport security measures, Dallas/Fort Worth International Airport (DFW) assembled a team of consultants to provide best solutions for the airport.

Under ATSA requirements, two major near-term security measures were related to the aviation industry, with deadlines for compliance:

1. Passenger checkpoint screening by November 31, 2002; and
2. Checked baggage screening by December 31, 2002.

The TSA assumed the responsibility for aviation and transportation security and implementing all security measures identified in ATSA. This presentation provides the airport operators' perspective to this major effort.

Implementing the TSA requirements by the deadlines presented airport operators with several challenges. These include overcoming issues related to

- Establishing a new airport security organization.
- Hiring qualified personnel.
- Developing approaches to satisfy ATSA's operation requirements.
- Implementing solutions at 429 airports in the United States:
  - Developing approaches and solutions for all airports;
  - Modifying, redesigning, and constructing facilities;
  - Procuring equipment; and
  - Hiring and training personnel.
- Identifying and securing required resources.
- Providing the information and personnel to succeed.

In order to successfully address the problem and comply with the deadlines required resources, information, and personnel had to be identified. First, the problem has to be classified vis-à-vis passenger and baggage processing and the tools required to rapidly formulate solutions with the context of queuing theory and simulation modeling techniques. Second, information is obtained on passenger and baggage arrival rates, equipment processing rates, screening protocols, and the measure of effectiveness (the 10-min impact rule). Third, a task force team is assembled, engaging personnel from operations research (OR) specialists, airline as well as airport professionals.

The outcome of this effort indicated that providing interim solutions with mitigating measures employed to conduct screening helped in the overall effort, effectiveness of OR specialists engaged in the analysis, and the direct involvement of airlines and airports on the team in the development and implementation of ATSA measures at airports. While a good deal was accomplished on passenger screening in airports, much is left to be accomplished later, mainly perimeter security, cargo/mail screening, and integrating information systems for passenger processing within the myriad of operations information systems existing in airports.

Click here to see Crites' Powerpoint presentation.

Airport Security
Transportation Security Administration Perspective

CLINT FISHER
Transportation Security Administration

THE BEGINNING

Aviation and Transportation Security Act

In November 2002, President Bush signed into law the ATSA creating the TSA. With the new law came the TSA mission to protect the nation's transportation systems to ensure freedom of movement for people and commerce. And it has dramatically changed the prevailing attitude towards transportation security in the air, on the sea, on the highways, and through our nation's pipelines.

ATSA directed the U.S. Department of Transportation (USDOT) to build a new security agency starting essentially from scratch—an agency with more people than the Federal Bureau of Investigation (FBI), the Drug Enforcement Administration, and the U.S. Customs and Immigration Service (USCIS) combined—and to get it done in the next 365 days. And so that effort has had our full attention this past year

Department of Transportation Role

Falling under the auspices of the DOT, the new agency received the unwavering support of Secretary Norman Y. Mineta and Deputy Secretary Michael Jackson. Recognizing its future role in the new post-September 11, 2001 (9/11), environment, Secretary Mineta said, "We are building the TSA so that it may serve as the core for President Bush's new Department of Homeland Security (DHS)." Clearly, he saw where the president was heading in the protection of America's transportation systems and the fight against terrorism.

DHS provided the space and the initial budget to get TSA's first handful of employees rolling. Still, TSA was being built from the ground up.

World-Class Security and World-Class Customer Service

This is important work to hold the balance both the president and Secretary Mineta demand: world-class security and world-class customer service.

EARLY DAYS

Go Teams

The first few months after the act was signed were a time of intense planning and light-speed organization. The fledgling TSA consisted of a collection of "Go Teams," each with a specific focus on a portion of the massive transportation security picture. There were groups developing passenger and baggage screener training programs, screening technologies, and security policies—while other teams were scrambling to build the agency infrastructure.

Private Sector Firms

Thus we did quick, comprehensive, and fully open procurements, that added six terrific private sector firms to the larger TSA team: NCS Pearson for screener recruitment; Lockheed Martin for screener training; Boeing–Siemens for explosive detection deployment and maintenance; Lockheed Martin for roll-out coordination and checkpoint construction; Unisys to manage deployment of core information technology (IT) tools; and VF Solutions to get the right uniforms to the right people at the right time. Each of these firms—and many others who have helped along the way—made it possible to meet the Congressional mandates successfully.

Early Office Environment

Our "veterans" (whose employment goes back to January or February) can tell stories of sharing a desk in a bullpen, splitting time with co-workers on a telephone and computer, bringing personal office supplies in to work, and getting paid with a handwritten check. Amazing progress has been made since those early days.

The first federal passenger screeners graduated from training classes and took their posts at a Baltimore–Washington International Airport security checkpoint in April 2002.

CURRENT STATUS

50,000 Employees

Like a high-performance vehicle, we have gone from zero to over 50,000 employees in the past year, but mostly in the last few months. When we met our congressional deadline on November 19, 2002, to federalize passenger screening, we met it by placing over 45,000 hand-picked, well-trained, and deeply committed screeners at 429 commercial airports across the country.

Congressional Deadlines

As you may know, Congress set down 36 mandates when it created the TSA. The skeptics insisted we couldn't create the TSA and have federal passenger screeners fully deployed by November 19, our first anniversary. We proved the skeptics wrong. We have met all 36 mandates—on time, within tight budgets, and under constant public scrutiny.

MOVING FORWARD

Changing Focus to Include All Modes of Transportation

Further, our initial concentration was on aviation security. Given the terrorists' means of delivery, the president's immediate concern was to secure the nation's airways. But TSA's security concerns cross all modes of transportation.

We're focusing more intently on the vulnerabilities of the 95,000 mi of open coastline and the 361 ports in the United States. We're also looking towards securing the railway systems across the nation. The FBI's warning this fall about a heightened threat against railways has been a constant reminder of that susceptibility. We are constantly looking for and examining new security technologies, new policies, and new approaches to threat mitigation for the nation's transportation systems.

NEW SECURITY TECHNOLOGY

Registered Traveler Program

From a technology standpoint, we're looking at better, stronger, faster screening equipment to get people and products to their destinations as quickly as possible, with no compromise in security. Under the Registered Traveler Program (RTP), passengers voluntarily sign up for background checks and identification verification. These registered travelers would then be able to clear through security quickly.

Transportation Worker Identification Credential

Another similar identification program we have in the works is the Transportation Worker Identification Credential or TWIC program. Actually, the RTP will grow from this initiative.

The TWIC program combines personal information and biometrics to positively identify transportation employees having access to secure areas. In the aviation industry these people are everyone from pilots to mechanics to catering and custodial workers. In the trucking industry, they're drivers and workers loading pallets and trailers. In maritime commerce, they're dock workers and ship crews.

The idea is to have these employees undergo only one standard criminal background investigation. It would link them to a central database that would be accessible nationwide. It could serve as an international standard.

Truck drivers, for example, currently carry multiple identification (ID) cards and pay for several background investigations to allow for interstate travel. The record number of IDs we know about is 23. These are drivers carrying everything from bananas to spent nuclear fuel. Under the TWIC program, they'll only have one ID card to deal with, which would be acceptable across the United States. The TWIC program has received authorization to plan the initiation of two regional multimodal pilot projects. The pilots will include testing credentialing applications for aviation, highway, maritime, rail workers, and others.

Los Angeles/Long Beach and the Delaware River area have been selected as the TWIC regional pilot sites based on the broad range of facility types (e.g., mode, size, infrastructure, etc.)

Positive ID on a national basis, especially in sensitive employment fields, is an idea worth serious consideration and discussion. And perhaps the definition of "sensitive" will continue to expand as it has over the past decade. How many would have thought that a truck driver could be a security risk until a homemade bomb was detonated in Oklahoma City a few years ago?

These are just a sampling of our current operations at TSA. Our present, however, is inextricably tied to our immediate future.

TSA is leading efforts to develop next generation technologies for use at airport checkpoints and to inspect checked bags. We're developing methods to help us control access to airport perimeters and ensure that only authorized people are allowed in secure areas.

Some efforts will optimize human performance by improving screener selection, training and evaluation methods. In addition we're expanding our research efforts in order to assess the terrorist threat to all transportation modes, particularly as it relates to cargo.

SECURITY IMPROVEMENTS

Federal Screeners

I have to take a minute or two to mention a few of the many security improvements that TSA had implemented. Our federal screeners are the most visible security change. They are the face of security at airport checkpoints nationwide. We are proud of this diverse and well-trained workforce, a faithful army of patriots who came to the call of their country.

As our military provides defense in this war on terrorism, so do our TSA employees provide defense right here at home.

Federal Air Marshals

We have an immensely expanded Federal Air Marshal (FAM) program. An overwhelming number of dedicated Americans responded to the call of country by joining the FAM service. TSA is completely supporting them and they completely support aviation security. Let there be no misunderstanding that the FAM service is providing the largest, highest-quality, best-trained, and most professional protective force in American aviation history.

Federal Security Directors

We are also pleased with our highly experienced Federal Security Directors (FSDs) deployed at airports around the country. Some FSDs have deputies to assist with the security management of some of the smaller airports. I realize that some of you may have wondered about the length of time it took to recruit, hire, train, and deploy these executives for particular airports. This process has actually gone remarkably well considering the number and location of the airports and the fact that all of the individuals we selected were employed in other important jobs.

Unnecessary Rules

As part of Administrator Loy's plan to bring common sense into the aviation security area, we have taken and continue to take aggressive steps to reduce the "hassle factor" at airports and eliminate what we refer to as "unnecessary rules."

We've revised the policy on passengers carrying beverages through security screening checkpoints. No one asks passengers to drink or eat from food or liquid containers. Gone are the 16-year-old questions asked at ticket counters and at curbside check-in about who packed the bags and in whose control they've been.

Moving on, I know the 300-ft rule has been a point of contention in conducting airport business. We have come up with a secure and reasonable approach to dealing with the original intent of the 300-ft rule. The elimination of this rule is basic common sense—removing something that sacrifices substantial revenues while not significantly enhancing security. The reality is that we had to make fundamental and important policy determinations.

We've determined that we must base our security on the threat level—why do something that may not be needed and why not do something that should be done! We've tied the security approach to the homeland security alert conditions.

I'll cut to the chase because I know you'll have questions. We're lifting the 300-ft rule under the yellow threat level. However, we've developed procedures to address parking concerns under orange and red threat levels. The bottom line—a piece of good news for airport directors—is that we've preserved important flexibility in decision making for the FSDs and the airport directors. They must work together to develop an airport security program that addresses minimum-security requirements, but they have the flexibility to determine the best way to get their job done at their respective airport.

TSA will also implement an improved system of gate screening at most airports. This change will eliminate much of the predictability in the current process. The new system will rely on a pattern of random, hard-to-predict gate screening.

As a result of this enhancement, some current gate screeners will be deployed to screen checked bags, while others will bolster our checkpoint screening presence. The current gate screening process was instituted after 9/11 as backup to a security system considered ineffective, at a time when airport security was a handful of companies enforcing checkpoint screening very inconsistently.

We're able to make these improvements because today, thousands of FAMs are on hundreds of flights each day, new federal screeners are better trained to check passengers, law enforcement officers are in position at every checkpoint, and we will soon screen every piece of checked baggage. Also, we now have better threat assessment information and cockpit doors have been or will be reinforced.

DEPARTMENT OF HOMELAND SECURITY

Reorganization

With the DHS will come the largest reorganization of federal government since President Truman merged the Navy and the War Department to create the Department of Defense in 1947. TSA is one of 22 agencies that will be subsumed into the department. It will fall under the division of

Border and Transportation Security, which will comprise approximately 150,000 of the department's 170,000 total employees.

Integration

Under the new DHS, there will be more to contend with than integrating e-mail systems into a common "www.dhs.gov" address. It will seek to minimize the duplication of efforts of various agencies by combining functions that are currently fragmented and inefficient. Dozens of IT systems will be linked together. Intelligence reports and multiple databases will require integration so as to be useful to various divisions. There will be administrative, technological, and cultural challenges to overcome. But this new interagency alignment will ultimately allow the means of analysis and communication to prevent and respond to the ever-present threat of terrorism.

Examples abound of new federal cooperation. Just as we are developing partnerships with business and industry, TSA is working with the U.S. Coast Guard and USCIS on several programs that will enhance security of maritime shipping through partnership with business. Transition working groups have been working hard on intelligence and information sharing, on emergency response, and critical infrastructure protection, among many other fundamental and important ways to improve our homeland security programs.

Next Major Focus

From an overall perspective we want to complete the transition from a start-up organization into a more stable organization. We need to complete the remaining portions of the roll-out: explosive detection system/explosives trace detection (EDS/ETD) deployment and finish staffing the FSD organization while right-sizing the number of screeners.

On the aviation front we need to continue development and deployment of risk analysis and other identification validation systems to ensure security of airports and aircraft. These include CAPPS II, TWIC, RTP, and more efficient procedures for background checks and vetting of employee backgrounds.

We will continue collaboration with our stakeholders to resolve outstanding issues on the role of federal law enforcement officials (employed or deputized) within the airport environment.

We are currently hard at work at developing a reasonable federal flight deck officer program that is compliant with congressional requirements. We will deploy this program this year as required by Congress.

We will be working on air cargo pilot programs and creating a more robust regulatory and inspection regime in conjunction with our stakeholders for air cargo.

In other areas we will be continuing our work with industry and stakeholders on next generation security equipment to better detect threats and increase throughputs without compromising security.

We will also work to strengthen TSA's role in securing other transportation modes, with a strong emphasis on setting national transportation security policies to ensure intermodal shipments receive similar levels of screening throughout the national transportation network.

Once again, I appreciate the opportunity to speak to you today.

Click here to see Fisher's Powerpoint presentation.

Database Management for Airport Security Simulations

JONATHAN BRANKER
Société Internationale de Télécommunications Aéronautiques

The past two decades have seen an increase in security measures at airports around the world that were triggered by major events. There had been a steady increase in air travel and airports had been moving towards a more business model with the emphasis on passengers and profitability.

Major airports around the world changed their business practices to ease the movement of passengers more freely through their facilities with minimal security. However, December 21, 1988, changed the model for airports when Pan Am Flight 103 crashed in Scotland and the cause was traced to a hole in the security measures for baggage. This was the first event that resulted in significant increases in security operations at airports worldwide.

This event and subsequent events leading to the 9/11, simultaneous World Trade Center, Pentagon, and Pennsylvania crashes has accelerated the need for increased security at major airports. The 9/11 events have permanently changed the way security is addressed at airports globally. Airports themselves have changed the way they operate with many changing from government–city–county direct management to the creation of airport authorities and management companies.

The need to demonstrate profitability and ease of movement for passengers and freight along with the enhanced security has created an environment of rapid change to the overall operations of the airport. Technological advances continue to evolve with the introduction of new methods to enhance security of airports. These advances have resulted in increased needs to capture information on the operation of the airport and the need to share information.

Enhanced security and the need to have timely, accurate, real-time information sharing have resulted in the increased use of databases. However, the lack of common interfaces and standards has contributed to proprietary database formats and solutions. Information exchange amongst operating departments within the airport has become difficult resulting in missed opportunities and miscommunications in times of crises.

Historically, simulation of airport operations only addressed security as it related to passenger queues at checkpoints (departures and some international arrivals). The new model for simulations today have to look at security for all passenger departures and arrivals, baggage, airport and airline personnel, access control to airport facilities, government requirements and interagency operations (local, national, and international).

The data elements that drive security simulations have to look at airports with multiple dissimilar databases, multiple stakeholders with dissimilar requirements, and government changes mandated to improve security.

This presentation looks at the airport operations and the elements that should be considered when running a simulation. The goal is to give the airport simulation community a better understanding of the inputs that are necessary to provide a more realistic view of airport operations.

Click here to see Branker's Powerpoint presentation.

Airport Security Simulation Performance Metrics

KEITH THOMPSON
Gensler

INTRODUCTION

Security Simulations Are Complicated by the Different Types of Situations to Be Evaluated:

1. SSCP,
2. Bag screening,
3. Selectees, and
4. Protection from explosive forces.

What Range of Simulation Tools Are Available?

1. Pencil and paper,
2. Spreadsheet models, and
3. Dynamic simulation.

Architects View of the World (i.e., the Design Process)

1. Burn rate and design schedule;
2. Architects can "do the math," but their objective is the design of physical space, not quantitative sophistication for its own sake; and
3. Lack of TSA responsiveness in providing design information.

METRICS TO BE USED FOR SIMULATING AIRPORT SECURITY FOR ARCHITECTS

What Type of Simulation Information Does an Architect Need?

1. Number of pieces of equipment,
2. Spatial characteristics of installation, and
3. Number of passengers/employees to be accommodated in the queue.

Basic Inputs for Simulations

1. Passenger Behavior:
   a. Earliness of arrival,
   b. Checked bag ratio,
   c. International/domestic connect rate (for international), and
   d. Selectee rate.

2. Screening Equipment:
   a. Throughput per device (or device group) based on local conditions,
   b. Pieces/type of equipment to be employed,
   c. Input rate of passengers/bags,
   d. Plan of building area, and
   e. Airline last-bag closeout time (for bag screening).
3. Blast protection:
   a. Explosive charge weight,
   b. Location of charge relative to structure, and
   c. Basic structural plans and assessment of building envelope.
4. The potential for over-analysis:
   a. How long does it take to collect detailed info?
   b. Does random variation really matter?
   c. Impact of solutions too tightly linked to activity assumptions.

Considerations Affecting Performance That Are Not (Easily) Simulated

1. Physical:
   a. Physical space impacts configuration and subsequent throughput (re: LAX T8);
   b. Space available may not accommodate the optimal equipment layout or queue;
   c. Arrival or processing through multiple decision points (i.e., lobby-based ETD);
   d. The impact of overlapping queues (i.e., SSCP queue interacting with those of lobby-based ETD); and
   e. Impact of unique architectural conditions (i.e., split-level marshalling at escalators at Los Angeles International Airport).
2. Operational:
   a. Equipment does not equal staffing and are both integer quantities;
   b. Uncertainty of equipment downtime;
   c. Downstream queues due to secondary screening (without protocols); and
   d. The Southwest Airlines factor.
3. Behavioral:
   a. Changes in human behavior;
   b. Season/weather (coats, packages); and
   c. Sophistication of the traveler.

ESTABLISHING THE CORRELATION BETWEEN QUEUE LENGTH AND DURATION, VIS-À-VIS ACCEPTABLE LEVELS-OF-SERVICE (LOS)

Establish When the Measured Queue Time Starts and When It Ends in the Process

1. SSCP:
   a. Entry to passenger queue to threshold of magnetometer?
   b. Marked queue entry to marshalling from ticket queue?
2. EDS/ETD:
   a. Entering check-in queue to delivery of bag to EDS/ETD?

    b. Entering of (separate) EDS/ETD queue to delivery of bag to device?
3. How do we measure the magic 85% (in 10 min or less)?
    a. 85% of the passengers or 85% of the time?
    b. Are there any maximums for the remaining 15%?
4. Are separate queues in the process individual or cumulative in the level of service (LOS) metric?
5. What happens when queues exceed the space available—even if within an acceptable LOS (i.e., queuing within the building)?
6. Other overriding concerns:
    a. Life safety (blocked exits, other threats to assembly areas); and
    b. Maintaining visual continuity and wayfinding for passengers in increasingly congested areas.

SUMMARY

What Metrics Are Useful in Simulating Airport Security for Architects?

Ones that are simple to apply, easy to collect, and timely to produce.

Considerations Affecting Performance That Are Not (Easily) Simulated

1. Physical,
2. Operational, and
3. Behavioral.

Establishing the Correlation Between Queue Length and Duration, Vis-À-Vis Acceptable LOS

1. Foster a clear, mutual understanding among stakeholders of the inputs and assumptions used for the simulation and a consensus on the numerator and denominator used to calculate the LOS.
2. Use simple simulation models to establish basic design parameters, and more complex ones validate design, tune procedures, and test sensitivity, rather than as a proscriptive design tool.

Click here to see Thompson's Powerpoint presentation.

Staff and Lane Modeling Methodology for TSA Checkpoint Passenger Screening

M. P. TIMOTHY BRADLEY
Lockheed Martin

JAY GOYAL
Transportation Security Administration

As part of the TSA mandate to implement the new airport screening measures, important considerations critical to this effort included:

1. Appropriate number of checkpoint lanes required for handling airport passenger volume efficiently.
2. New types of checkpoints and related demand and the required resources and priority basis.
3. Staffing requirements to comply with TSA security screening operations and related standards.

These issues are important to the planning and implementation of these measures and would determine the success for the simulations used as the tool of choice to implement the TSA airport security measures.

Another important consideration is the airport data collection required for the simulations. Input data required for this exercise cover airport baseline layout, airline data, passenger throughput data, and other airport operations databases.

Analysis of the data seems to indicate that while checkpoint performance was meeting the primary TSA criteria, certain aspects of the data could have been misleading. In particular, the influence of airline transfer (hubbing) and operational characteristics of the equipment indicates that results show excessive variations in lane throughput rates.

The presentation described the passenger screening process focusing on "trade offs" between operations details and the TSA measures. Simulations were used to determine necessary checkpoint lane requirements in compliance with TSA mandated standards. The simulations indicated that about 10% increase in the number of lanes provided given the normalized equipment capacity and proper screening procedures.

The following step in this process is to determine airport security screening staffing requirements. Issues tackled include screening staffing levels by demand level, lane open-close procedures, staff optimization for working versus needed staff, and passenger flow/operations management issues.

For this purpose, a staffing profile model was developed to provide profiles for number of lanes that are required to be staffed hourly to meet TSA delay–wait standards for different demand levels (i.e., passenger loading). The staffing profile could be broken down into type of staff and multiple shift patterns.

These simulation and modeling techniques are efficient and practical tools utilized to achieve optimized implementation for all airports required to comply with mandated TSA checkpoint passenger screening requirements.

Click here to see Bradley and Goyal's Powerpoint presentation.

Simulation of Airport Baggage Screening

William Hepler
Preston Aviation Solutions

Preston Aviation Solutions, a Boeing subsidiary, is currently using its Passenger Movement Simulation System (PaxSim) software product to model and simulate U.S. airports for Boeing's EDS contract with the TSA. PaxSim is a state-of-the-art, graphics-based computer program used to both view and report results from fast-time simulation of passenger flows inside an airport terminal building or similar passenger facility. Check-in and carry-on baggage processing and flows are also being modeled and simulated to provide options for EDS/EDT machine numbers and placement.

PaxSim processes flight schedules and actual passenger numbers for each flight or, if not available, average aircraft seating capacity and load factors, to generate the flow of departing and arriving passengers. The system employs sophisticated algorithms to produce realistic passenger behavior. The statistical information generated is used to determine optimum usage patterns for various passenger processing and dwell areas, as well as various baggage systems in the airport.

The simulation can be viewed and interactively controlled on screen. The speed of the simulation can be varied from real-time to hundreds of times faster than real time. PaxSim also produces a variety of statistical reports during a simulation. The reports are formatted for direct import into Microsoft Excel or similar spreadsheet database tools.

The starting point for any simulation is a detailed drawing specifying the layout of the terminal building. All areas through which passengers move must be determined and their function specified. In addition, aircraft parking bays and points where passengers queue must be identified. There may be separate renderings for an airport's departure and arrival levels as different elements are important in arrival and departure simulation.

Once the design has been completed and all data set up to user's satisfaction, they are ready to run a simulation process. Multiple instances of simulations can be run simultaneously, side by side, on the same project or on entirely different projects or the same baseline project with certain data, service times altered in each simulation.

Individuals, represented by small icons, move according to their target destination (e.g., a departure gate or exit if arriving). Passengers can spend time in shops, restaurants, and toilets; stand in queues; wait at baggage carousels; or just wander if they have time left before departure. PaxSim recognizes passengers moving along a path or within a grid system and applies a collision avoidance principle to realistically model people movement. Different walking speeds can be used and set by an operator or for moving walkways. Movement areas can also be set to have different spacing between passengers such as closer in queues and further apart when walking, all controlled by the operator.

Where passenger processing and movement flow simulation is selected, PaxSim displays the passengers in an animated graphical form on the airport layout. PaxSim can display the position and movement of all passengers and baggage in the terminal. The service times at various points can be adjusted to provide an accurate representation of reality.

Passenger flow rates, including the speed of pedestrian movement, may be changed to reflect the difference between departing, transiting and arriving passengers. PaxSim's pan and zoom capability provides graduated views of the simulation model, from a view of the complete airport terminal down to the behavior of passengers at an individual service point, such as at a check-in counter or an immigration desk.

The “ripple” effect of changing service time parameters on passenger throughput can be tested. For instance, an increase of customs service or security checkpoint times may cause a bottleneck back through to the baggage hall and require space. Different security equipment types and procedures may be evaluated using PaxSim since different processing times can be assigned to each type or individual machine.

New procedures can be modeled, new airport security initiatives evaluated, to include the installation of new screening equipment. This feature enables the user to increase or decrease the percentage or number of passengers screened. This can be evaluated in PaxSim and can be done for both the final result (new equipment installed and operational) and the installation process (disruption to passenger movements due to construction) simulations.

As the simulation runs, numerous statistical reports may be collected, such as passenger movements, delays, queue lengths, waiting times, etc. These reports can be viewed on screen at any time during a simulation or imported into a spreadsheet or database program for further analysis.

In conclusion, PaxSim may assist in evaluating changes to the airport layout and resources necessary to implement the stipulated procedures.

PaxSim helps airport planners and managers

- Evaluate the efficiency of airport layouts;
- Validate the capacity of an airport design;
- Determine typical airport processing times; and
- Analyze future seasonal schedules.

The working model can also be run in fast time mode as a forward planning tool to determine future projections for passengers queues and movement at

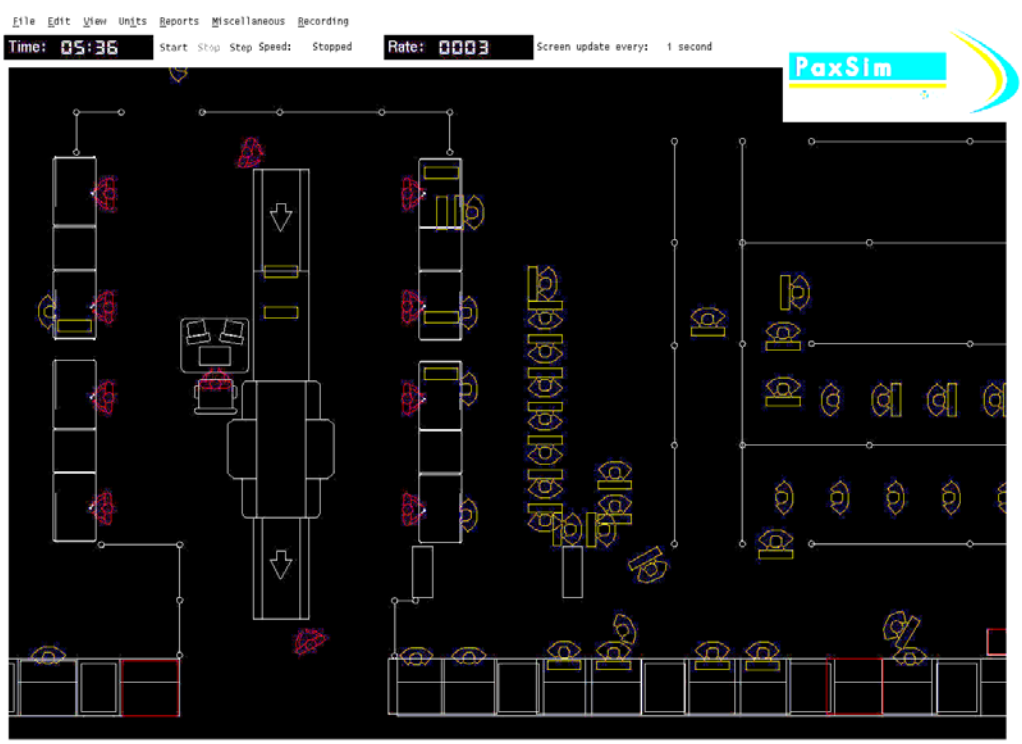
- Baggage check-in and ticketing,
- Outward immigration,
- Security checkpoints,
- Airport retail concessions and duty-free shops,
- Boarding desk at gate lounges,
- Customs and inward immigration, and
- Baggage collection.

Click here to see Hepler and Wendt’s Powerpoint presentation.

PaxSim Simulation Model
General Overview

DOUG WENDT
Preston Aviation Solutions

The PaxSim is a state-of-the-art, graphics-based computer program used to both view and report results from the fast-time simulation of passenger flows inside an airport terminal building. PaxSim processes flight schedules and actual passenger numbers for each flight or, if not available, average aircraft seating capacity and load factors, to generate the flow of departing and arriving passengers. The system employs sophisticated algorithms to produce realistic passenger behavior. Statistical information, where available, can be used to specify the usage patterns for various dwell areas and facilities of the airport. The simulation can be viewed and interactively controlled on the screen. The speed of the simulation can be varied from real-time to hundreds of times faster than real time. This allows the user to test many iterations or "what-if" scenarios quickly and productively. PaxSim produces a variety of statistical reports during a simulation. Such reports incorporate check-in counter utilization, queue lengths and delays. The reports are formatted for direct import into Microsoft Excel or similar spreadsheet database tools. Using interactive, animated simulation and scheduling tools, PaxSim enables airport planners to efficiently perform and control the simulation of passenger movement inside the terminal building. With the capability of modeling physical space constraints, PaxSim can simulate queue lines overlapping or stretching outside.



BAGGAGE CONSIDERATIONS

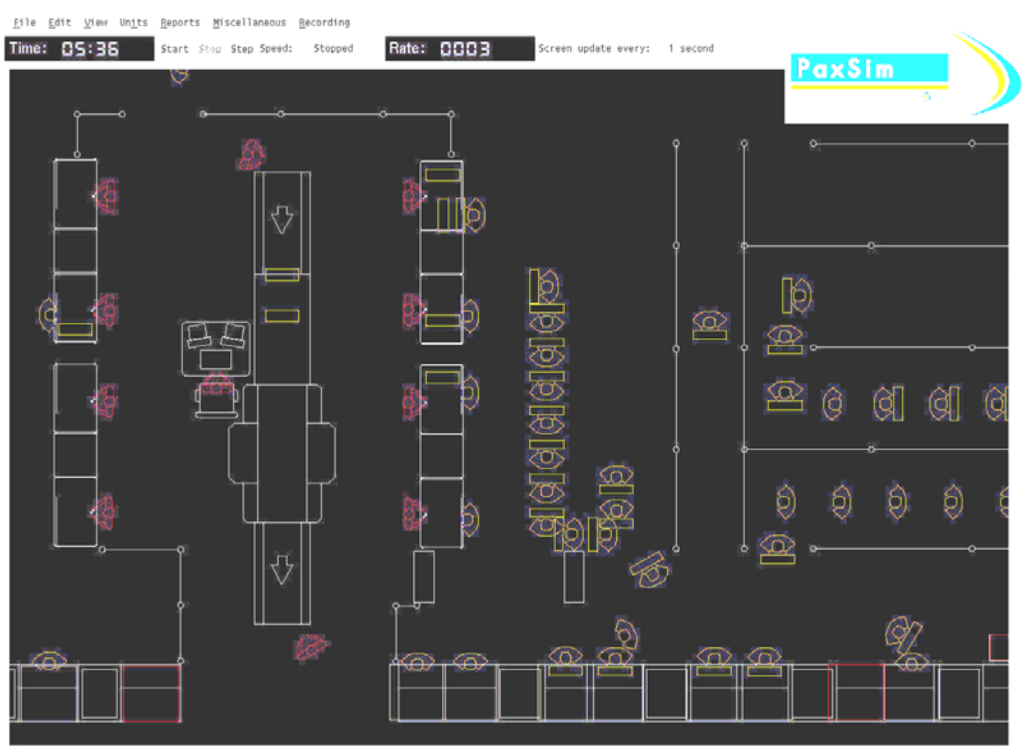
PaxSim considers the impact that passenger baggage has on passenger movement through the airport. Baggage, be it check-in or carry-on, effects the ultimate efficiency of terminal operations. The time taken for baggage to be screened at various security points, such as major detection areas (for check-in baggage) and areas for the X-ray of hand-held bags can be modeled in PaxSim. Each piece of baggage (of either type) is uniquely identifiable with each passenger, because when a scan is performed the passenger must either wait until the bag is cleared or be separated from it. In either case either the passenger or the bag will wait for the other. Note, however, that at an X-ray machine, a passenger may be selected for further checking and other passengers may collect bags from the X-ray machine before the passenger being checked.

Two types of baggage are considered for this functionality: carry-on and chick-in to be associated with passengers, with support for multiple items of each type.

As passengers are processed, they will at some stage be separated from their bag (either at check-in or at an EDS machine). They will then travel separately from their bag to a point where they have to wait until their bag is scanned and opened in their presence, or cleared so that they can continue without their bag to their gate.

Further on in the terminal, passengers will put their carry-on baggage/items through an X-ray machine. They will then walk independently past the machine and either immediately collect their carry-on baggage from the machine output area or they will be hand scanned with a metal detector first.

PaxSim users will be able to view this process (the baggage separating from the passenger, moving through the detection machine and joining up with passenger).



Passengers will be shown moving through the terminal with the pieces of baggage the distribution profile has allocated them.

PASSENGER AND BAGGAGE TRACKING CAPABILITY

Details on the tags a passenger has at a particular time are available from the simulation. A right-click on the actual point where the passenger is will display a table showing where a passenger has been, where they are going, and what type of passenger they are, first, business, economy, international, domestic, etc. The table also shows how many pieces of baggage they have and the break up of carry-on and check-in baggage.

The same procedure can be preformed for a piece of baggage that has been separated from its respective owner. Right-click on the baggage and a table will come up showing details of where the bag has been, where it is going, and whom it belongs to.

Click here to see Hepler and Wendt's Powerpoint presentation.

Modeling Checked Baggage Requirements for Dallas/Fort Worth International Airport

ERIC MILLER
TransSolutions

As part of the TSA effort to implement the new airport security measures and meet Congress' mandate and to determine the impact of this law on its operations, DFW fielded a team of 18 firms to develop the best solution for the airport.

DFW has several unique characteristics related to simulation, planning, and operations. Historically, DFW is the first airport that was actually designed using simulation technique; both airside and landside, back in the 1960s. From a planning perspective, DFW's terminal configuration have a unique layout with average depth for passenger processing of only 35 ft, with 340 ticket counter positions in 18 ticketing lobbies. In terms of operation, the airport has a wide mix of types of passengers and air carrier operations, with average baggage throughput of about 55,000 bags daily.

In using simulations to implement the TSA airport security measures, the relevant issues addressed include the performance metrics, data, and simulation tools to be used for the analysis of DFW terminals, and as described:

1. Performance Metrics. In terms of time, the primary performance metric, 95% of bags in the peak-hour spend no more than 10 min in the security screening process. In terms of space, adequate space must be provided with adequate storage capacity to process all passengers and baggage, accommodate EDS/ETD footprint, provide adequate bag system capacity and offer adequate service standards for passengers.
2. Data Gathering. The following information was obtained as input to the simulation:
    a. Flight schedules;
    b. Originating and departing percentages by time of day;
    c. Load factors;
    d. Passenger arrival curves by time of day and market;
    e. Passenger party (group) size;
    f. Number of bags per passenger;
    g. ATO and curbside check-in time and percentage split; and
    h. EDS/ETD processing times.
3. Demand Forecasts. Processing data to generate passenger and bag volumes relied on forecasting the level of demand, in terms of
    a. Applying load factors to the equipment capacity of each departing flight;
    b. Estimating number of originating passengers for each flight;
    c. Estimating the number of originating bags for each flight;
    d. Defining passenger arrival time distributions;
    e. Estimating passenger group size; and
    f. Obtaining the check-in location.
4. Simulation approach. The approach adopted to implement simulation for DFW was
    a. Mathematical model is first derived based on the initial estimates, where peak-hour demand levels are developed using queuing models to determine requirements.

b. Initial simulation model is conceptualized based on te intermediate equipment requirements, as well as evaluation nof conceptual EDS designs, specific geometry and location of EDS equipment, interdependencies between the processes modeled.

c. Detailed simlatuon model is finalized based on the final equipment and facility requirements provded to the team by TSA using detailed design drawings incorporating the geometry of buldings and baggage systems.

5. Configuration Concepts. A variety of configuration concepts were evaluated and simulated, including:

a. In-line EDS system;
b. EDS before ticketing;
c. Expand ticketing/EDS at curbside check-in;
d. EDS before baggage handling system after ticketing;
e. EDS in garage with check-in at ticketing;
f. EDS (only) in garage;
g. Ticketing/EDS in garage;
h. Inbound baggage in garage;
i. Secure airport model;
j. The "Heathrow Concept"; and
k. The "Salt Lake City Concept" (ETD pre-ticketing).

In evaluating these alternative concepts, only the "EDS in-line" and "ATO" options complied with TSA requirements. All options required a significant investment in equipment and personnel.

6. Space Requirements. The analysis indicated that many of the DFW terminal sections lobbies could not accommodate a lobby solution and maintain an acceptable level of service to passengers. The problem is not necessarily the queue created by the lobby solution, but the space displaced by the equipment. The analysis indicated that DFW airport developed a mixed technology solution to address the unique constraints of each of its terminals' section.

The DFW simulation analysis concluded that best solutions identified to ensure the airport's performance goals could be achieved while meeting the TSA requirements, but there is no "magic bullet" solution. The in-line system seemed to be the best long-term option, most efficient with best customer service, and has the lowest long-term cost. The flexible modeling approach used enabled the airport to quickly adapt the simulation models to different alternatives, where recommendations on long-term solution remained essentially unchanged. In this respect DFW was the first airport to present a passenger plan to the TSA to implement the airport security measures on passenger checked baggage requirements. The approach adopted by DFW became a template for identifying requirements nationwide.

Click here to see Miller's Powerpoint presentation.

Measures of Effectiveness for Passenger Baggage Security Screening

KELLY LEONE
Transportation Security Administration

RONGFANG "RACHEL" LIU
New Jersey Institute of Technology

One of the most challenging tasks of the ATSA is to meet the goal of performing EDS screening on 100% of checked baggage by the end of calendar year 2002. Accomplishing this goal within the imposed deadline and within the typically tight space constraints of the airport terminals will require significant changes in the way airlines and airports manage passengers and their baggage.

One of the up-front keys to integrate 100% checked bag screening into airports is to identify realistic throughput rates of various EDS machines available to TSA planners. This study discusses some of the issues associated with the implementation of EDS equipment and performs an analysis on the throughput of the equipment using modeling and discrete event simulation tools.

Although development of a simulation model cannot always be composed into a simple sequential process, a conceptual framework for conducting simulation studies can be visualized in Figure 1. It is important to note about the process is that it starts with a clear definition of the study's objectives, from which all else flows. Also noteworthy is that the model development process is iterative, with feedback loops between model conceptualization and real-life data. Finally, strong emphasis is placed on model verification and validation prior to considering it sufficient to guide other, more costly activities, such as experimental designs or implementation.

Not all simulation projects follow this exact sequence. Specifically, the EDS effective throughput simulation study team was challenged into rethinking the model late in the process because of knowledge gained along the way regarding different alarm resolution protocols. Recurrent processing of the earlier steps was required and is characteristic of the vast majority of simulation projects. However, in the end, all steps were visited and are discussed in the following sections.

The results show that the initial scan rate, 360 bags per hour (bph), was significantly impacted with the addition of the processes for operator alarm resolution and secondary screening level. For example, when using on-screen operator resolution protocol with one operator performing both the level 1, CTX5500, and level 2, directed search, screening, effective throughput is less than half of the stated scan rate or throughput rate, that is 168 bph versus 360 bph. Also, while the effective throughput rate increases slightly with two operators, where one performs the duties at the CTX5500 and the other at the secondary screening station, there is still quite a difference between the scan rate and effective rate.

The results indicate that there is a correlation between resolution time and effective rate time, where longer resolution times decrease throughput. This can been seen by comparing the results between scenarios 1 and 2. In scenario 1 only 21 sec on average was used for the operator resolution time, while in scenario 2 this figure was raised by 50%.

Another significant finding is shown in the difference between scenarios 1, 2, and 3. Scenario 3 involved no operator on-screen alarm resolution, meaning that all alarm bags were sent to the secondary screening level and opened. With one operator performing both level 1 and level 2 screening tasks, the effective throughput rate really suffers, which is expected. However, with two operators performing each function separately, the effective throughput rate is not that much different from scenarios 1 and 2, where on-screen resolution is performed. This suggests that the operator on-screen resolution protocol may not be much faster than opening the bag. Historically, both TSA and air carrier representatives balked at the idea of opening passenger baggage for screening believing that the process was too slow, as well as intrusive. While the study showed that the on-screen resolution process may not be that much more efficient than opening bags, it is the goal of the TSA to open as few bags as possible. Many travelers still do not want to see their belongings rummaged through, especially in full view of other passengers.

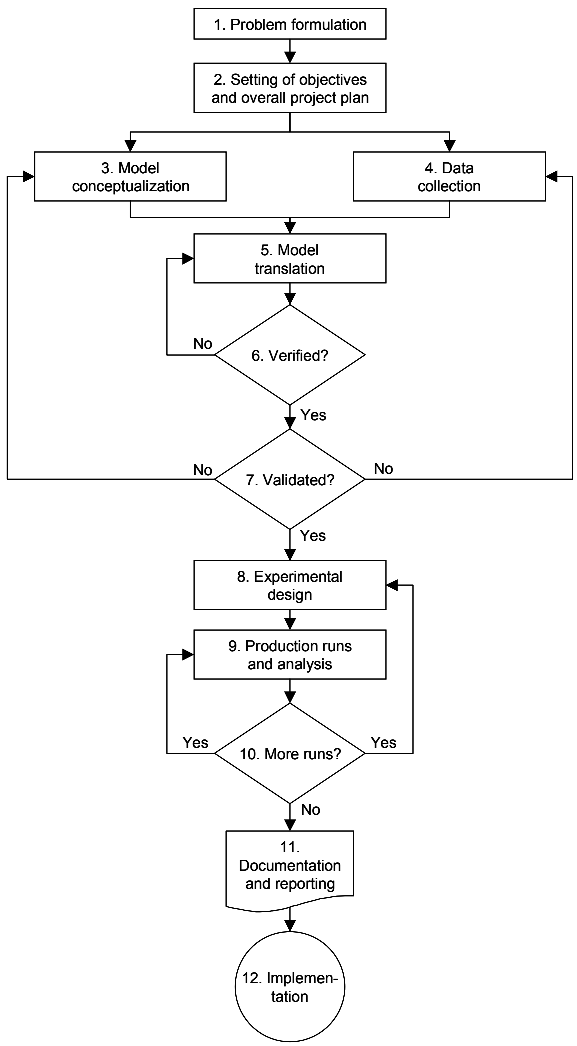


FIGURE 1

Click here to see Leone and Liu's Powerpoint presentation.

EDS/ETD Deployment Program
Modeling and Simulation Approach

EVERT MEYER
MARK LUNSFORD
Leigh Fisher Associates

An overview of the modeling and simulation effort to deploy the TSA EDS/ETD program that is mandated by law is presented. This program was conducted by a team led by Boeing and included Boeing Preston Aviation Solutions (Preston) and Leigh Fisher Associates (LFA), in coordination with TSA.

The role of modeling and simulation was significant in providing effective results for the design of new screening measures. In this context, new generic security screening concepts utilizing were developed and tested; simulations were used to estimate EDS and ETD equipment requirements; and analytical methods adopted to assess the screening operations and ystem performance at each airport. Based on this, the preferred solution for each airport was selected and future improvement of the system outlined.

Simulaiton tools utilized in this program include:

1. PaxSim: Developed by Preston, for passenger flow simulation;
2. EDS-SIM: Developed by LFA for simulation of EDS operation at airports;
3. Flow-Model: Developed by LFA as the analytical tool for the simulation modes; and
4. AutoMod: A commercial COTS product, to analyze the baggage screening operation.

The deployment program adopted a strategy that is outlined by the following steps:

1. Assessment of the airport environment vis-à-vis space and screening operations;
2. Review of the technical details of airport security screening and coordination with TSA;
3. Conducting surveys to obtain data required for the simulation and analysis; and
4. Design of the screening facilities and effectiveness of the system for each airport.

An important element of this work is data management, in terms of data sources, processing, verification, and utilization of this data in simulation models. Data requirements for the Flow Model and EDS-SIM include Official Airline Guide schedules, industry trends, airline-airport operations and field observations of flow and service.

In executing this task, each and every airport of the 429 airports covered in the analysis was analyzed individually vis-à-vis application of models and simulation and respective analysis. Flow Model was applied to all (429) airports; EDS-SIM to 127 terminals in 90 airports; and PaxSim to 60 terminals in 30 airports.

Click here to see Meyer and Lunsford's Powerpoint presentation.

APPENDIX A

Participant Biographies

M. P. Timothy "Tim" Bradley
Director of Homeland Security Advanced Programs
Lockheed Martin Mission Systems

Bradley is Program Director of the Strategic Airport Security Rollout Program, a contract awarded to Lockheed Martin in June 2002 for the provision of passenger checkpoint security redesign and implementation.

Bradley was educated at Imperial College of Science and Technology, London, England and holds seven patents and has published over 30 papers in the field of Analytical Chemistry.

He has worked in the field of large complex systems for the last 20 years, predominately as a Program Manager and he is a recipient of a Federal 100 Award for Program Management.

Jonathan M. Branker
Director, Network Business Development
Société Internationale de Télécommunications Aéronautiques

Branker is a 1981 graduate of New Jersey Institute of Technology, with a B.S. in Computer Science. He began his professional career as an Associate Engineer with Codex Corporation, which was renamed Motorola Information Systems Group, working on the design, development, and support of Statistical Multiplexors.

Branker continued his tenure with Motorola the Engineering Team working on the development of the Vanguard Frame Relay product line and later headed the Global Support team for this and other products.

After 14 years, Branker took a sabbatical from the Engineering Team and moved to the Reebok Corporation as Director of Information Technology (IT) and Telecommunications, Asia-Pacific, based in Hong Kong, where his responsibilities included the roll-out of IT to the contract production factories in Hong Kong, the Philippines, Taiwan, South Korea, India, China, Thailand, and Indonesia.

Branker then returned to the United States to join Hughes Network Systems based in Germantown, Maryland, as head of Global Engineering for Enterprise products.

The primary support customer of this product line was the FAA. Branker later joined the contracting office AOP-400 of the FAA, which had responsibility for Telecommunications, Maintenance, and Operations. While assigned to the FAA, Branker worked on the Transition Analysis Team that developed the plans for the Investment Analysis of the FTI program (which was the $4.7 billion award made to Harris Corporation in 2002). Upon completion of the contract, Branker returned to the Asia-Pacific region as the Technical Marketing Director of Patton Electronics and was responsible for their xDSL and Remote Access Server product lines.

Branker then joined Société Internationale de Télécommunications Aéronautiques (SITA) as the Solutions Design Director for the Americas where he headed the design teams that provide solutions to the Air Transport Industry. He is currently the Director of Network Business Development within the Airports Division of SITA.

Branker's interests are in the areas of Security and Biometrics and he is the on the RTCA Special Committee 199 which recently submitted the draft standards for Airport Security Access Control Systems. He has also been a member of the Aircraft Owners and Pilots Association since 1982 and a member of IEEE for the past 24 years.

Branker can be reached at 3100 Cumberland Boulevard, Atlanta, Georgia 30339; phone: 770-303-3524; fax: 770-612-2265; e-mail: jonathan.branker@sita.aero.

James M. Crites
Dallas/Fort Worth International Airport

Crites serves as Executive Vice President of Operations at Dallas/Fort Worth International Airport. He oversees the activities of Airport Operations, Airport Maintenance, Customer Service, Department of Public Safety, and Environmental Affairs.

Prior to this Crites worked in several key management positions at American Airlines, Inc. He previously served as the Managing Director of Airport Services and Managing Director of Financial Planning for American Airlines, Inc.

Crites is a graduate of the University of Illinois with a B.S. in Business Administration and the Naval Postgraduate School in Monterey, California, with a Masters in Operations Research.

He is a member of the National Academy of Sciences and is Chair of the Airfield and Airspace Capacity and Delay Committee of the Transportation Research Board (A1J05). He is also a member of the Airports Council International Technical Safety Standing Committee, the FAA Research Engineering and Development Advisory Committee, and the Texas Emissions Reduction Plan Advisory Board.

Clint Fisher
Transportation Security Administration

Fisher worked in the George H. W. Bush Administration at the Department of Transportation, USIA, and the Agency for International Development as the business liaison.

He received MBA in Finance and International Business from American University, Washington, D.C., in 1994.

Fisher was Senior Director of International Air Service for Airports Council International (ACI) from 1994 to 1998; from 1998 to 2000 he was the Senior Analyst–Route Strategy and Planning for US Airways; and from 2000 to 2002 he was Manager of National Corporate Accounts for US Airways

He joined the Transportation Security Administration as Director of External Affairs on July 1, 2002.

Fisher is a 1987 graduate of Washington & Lee University with a double major in economics and German.

William “Bill” Hepler
Preston Aviation Solutions

Hepler is the Business Development Manager at Preston Aviation Solutions in Atlanta, Georgia, and is responsible for the sale of Preston’s suite of aviation products throughout North and South America.

His aviation background includes an Air Force career as a combat fighter pilot and as an Operational F-16 Commander. He was the first Operations Commander of the F-117 Stealth Fighter and has taught Air Campaign Planning at the Air War College at Maxwell Air Force Base, Alabama. He also worked on the F-22 Stealth Fighter program and has extensive foreign military sales experience throughout the Middle East with Lockheed Martin.

Bill led Preston’s initial effort to develop the modeling and simulation portion of Boeing’s TSA EDS contract. As a result, the passenger and baggage simulation product, PaxSim, is being used to help determine the number and location of EDS and EDT machines at U.S. airports.

Kelly Leone
Transportation Security Administration

Leone is an engineer with TSA’s Security Research and Development (R&D) Division and is responsible for managing the checked baggage R&D program.

Prior to joining the Aviation Security Division, Leone worked on various Air Traffic Control automation systems at FAA’s William J. Hughes Technical Center and the German Bureau of Flight Safety in Frankfurt, Germany.

Leone earned her B.S. in Computer Science from Seton Hall University in South Orange, New Jersey, and a M.S. degree in Aeronautical Science from Embry-Riddle Aeronautical University. She is currently pursuing a Ph.D. in Transportation Engineering from the New Jersey Institute of Technology (NJIT).

Rongfang “Rachel” Liu
New Jersey Institute of Technology

Liu is a faculty member in the Department of Civil and Environmental Engineering at NJIT and she is also affiliated with the transportation research centers in NJIT.

Liu’s research interests include safety conscious transportation planning, travel behavior and demand modeling, and operation research/simulations.

Prior to joining NJIT, Rachel worked as a consultant for a number of years and managed numerous projects, which provided her extensive industrial experiences.

Liu has actively participated in a number of TRB committees and She a professional engineer as well as a certified planner.

Keith Thompson
Vice President, Gensler

Thompson has more than 25 years of planning and design experience assignments at more than 60 airports worldwide. His experience in aviation facility planning and design includes project and program management, terminal and landside design and planning, forecasting, and simulation modeling.

Thompson provided design or technical leadership on a variety of recent Gensler airport terminal projects including Terminals 3 and 5 at Los Angeles International Airport (LAX); John Wayne Airport in Orange County, California; Palm Springs International Airport, California; Austin-Bergstrom International Airport, Texas; San Antonio Airport, Texas; Tulsa International Airport, Oklahoma; Norman Y. Mineta San Jose International Airport, California; Terminal 6 at Chicago O'Hare International Airport; Terminal 2 at San Diego International Airport's Lindbergh Field, California; and the new East International Terminal at Atlanta, Georgia.

More recently, Thompson has been engaged in developing both design and terminal security solutions at more than half a dozen U.S. airports and on the design and planning of terminal projects at LAX, San Antonio, Tulsa, Chicago, Palm Springs, and San Jose.

He is a participant in the TSA Airport Focus Group–Facilities.

In the area of simulation modeling, Thompson has developed several programs for simulating passenger and baggage use of terminal buildings, concentrating recently on adapting these models to spreadsheet-based models that meet the needs of airport designers.

Thompson has an Associate Degree in architectural engineering from the Franklin Institute of Boston, a B.S. in architecture from Massachusetts Institute of Technology, and an MBA in finance-management science from University of California–Los Angeles.

He was president of the Airport Consultants Council from 1999 to 2000 and currently serves as Terminal Committee Chair. He is also co-author of *FAA Advisory Circular AC150-5360-9: Planning and Design of Terminal Facilities at Non-Hub Locations* and various articles in *Airports, Passenger Terminal World, and World Market Almanac*.

Douglas Wendt
Preston Aviation Solutions

Douglas Wendt is a Simulation and Modeling Analyst at Preston Aviation Solutions. He is a graduate of Lewis University, Illinois, and holds a degree in Aviation Administration, along with a private pilot's license.

Doug spent 6 months working with TSA to implement the new mandatory passenger and baggage screening process for all 429 airports throughout the country.

His primary responsibilities at Preston Aviation Solutions include airport model and simulation development using the PaxSim tool.

APPENDIX B

Using Simulation to Evaluate Impacts of Airport Security

TRB Annual Sunday Simulation Workshop
8:15 a.m.–4:45 p.m., Sunday, January 12, 2003
Omni Shoreham Hotel, Washington, D.C.

8:15 a.m.	Welcome and Introduction—Workshop Chair Dr. Saleh Mumayiz (*Illgin Simulation Technologies)*
8:20	Airport Operators Perspective James M. Crites (*Dallas/Fort Worth International Airport)*
8:45	Airport Security—TSA Perspective Clint Fisher (*Transportation Security Administration*)
9:15	Database Management for Airport Security Simulations Jonathan Branker (*SITA*)
9:45	Airport Security Simulation Performance Metrics Keith Thompson (*Gensler*)
10:15	Coffee Break
10:30	Simulation of Airport Passenger Screening Timothy Bradley (*Lockheed Martin*)
11:15	Simulation of Airport Baggage Screening William Hepler (*Boeing-Preston Aviation Solutions*)
12:00–12:30 p.m.	Workshop Open Discussion
12:30–1:30	Lunch
1:30	Airport Security Simulations—Case Studies, Part 1 Belinda Hargrove and Eric Miller (*TransSolutions*)
2:15	Europe's Experience on Airport Security Dr. Kostas Zografos (*AUEB*)
3:00	Coffee Break
3:10	Measures of Effectiveness for Passenger Baggage Security Screening *(TRB paper # 03-2490)* Kelly Leone (*TSA*) and Rongfang Liu *(New Jersey Institute of Technology*)
3:40	Airport Security Simulations—Case Studies, Part 2 Dr. Bill Dunlay and Dr. Everet Meyer (*Leigh Fisher*)
4:20	Workshop Open Discussion
4:45 p.m.	Adjourn

The workshop is co-sponsored by the following TRB committees: Airspace and Airfield Capacity and Delay (A1J05), Airport Terminals and Ground Access (A1J04), and Critical Transportation Infrastructure Protection (A5021).

ABSTRACT

In this workshop, a comprehensive review of the impact that security requirements called for in the Aviation and Transportation Security Act are having and will have on all aspects of airport operations will be presented and discussed. The views of airport operators and security managers on this subject with be presented, case studies of airport simulations will be demonstrated by simulation experts, and the utilization of simulation techniques to evaluate the impacts of security measures on the planning, design and operations of airports will be discussed. Applications of simulation modeling of the airport passenger and baggage security screening process and other airport operations affected by the new security measures will be presented.

GENERAL NOTES

- Presentations should be hands-on and animated with simulation demos.
- Speakers need to provide a one- to two-page summary of the presentation at least 2 weeks ahead of the workshop date.
- Speakers should bring presentation summary hand-outs (and company material, if desired) during workshop for audience to follow.
- In order to promptly initiate the process of publishing these Workshop Proceedings as TRB e-Circular, speakers need to provide their presentation file(s) to Workshop Chair on the day of the workshop.
- Slide and computer projectors will be provided by TRB for the speakers to present.

SPEAKERS CONTACT DIRECTORY

Name	Affiliation	Telephone	e-mail Address
Timothy Bradley	Lockheed Martin		timothy.bradley@lmco.com
Jonathan Branker	SITA	770-303-3524	jonathan.branker@sita.int
James Crites	DFW International Airport	972-574-3207	JCrites@dfwairport.com
William Dunlay	Leigh Fisher	650-571-7722	billd@leighfisher.com
Clint Fisher	TSA	202-385-1235	clint.fisher@tsa.dot.gov
Belinda Hargrove	TransSolutions	817-359-2958	bhargrove@transsolution.com
William Hepler	Boeing–Preston Aviation Solutions	770-579-0915	wch@preston-aviation.com
Kelly Leone	TSA		
Rongfang Liu	New Jersey Institute of Technology		
Evret Meyer	Leigh Fisher	650-571-7722	evertm@webmail.leighfisher.com
Eric Miller	TransSolutions		emiller@transsolutions.com
Keith Thompson	Gensler	310-449-5600	keith_thompson@gensler.com
Kostas Zografos	AUEB/TRANSLOG	+3 010 8203 673-5	kostas.zografos@aueb.gr

APPENDIX C

Workshop Participants

Zale Anis
Volpe National Transportation Systems Center
U.S. Department of Transportation
55 Broadway, Kendall Square
Cambridge, Massachusetts 02142
617-494-2184
anis@volpe.dot.gov

Timothy Bradley
Strategic Airport Security Rollout
LM Mission Systems
Lockheed Martin
Clarksburg, Maryland
301-428-5001
Timothy.Bradley@lmco.com

James M. Crites
Dallas/Fort Worth International Airport
P.O. Drawer 619428
3200 E. Airfield Drive
DFW Airport, Texas 75261-9428
972-574-3207; 972-574-5509
jcrites@dfwairport.com

Augusto Dallorto
Badallsa Engineering
Las Grazos 406
Lima 27, Peru
agdallorto@yahoo.com

William Dunlay
Leigh Fisher and Associates
160 Bovet Road, Suite 300
San Mateo, California 94462
650-571-7722; 650-571-5220
billd@leighfisher.com

Papa M. Fall
Delaware Department of Transportation
800 Bay Road
Dover, Delaware 19903
302-760-2080
pfall@mail.dot.state.de.us

Anna Fenton
Leigh Fisher and Associates
160 Bovet Road, Suite 300
San Mateo, California 94462
650-571-7722; 650-571-5220
annaf@leighfisher.com

Berta Fernandez
Landrum & Brown
11279 Cornell Park Drive
Cincinnati, Ohio 45242
513-530-215; 513-530-1278
bfernandez@landrum-brown.com

Clint Fisher
Office of Security, Regulation, and Policy
Transportation Security Administration
400 7th SW (Room 3034-
Washington, D.C. 20590
202-385-1235
Clint.fisher@tsa.dot.gov

David Goldstein
U.S. General Accounting Office
441 G St. NW, Room ZT23
Washington, D.C. 20548
202-512 8190; 202-512-3766
goldsteindb@gao.gov

Geoffrey Gosling
Aviation System Planning
305 Colusa Avenue
Berkeley, California 94707
510-520-8741; 510-528-8745
gdgosling@aol.com

Jay Goyal
Strategic Airport Security Rollout Program
Transportation Security Administration
1011 Arlington Boulevard, #803
Arlington, Virginia 22202
Jay.goyal@tsa.dot.gov

Eric Grasser
Airport Security Report
Potomac, Maryland
301-354-1823
egrasser@pbimedia.com

Mohamed Hadi
PBS&J
3230 West Commercial Boulevard, #100
Fort Lauderdale, Florida 33309
954-733-7233; 954-733-1101
mhadi@pbsj.com

Belinda Hargrove
TransSolutions, Inc.
14600 Trinity Boulevard, Suite 200
Fort Worth, Texas 76135
817-359-2958; 817-359-2959
Bhargrove@transsolutions.com

William Hepler
Preston Aviation Solutions
3901 Boswell Road, Suite 207
Marietta, Georgia 30062
770-579-0915

Brendan Hogan
MITRE—CAASD
7515 Colshire Drive (Mississippi: N590)
McLean, Virginia 22102
bhogan@mitre.org

Michael Hunter
Center for Transportation Research
University of Texas at Austin
3208 Red River
Austin, Texas 78765
mhunter@mail.uTexas.edu

Howard Kass
Office of Legislative, Economic, and Regulatory Analysis
Transportation Security Administration
400 7th Street SW
Washington, D.C. 20590
571-227-2627
Howard.Kass@tsa.dot.gov

Max Kiesling
Ricondo & Associates
8610 N. New Brumfels
San Antonio, Texas
m-kiesling@ricondo.com

Craig Leiner
MASSPORT
One Harborside Drive, Suite 2005
Boston, Massachusetts
617-568-3536; 617-568-3518
cleiner@massport.com

Mark Long
1548 Bandera Court
Columbus, Ohio
H-mail@mindspring.com

Mark Lunsford
Leigh Fisher and Associates
160 Bovet Road, Suite 300
San Mateo, California 94402
650-961-1369; 650-961-9318
markl@leighfisher.com

Evert Meyer
Leigh Fisher and Associates
160 Bovet Road, Suite 300
San Mateo, California 94402
650-571-7722; 650-571-5220
evertm@leighfisher.com

Eric Miller
TransSolutions
14600 Trinity Boulevard, Suite 200
Fort Worth, Texas 76155
817-359-2950; 817-359-2959
emiller@transsolutions.com

David J. Nielson
Boeing Commercial Airplanes
P.O. Box 3707 (MC 0R-RM)
Seattle, Washington 98124-2207
425-342-7577
David.j.nielson@boeing.com

Cheech Ong
Leigh Fisher and Associates
160 Bovet Road, Suite 300
San Mateo, California 94462
650-571-7722; 650-571-5220
cheecho@leighfisher.com

Tom Phillips
Keiser Phillips Associates
Seattle, Washington
206-284-6994
airports@keiserphillips.com

Fengxiang Qiao
Texas Department of Transportation
Houston, Texas 77004
Qiao-fg@tsu.edu

Bud Reiff
Lane Council of Governments
99 E. Broadway
Eugene, Oregon 97401
541-682-4283
breiff@lane.cog.or.us

Adriana Rossiter
University of Maryland
6113 42nd Place
Hyattsville, Maryland 20789
301-927-1136
arossite@rhsmith.umd.edu

Anis Tannir
Consultant
3713 Dorsey Search Circle
aat@patriot.net

Charles Thomas Jr.
Southwest Airlines (HDQ-6FA)
2702 Love Field Drive
P.O. Box 36611
Dallas, Texas 75235
214-792-4156; 214-792-4022
Chuck.Thomas@wuco.com

Keith Thompson
Gensler
2500 Broadway
Santa Monica, California 90404
310-449-5809; 310-449-5850
Keith-thompson@gensler.com

Cenk Tunasar
TransSolution, Inc.
1600 B Huntley Creek
Alexandria, Virginia 22314
ctunasar@transsolutions.com

Waheed Uddin
Civil Engineering Deptartment (203)
University of Mississippi
University, Mississippi 38677-1848
652-915-5303; 652-915-5523
wuddin@olemiss.edu

Bo Underwood
Applied Research Associates
1208 Thomas Place
Fort Worth, Texas 76107
bo@ara.com

Doug Wendt
Preston Aviation Solutions
3901 Boswell Road, Suite 207
Marietta, Georgia 30062
770-579-1591; 770-579-1598
dsw@preston-aviation.com

Jody Yamanaka-Clovis
Port of Seattle
P.O. Box 68727
Seattle, Washington 98117
206-433-4640
Yamanaka.j@portseattle.org

Jin-Ru Yen
Department of Shipping and Transportation Management
National Taiwan Ocean University
STM304
Keelung, Taiwain
jyen@mail.ntou.edu.tw

Seth Young
Deptartment of Business
Embry-Riddle Aeronautical University
600 S. Clyde Morris Boulevard
Daytona Beach, Florida 32117
386-226-6723; 386-226-6696
yongs@arau.edu

Kate Hunter-Zaworski
CCEE
Oregon State University
202 Apperson Hall D54
Corvallis, Oregon 97331
hunterz@engr.orst.edu

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