Agenda

- Introduction & background
- TRACS
  - Input processor
  - Building models
  - Output analyzer
- Examples of airport modeling projects
- TRACS summary
Introduction & Background
TransSolutions’ Capabilities

Interdisciplinary staff
- Industrial engineers
- Operation researchers
- Scientists
- Mathematicians

Areas of expertise
- Terminals
- Air field
- Baggage systems
- Security areas
- Roadways/parking

Knowledge base
- Forecasting
- Logistics
- Mathematical programming
- Optimization
- Simulation
- Statistical analysis
- Stochastic processes

Models
- TRACS, Arena, AutoMod
- SIMMOD
- CORSIM, VISSIM
TransSolutions’ Projects

TransSolutions has worked at 24 of the 25 largest airports in the world.

Worked in Over 20 Countries
Modeling Approach

- Diverse set of tools are used based on project requirements
  - AutoMod - 3-D modeling, baggage systems
  - SIMMOD - Airfield and airspace modeling
  - ARENA - Initial modeling environment for most airport terminal models
  - CORSIM/VISSIM - Highway modeling
  - TRACS - Terminal, Roadway, and Curbside Simulation environment developed by TransSolutions for landside modeling and analysis

- Can model the total system of integrated airport components
  - Airport and airline operating environment
  - Interdependencies between functions

- Know what data is needed to accurately model various aspects of terminal operations
Typical Areas of Airport Modeling

- Airport access roadway
- Terminal curbside
- Parking garage
- Ticketing
- Checked bag security processing (i.e., EDS)
- Security checkpoints
- Concourse passenger movements
- Automated people mover
- Outbound baggage system
- Bag claim
- Federal inspection service (Immigration, Customs, etc.)
- Ramp operations (baggage handling, catering, fueling, etc.)
- Aircraft movements
Objective
- Compare options

System components
- Curbside roadway
- ATO, security
- Concessions, corridors
- Gates, holdrooms
- Inbound baggage

Performance criteria
- Roadway usage
- Passenger processing
- Level of service
- Resource usage
- Walking distances
TRACS

Terminal, Roadway, and Curbside Simulation

One Framework
- Individual passengers
- Baggage
- Ground vehicles

24-hour day
- Customized output statistics
- Level of service standards

Validated
- Over 200 studies
- 10 years of use
- Statistical validations to real-world data

Seamless animation
- Vehicle arrival to curbside
- Passengers enter terminal
- Ticket counters
- Baggage check-in
- Security inspection
- Customs, immigrations
- Baggage claim

Can be linked to:
- SIMMOD, TAAM, etc.
- CORSIM, VISSIM
TRACS Process Design

- Input Processor: Flight Schedule and Data
- Simulation Model
- Output Processor: Analysis and Demand Results
Input Processor

Scenario Management

- Data input and organization
- Flight schedule and related information
- Passenger and operational characteristics

Demand development for simulation model(s)
Input Processor

Scenario Management

- Data input and organization
- Flight schedule and related information
- Passenger and operational characteristics

- Demand development for simulation model(s)
TRACS Process Design

Input Processor

Flight Schedule and Data

Demand

Simulation Model

Results

Output Processor

Analysis
Airport-specific templates

- Quick insertion of components to model
- Customized input data
- Flexible, combined with Arena code
Simulation Model

- Airport-specific templates
- Quick insertion of components to model
- Customized input data
- Flexible, combined with Arena code
Simulation Model
Simulation Model
Simulation Model
Simulation Model
Simulation Model
Simulation Model
TRACS Process Design

Input Processor
Flight Schedule and Data

Simulation Model
Demand
Results

Output Processor

Analysis

Demand

Results
Output Processor

- Collects and organizes results from model
- Output data management
- One step to produce charts
- Flexible in chart characteristics
- Easily export data to other presentations
Output Processor

- Collects and organizes results from model
- Output data management
- One step to produce charts
- Flexible in chart characteristics
- Easily export data to other presentations
Collects and organizes results from model
- Output data management
- One step to produce charts
- Flexible in chart characteristics
- Easily export data to other presentations
Output Processor

- Collects and organizes results from model
- Output data management
- One step to produce charts
- Flexible in chart characteristics
- Easily export data to other presentations
Output Processor

- Collects and organizes results from model
- Output data management
- One step to produce charts
- Flexible in chart characteristics
- Easily export data to other presentations
Examples of Airport Modeling Projects
## Recent Project Work

<table>
<thead>
<tr>
<th></th>
<th>ATL</th>
<th>BOS</th>
<th>DFW</th>
<th>IAH</th>
<th>JFK</th>
<th>MIA</th>
<th>MCI</th>
<th>OAK</th>
<th>SJC</th>
<th>SFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport Access Roadway</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Terminal Curbside</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Parking Garage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ticketing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Checked Bag Security</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Security Checkpoints</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Concourse Passenger Flow</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Automated People Mover</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Outbound Baggage System</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Bag Claim</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Federal Inspection Service</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ramp Operations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Aircraft Movements</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
George Bush Intercontinental Airport Houston (IAH) Roadway
IAH Roadway

Objective

- Assess roadway and curbside capacity under various construction projects

Performance criteria

- Roadway throughput
- Vehicle delays
IAH Roadway (TRACS)

- System components
  - Complete airport curbsides and circulation roadways
  - Access to and from parking facilities
IAH Roadway (CORSIM)

- System components
  - Regional freeways
    - Beltway 8
    - US 59
    - Hardy Toll Road connector
  - Airport access roadways
    - JFK Blvd
    - Will Clayton Pkwy
IAH Simulation Model Results

- Model Validation Results

**Rate of Vehicles on a Test Segment**

- **Time of Day**
  - 6:00, 6:30, 7:00, 7:30, 8:00, 8:30, 9:00

- **Number of Vehicles / 5 minutes**
  - 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200

- **Field Test**
- **Model Avg**

---

**Graph Description:**

- The graph shows the rate of vehicles on a test segment over time.
- The x-axis represents the time of day from 6:00 to 9:00.
- The y-axis represents the number of vehicles in 5-minute intervals.
- The graph compares the field test data with the model average.

---

**Legend:**

- Field Test
- Model Avg

---

**Translation:**

- IAH Simulation Model Results

- Model Validation Results

**Rate of Vehicles on a Test Segment**

- **Time of Day**
  - 6:00, 6:30, 7:00, 7:30, 8:00, 8:30, 9:00

- **Number of Vehicles / 5 minutes**
  - 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200

- **Field Test**
- **Model Avg**

---

**Legend:**

- Field Test
- Model Avg
IAH Simulation Model Results

- Benefits to client
  - Afforded the client the ability to forecast the impact of scheduled lane closures (due to construction) on curbside roadway traffic
  - Helped client to determine the required capacity (number of lanes) to meet traffic demand during peak periods

![Vehicle Queues at Terminal C U-Ramp](image)
San Francisco International Airport

- **Objective**
  - Quantify the impacts of modifications to the ticketing process

- **Areas modeled**
  - Curbside
  - Ticketing
  - Security checkpoints

- **Performance criteria**
  - Minimize passenger flow times, queues through ticketing and security
  - Level of Service in the corridors and lobby areas
Dallas/Fort Worth Baggage System Analysis

Objective
- Assist in developing bag system design

Areas modeled
- Mainline conveyors
- EDS screening areas
- Manual encoders
- ATO, curbside, and transfer input belts
- Early bag storage (EBS) facility

Performance criteria
- Bags reach gates before departure
- Prevent excessive queuing in system
- Adequate EDS processing area
Objectives
- Evaluate the performance of the proposed Federal Inspection Service (FIS)

Areas studied
- Immigration
- International bag claim
- Customs/Agriculture
- Recheck

Performance criteria
- Queue lengths
- Time through FIS
- Level of service
Miami International Airport Ramp

- Objective
  - Determine if adequate space is provided for Ground Support Equipment (GSE) movement

- Areas modeled
  - Aircraft movement
  - Cart staging
  - Aircraft loading/unloading
  - Vehicle movements

- Performance criteria
  - Ramp space for staging
  - Delivery time
Modeling Passenger Behavior

- Amount of detail depends on modeling objectives
- Behavior needs to be identified through observation and data collection
- Model behavior as discrete events/decisions
  - Vehicles
  - Passenger movements
  - Congestion
  - Discretionary time
DEN Checkpoint Screening

- **Objective**
  - Determine number of checkpoints needed
    - Today
    - Future

- **Areas modeled**
  - South checkpoint
  - North checkpoint
  - Concourse A

- **Performance criteria**
  - Passenger time in queue
TRACS Summary

- Provides ability to perform quick analyses
  - Scenario control and data management
  - Flexible and powerful model
  - Automated outputs and graphics development

- User can concentrate on analyses and conclusions rather than managing data or developing code

- Flexible and capable of modeling all landside aspects of airport terminal

- Can be interfaced with other tools to analyze entire airport system