Venue Public Security & Stadium Access Security

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CCICADA

• Founded 2009 as DHS University COE
  – Based at Rutgers University; many partners
  – Data analysis, modeling, and simulation; information-based decision making and planning

• *Here a selection of CCICADA projects relevant to transportation security:*
  – *Port Authority Bus Terminal NYC:* Modeling & simulation; “what-if” planning for evacuation, active shooter, emergency situations, crowd management
  – *Modeling tools for design/redesign of facilities* with safety in mind
  – *Patron screening tools* developed for and used by all major sports leagues – for planning & investment
  – *How WTMDs work in real-world stadium situations:* Experimental Results
Evacuation Planning Tool

- Work with 6 NFL teams & Super Bowls
- CCICADA component of the work: behavioral aspects of stadium evacuation
CCICADA: From Evacuation to a Large Stadium Security Program

Engagement with stadiums and Super Bowl through “sport evac” process led to connections to stadium security: *work with all major sports leagues*

- *All aspects of stadium security*
- “*Best Practices for Stadium Security*” with DHS Office of SAFETY Act Implementation (OSAI) – *on OSAI website*
  - Widely used. E.g, new Little Caesars Arena, Detroit
- OSAI II: *Metrics*, Effectiveness, and Training for Inspections and Credentialing – *on OSAI website*
- OSAI III: *randomness*: ongoing
- *Crowd Management*
I. Port Authority Bus Terminal

- PABT in NYC: world’s busiest bus terminal
- Critical transit facility to move people between NYC and NJ
- Central part of any emergency evacuation scenario for Manhattan
- Our stadium work led to a project for PABT:
  - LiDAR to produce Building Information Model
  - Crowd Management Simulation Software
Why Crowd Simulation?

- Evaluate surveillance and inspection strategies
- Evacuation scenarios and extreme conditions
- Study queuing and crowd management strategies
- Structural changes, construction and gate reassignment
- Impact on retail and commercial venues
Port Authority Bus Terminal Scenarios

- We built a detailed model of the Port Authority Bus Terminal
  - Used CAD drawings, improved by LiDAR
  - Used detailed information including:
    - pedestrian arrivals/departures
    - origin/destination information
    - subway arrivals
    - bus schedules
- To do “what if” experiments for scenarios such as:
  - Evacuation
  - Active Shooter
  - Delayed bus departures due to weather or accident
Agent Based Models

• Comprehensive agent-based models; each pedestrian modeled individually

• Level of detail provides many advantages:
  - Can study heterogeneous crowds with different behaviors:
    ➢ Carrying suitcase
    ➢ In a wheelchair
    ➢ Family group
    ➢ Emergent properties arising from individual behaviors
  - Can study interaction between individuals
  - Can study interaction between individual & building geometry

• Here part of an evacuation simulation
Behavior of Simulated Pedestrians

- Simulated pedestrians can visit different places: restaurant, vendor, restroom, ticket machine, … - depending upon
  - Time until bus
  - Distance
  - Capacity
- Desires based on parameterized distributions
  - Updated dynamically
II. Simulation-based Crowd Management and Environment Design

- Tools to automatically discover crowd behaviors to optimize certain criteria
- On the right, cooperation to exit narrow bottleneck faster
Office Evacuation

• Our tools helped design an optimized evacuation of 1000 people from office building.
• Time optimized model evacuates building in half the time.
Tools for Designing Environments

- We are developing tools for designing environments to achieve goals
- Here, studying effect of pillar design on crowd movement to exit
- Goal in green, crowd in blue, pillar in red
Reconfiguring an Airport Concourse to Maximize Visibility of Exit from Fixed Cameras

- Three green barriers can be moved to different locations
- Goal: Move barriers so fixed yellow cameras see red exit to optimize visibility
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III. CCICADA Stadium Simulator

• Developed to simulate patron screening processes when MetLife Stadium investigated WTMD Issues:
  – How many WTMDs needed?
  – How many screeners needed?
  – What is the “throughput”? 
  – Performance in bad weather?

• Observed experimental WTMD use at MetLife

  Preliminary conclusion: Small # of WTMDs unlikely to get everyone through quickly enough.

• Now usable for many screening methods

• Used at various stadiums for investment and screening design choices
The Stadium Simulator

Most of the parameters can be obtained by choosing a representative game.

- **Parameters**
  - Arrival rates
  - Number of lanes
  - Wanding times
  - Pat-down times
  - WTMD times

- **Screening Strategy**
  - Switching inspection type (Y/N)
    - Number of patrons in queue to switch the process, or
    - Time of switch
  - Does phase 2 include randomization? (Y/N)
    - Ratio of patrons in each type of inspection in the randomization

The model output file includes

- In Queue @ kickoff
- Queue clearance time
- Max Waiting Time per patron
- Max Queue length
Newer Features of the CCICADA Stadium Simulator

• Some of the new features added:
  – Randomly select patrons for secondary inspection
  – Additional WTMDs can be rolled out during inspection if lines get too long
  – Additional WTMDs can be rolled out at prescribed time based on planning for arrival rates and minimizing staff time
  – Reversing inspection and ticket scanning to gain information about patrons
  – Extra perimeter for bag-check
  – Change security settings on WTMDs at random times
  – Randomly select patrons for secondary screening
  – Check impact of incentives to get patrons in early
IV. Performance of WTMDs in Real Stadium Applications

• WTMDs rolled out by major sports leagues
• Don’t work the way they do in the lab
• Extensive CCICADA experiments: Effect of:
  o Height & Orientation
  o Proximity of other metal objects
  o Human gait
  o Speed
• Leading to need to rethink NIST standards
# Height and Orientation Results

- Summary of Medium sized NILECJ test objects (A & B) and Small test object (A) – WTMD Brand **anonymized here for security reasons**

<table>
<thead>
<tr>
<th>WTMD Brand 3</th>
<th>Medium A</th>
<th>WTMD Brand 3</th>
<th>Medium B</th>
<th>WTMD Brand 3</th>
<th>Medium A</th>
<th>WTMD Brand 3</th>
<th>Small A</th>
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<tbody>
<tr>
<td><strong>Orientation</strong></td>
<td><strong>Height E</strong></td>
<td><strong>Height F</strong></td>
<td><strong>Height G</strong></td>
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<th>Medium A</th>
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</table>

**Green** = successful detection 19 out of 20 trials

**Red** = failure
### Speed Results

#### WTMD - Brand 1, Height E

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Test Object</th>
<th>Speed 1 Pass</th>
<th>Speed 2 Pass</th>
<th>Speed 3 Pass</th>
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<tbody>
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<td>Medium B</td>
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<tr>
<td>B</td>
<td>Medium A</td>
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<tr>
<td>C</td>
<td>Medium B</td>
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<td>80%</td>
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#### WTMD - Brand 1, Height G

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<th>Test Object</th>
<th>Speed 1 Pass</th>
<th>Speed 2 Pass</th>
<th>Speed 3 Pass</th>
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<tbody>
<tr>
<td>A</td>
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<tr>
<td>A</td>
<td>Medium A</td>
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<tr>
<td>B</td>
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<tr>
<td>C</td>
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#### WTMD - Brand 2, Height E

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<th>Speed 2 Pass</th>
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#### WTMD - Brand 2, Height G

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#### WTMD - Brand 3, Height E

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<td>C</td>
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#### WTMD - Brand 3, at Height G

<table>
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<td>C</td>
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<td>30%</td>
<td>20%</td>
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Relevance to Aviation Security

- Modeling & simulation for crowd management allows for detailed planning of responses in emergency situations in transportation facilities.
- Modeling & simulation can be used to design/redesign aviation facilities with security in mind.
- Modeling & simulation allow the user to experiment with many alternative screening protocols and to predict the impact on security of investments in security technologies.
- Security technologies such as WTMDs do not always work as well “in the field” as they do in the laboratory.
  - New standards are called for for WTMDs in various real-world situations.
Acknowledgements

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