Venue Public Security & Stadium Access Security

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Command, Control, and Interoperability Center for Advanced Data Analysis

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**

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Evacuation Planning Tool

Credit:
Wikipedia
Commons

- Work with 6 NFL teams & Super Bowls
- CCICADA component of the work: behavioral aspects of stadium evacuation

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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***

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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***
- 

Credit: online.WSJ.com

Credit: Wikipedia

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Why Crowd Simulation?

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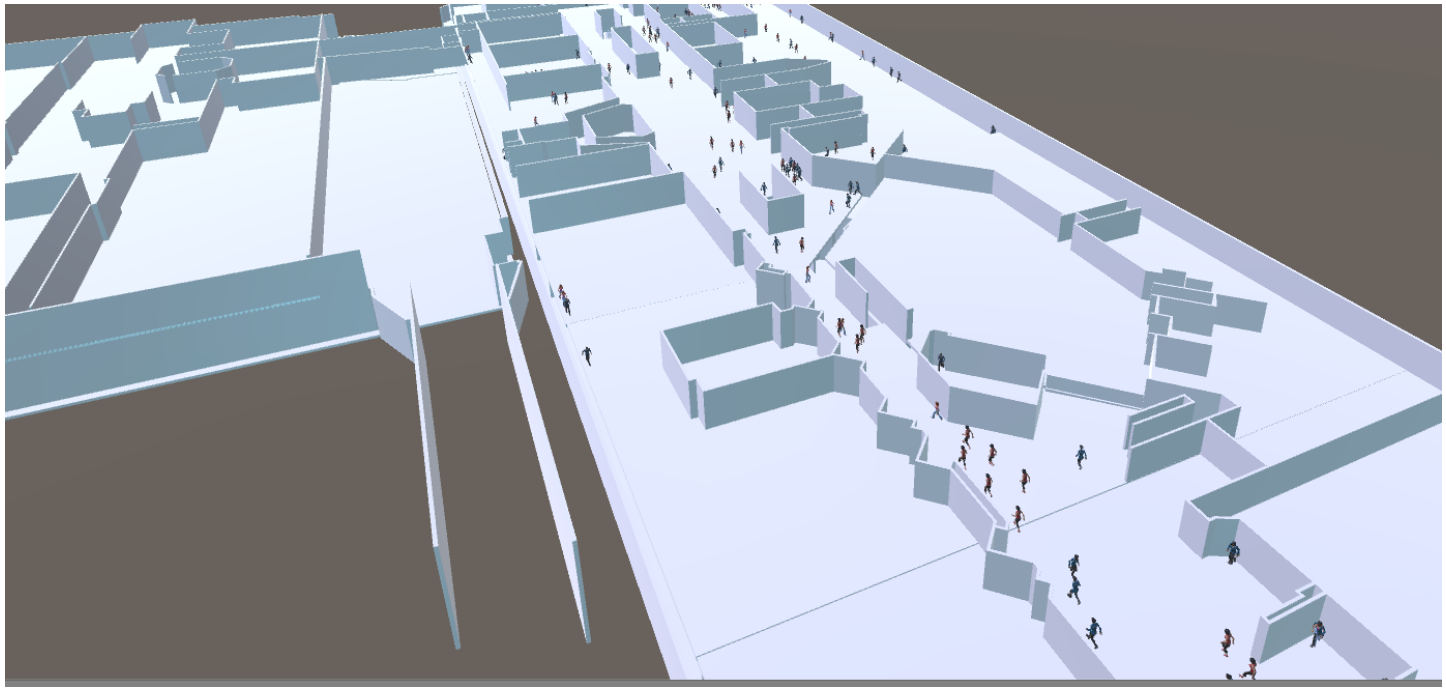
- Evaluate surveillance and inspection strategies
- Evacuation scenarios and extreme conditions
- Study queuing and crowd management strategies
- Structural changes, construction and gate reassignment
- Impact on retail and commercial venues



Port Authority Bus Terminal Scenarios

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- 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

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- 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

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- 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

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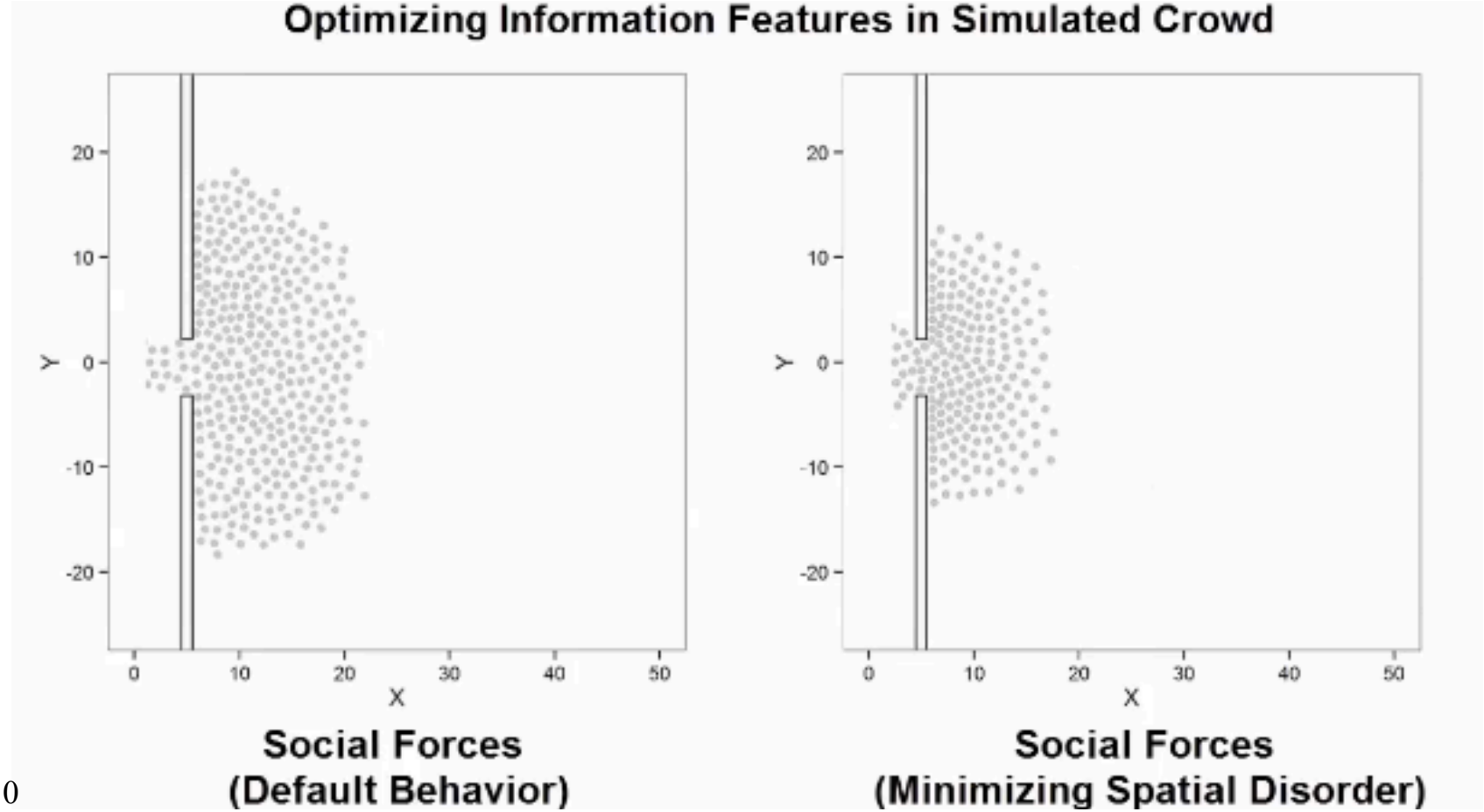
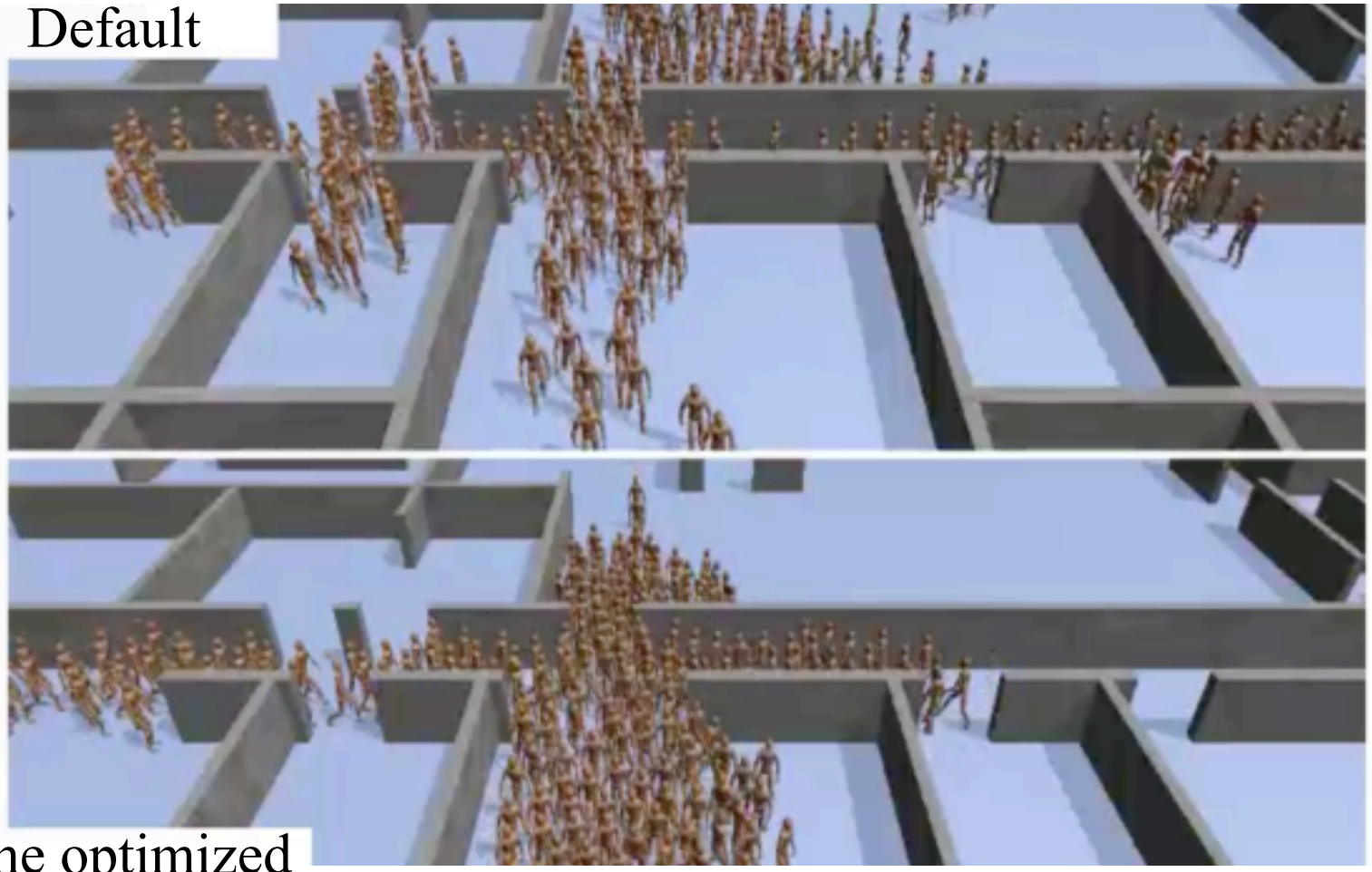
- Tools to automatically discover crowd behaviors to optimize certain criteria
- On the right, cooperation to exit narrow bottleneck faster



Office Evacuation

- Our tools helped design an optimized evacuation of 1000 people from office building.
- Time optimized model evacuates building in half the time.

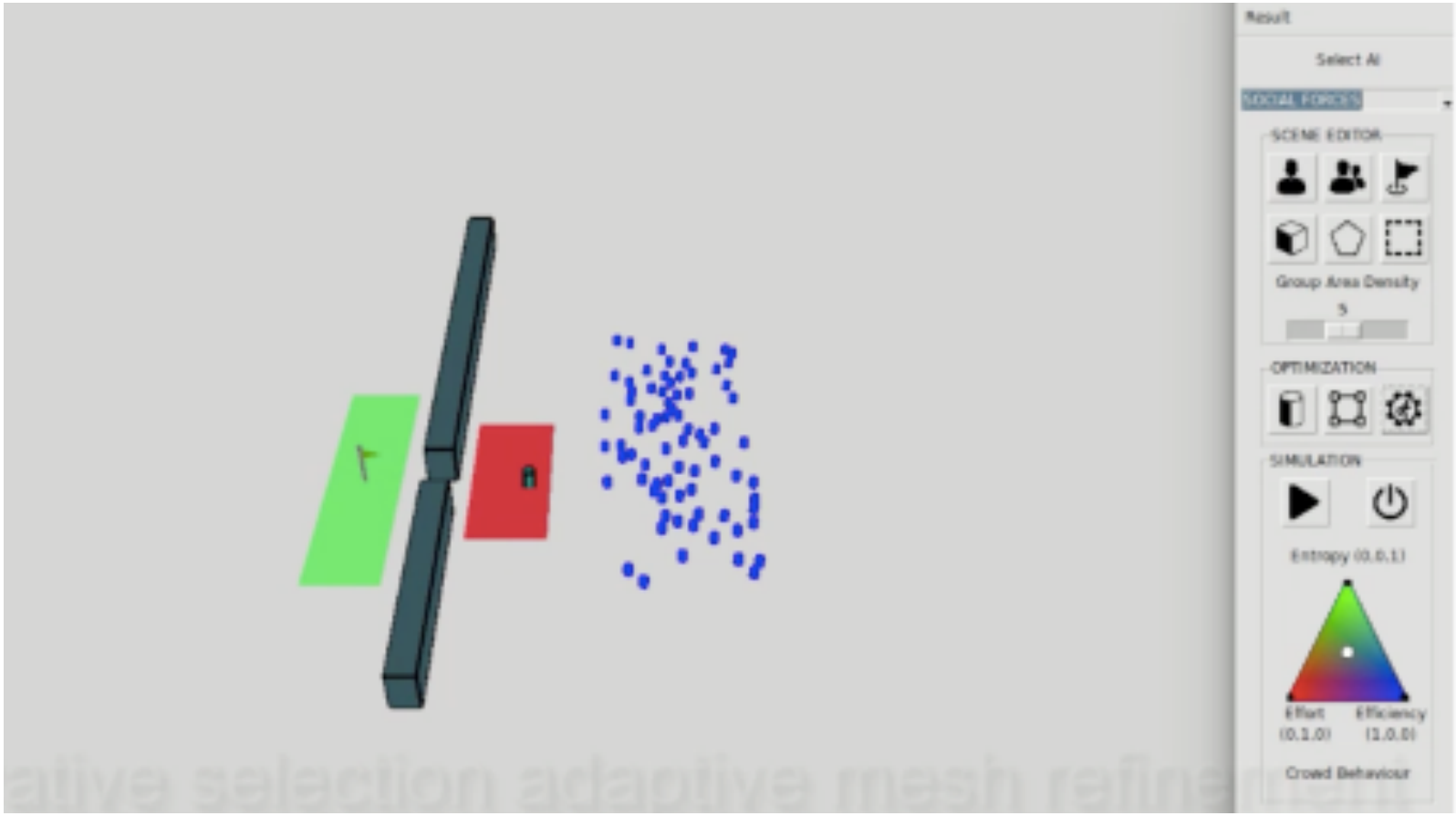
Default



Time optimized

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

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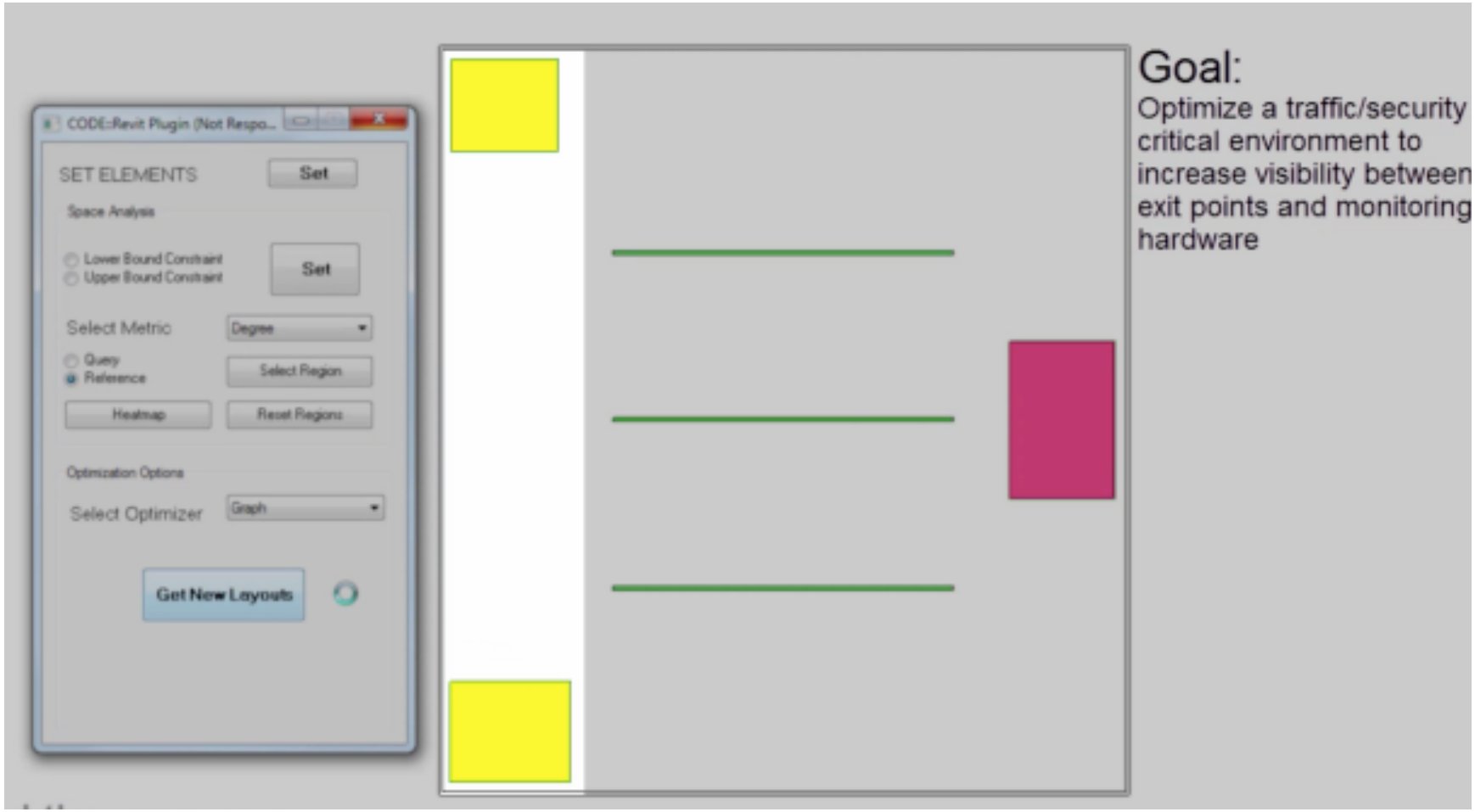
- Three green barriers can be moved to different locations
- Goal: Move barriers so fixed yellow cameras see red exit to optimize visibility



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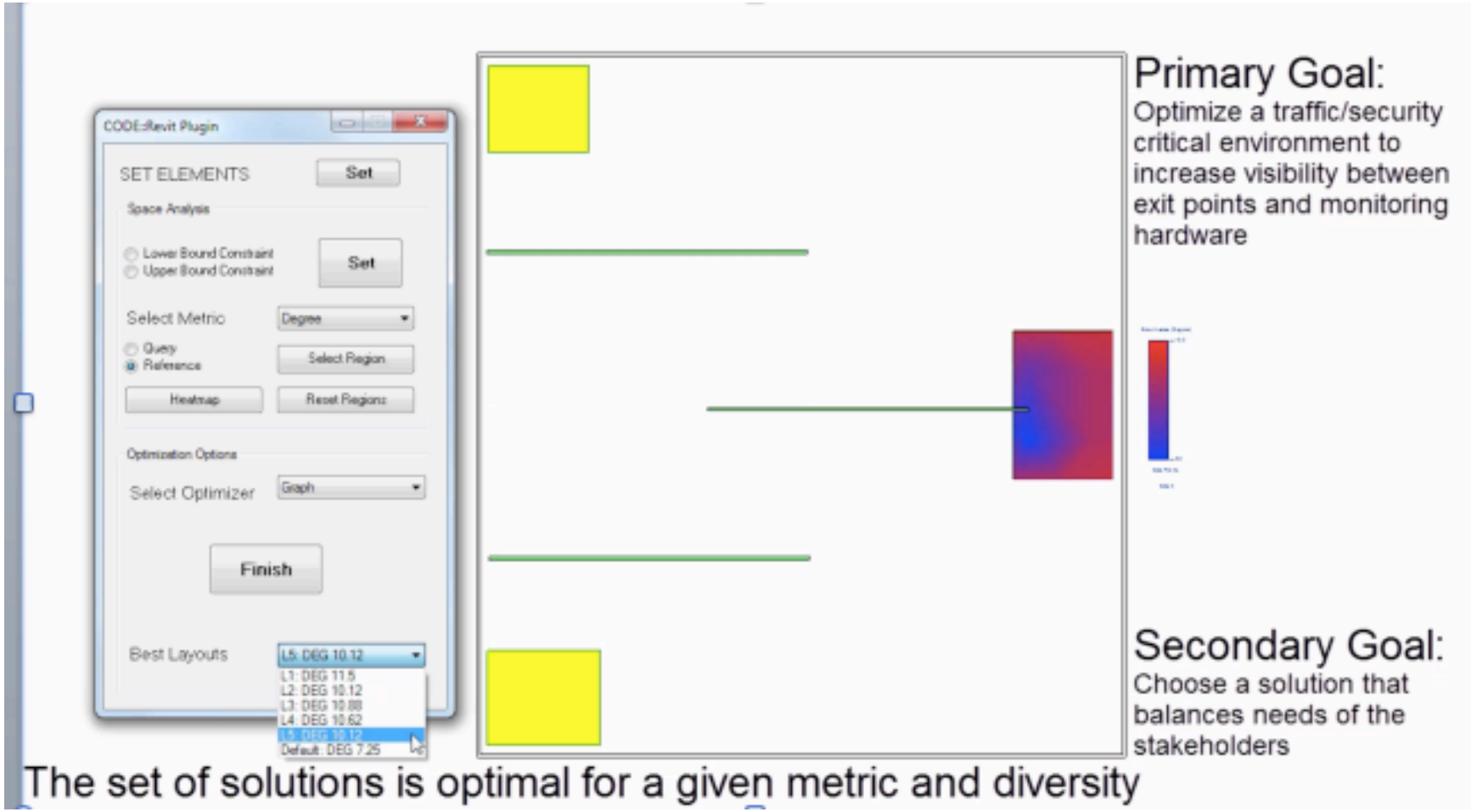

III. CCICADA Stadium Simulator

- ***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***

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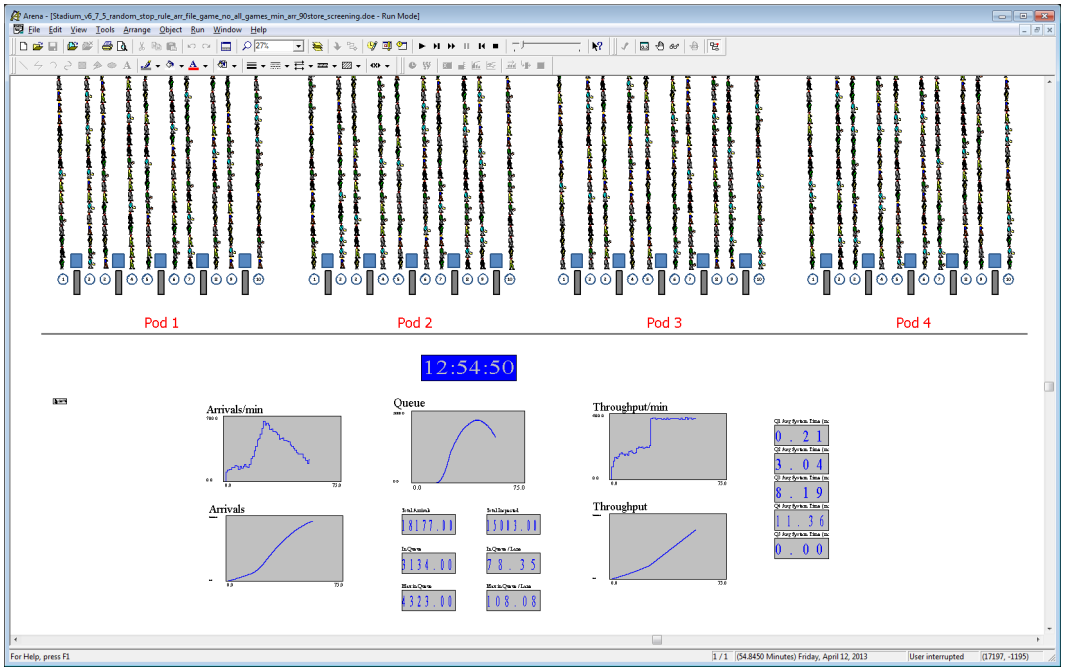
The Stadium Simulator

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**

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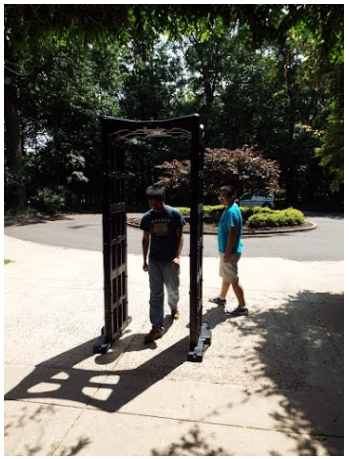
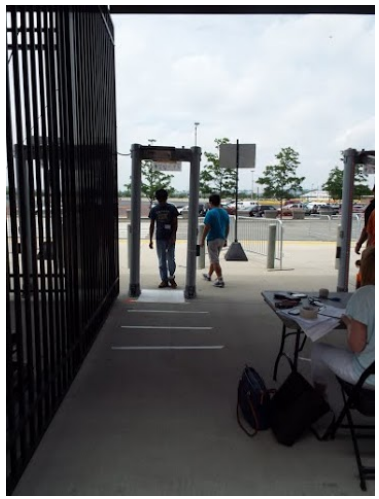
Newer Features of the CCICADA Stadium Simulator

- 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:
  - Height & Orientation
  - Proximity of other metal objects
  - Human gait
  - Speed
- Leading to need to rethink NIST standards





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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*

Medium A

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	25.0%	100.0%	95.0%
B	30.0%	100.0%	100.0%
C	85.0%	100.0%	100.0%

Medium B

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	0.0%	5.0%	90.0%
B	0.0%	0.0%	0.0%
C	5.0%	5.0%	60.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	75.0%
B	40.0%	60.0%	50.0%
C	100.0%	100.0%	75.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	35.0%
B	10.0%	100.0%	25.0%
C	100.0%	100.0%	0.0%

Small A

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	35.0%	95.0%	100.0%
B	100.0%	100.0%	100.0%
C	50.0%	100.0%	100.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A			
B			
C			

Green = successful detection 19 out of 20 trials
Red = failure

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Speed Results

WTMD - Brand 1, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	70%	90%	60%
B	Medium B	100%	70%	50%
B	Medium A	80%	100%	100%
C	Medium B	100%	90%	80%

WTMD - Brand 1, Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	50%	0%	80%
A	Medium A	10%	50%	50%
B	Medium A	70%	50%	70%
C	Medium A	0%	60%	80%

WTMD - Brand 2, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
B	Medium B	100%	100%	100%
B	Medium A	100%	100%	100%
C	Medium B	100%	100%	100%

WTMD - Brand 2, Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
A	Medium A	100%	100%	100%
B	Medium A	0%	100%	100%
C	Medium A	90%	100%	100%

WTMD - Brand 3, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
B	Medium B	100%	100%	100%
B	Medium A	0%	0%	0%
C	Medium B	100%	100%	100%

WTMD - Brand 3, at Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
A	Medium A	50%	40%	20%
B	Medium A	0%	0%	0%
C	Medium A	50%	30%	20%

Green = successful detection 19 out of 20 trials

Red = failure

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.

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