



# Pedestrian Simulation Modeling World Trade Center Memorial

**CSS National Dialogue**

**Tuesday, March 16, 2010**

**Busch Campus Center, Rutgers University**

**Piscataway, New Jersey**

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**The Louis Berger Group, Inc.**



## Presentation Outline

- Model Methodology
- World Trade Center Memorial Background
- Analysis Results/Application of CSS
- Questions/Answers



# Pedestrian Simulation Modeling

## Why Use Pedestrian Simulation Software?

- Evaluate Complex Pedestrian Environments
- Analyze to “scale” in two-dimensions in real time
- Accurately Depict Pedestrian Movement
- Model Multiple Pedestrian Behavior
- Add Pedestrian Factor to Design Process
- Can Design Accommodate Pedestrians?



## Notable Pedestrian Analysis Tools

- Analytical
  - HCS
  - Fruin Methodology (Spreadsheets)
- Simulation
  - STEPS
  - Myriad (Crowd Dynamics)
  - Legion
  - IATA

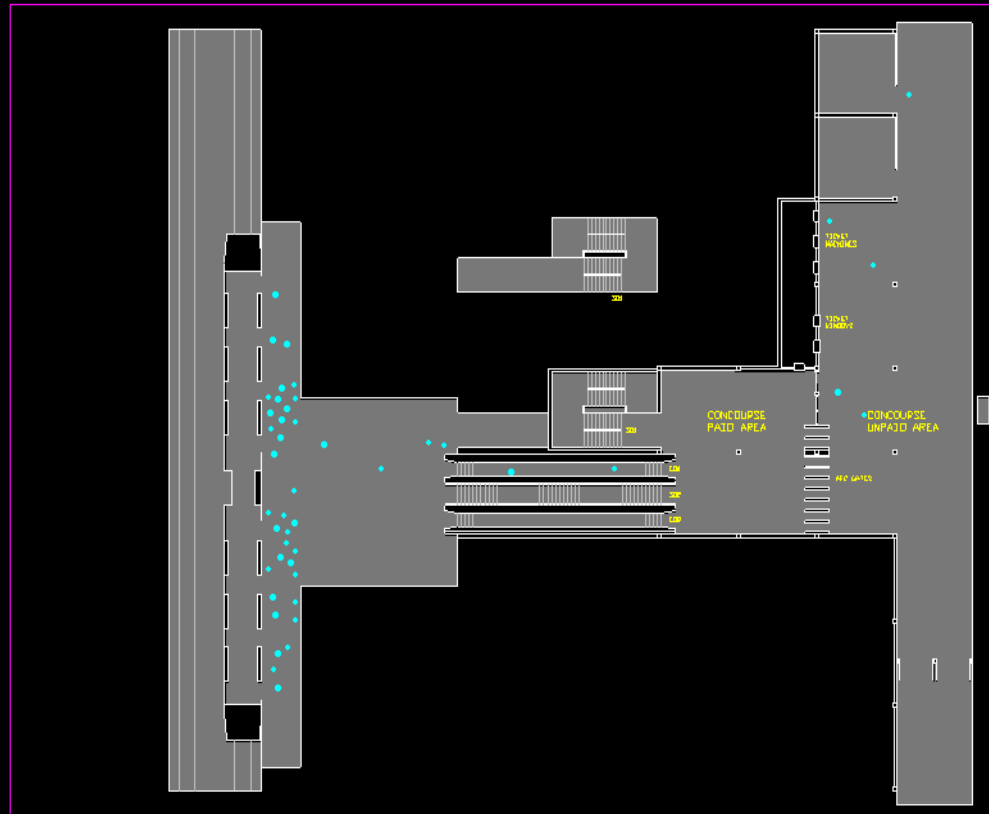


## What is LEGION Software?

- Dynamic Simulation
- Real-time
- 2-D
- Non-grid based
- Smart
- Based on Empirical Data



# Pedestrian Simulation Modeling



LEGION

17:58:00.0

## Legend

**Blue Dots** = Commuters entering the Station

**Red Dots** = Commuters leaving the Station

**Yellow Dots** = Tourists entering/leaving the station



## What do the Dots Represent?

- 2-D People with Individual Profiles
  - Age
  - Size
  - Walking Speed
  - Itinerary



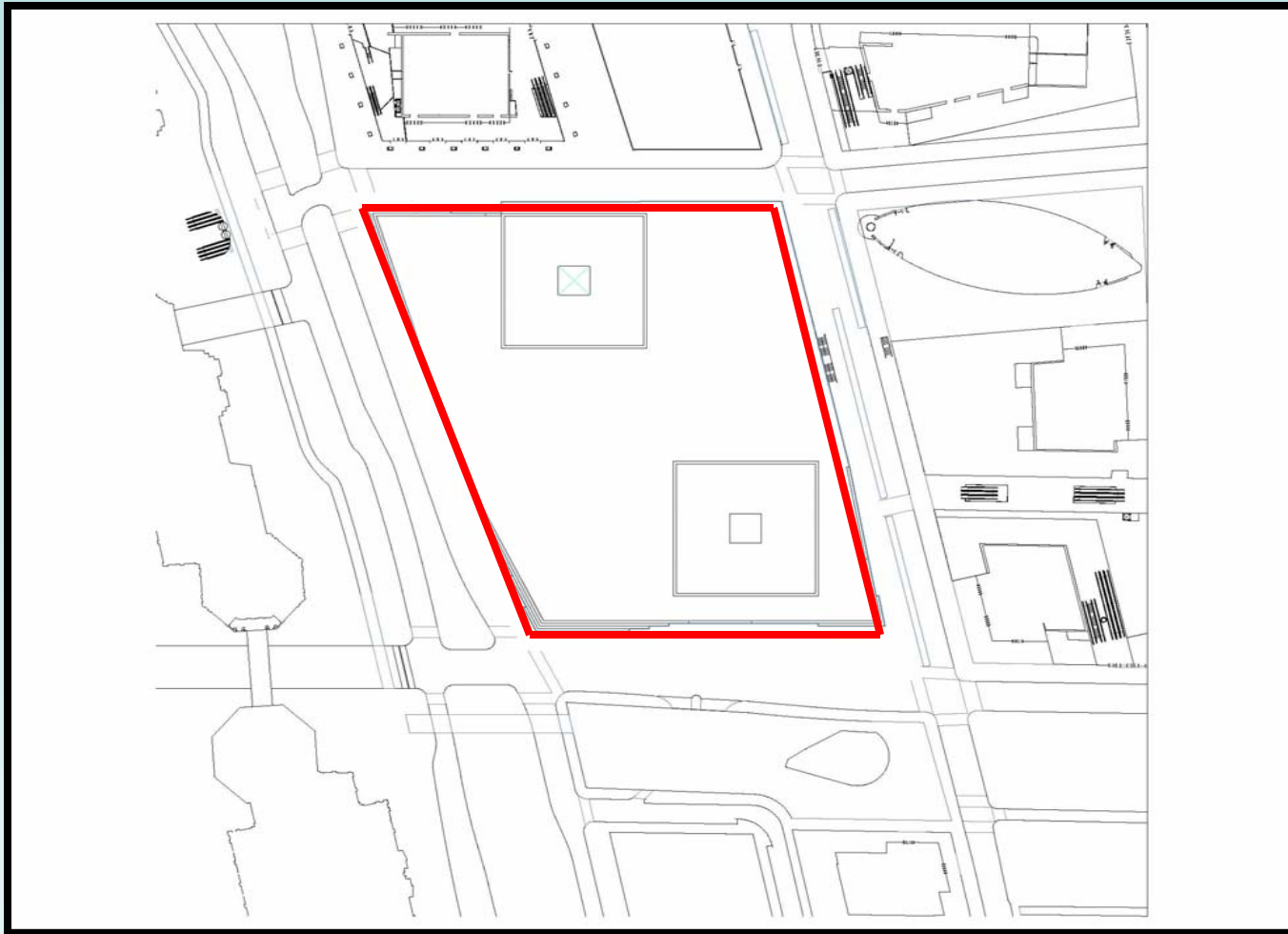
## What are the Profiles Based Upon?

- Data Collected from:
  - Europe
  - Far East
  - North America
- Pedestrian profile categories include:
  - Commuters
  - Tourists





# Pedestrian Simulation Modeling

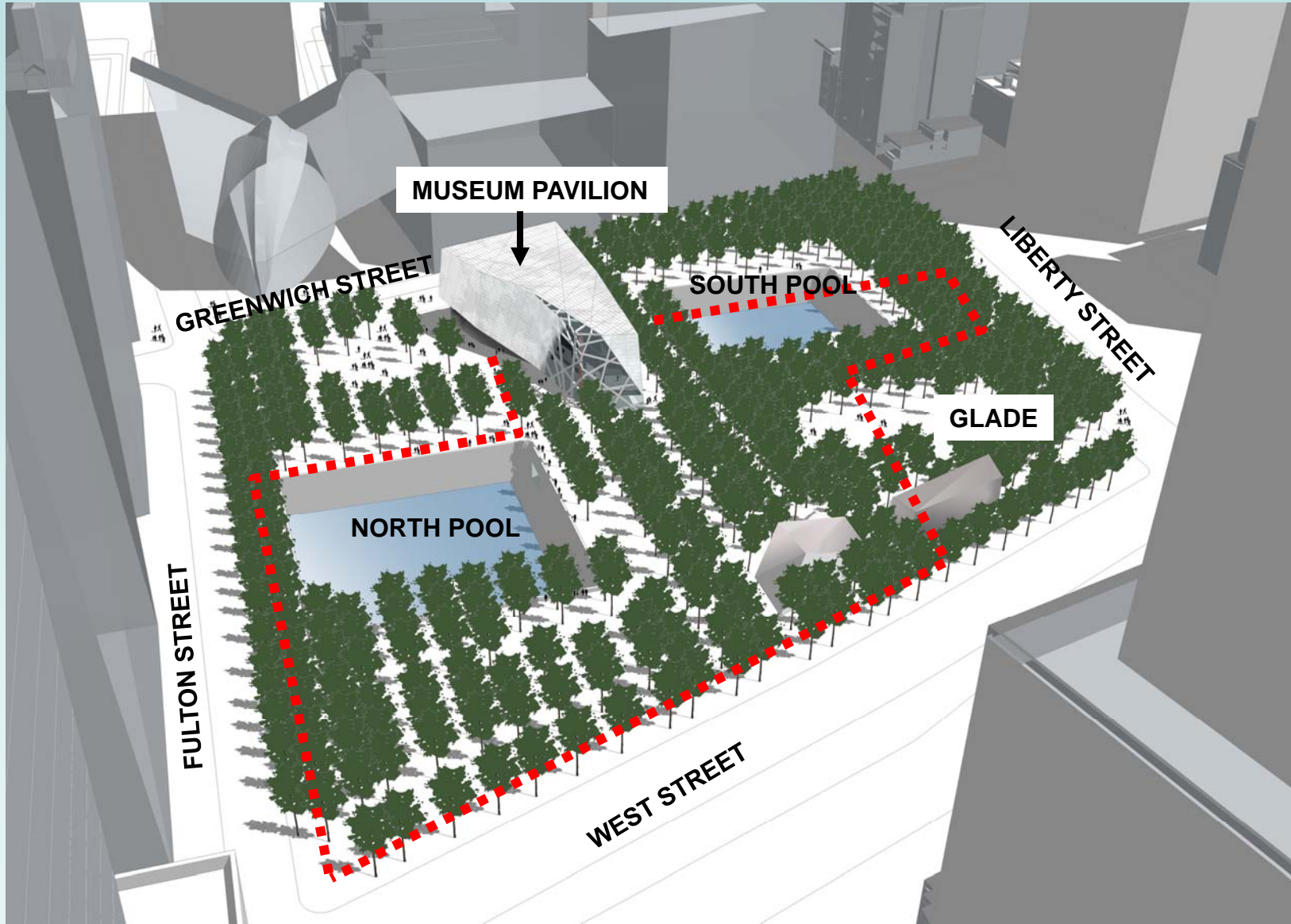


— Memorial Quadrant



# Pedestrian Simulation Modeling

## The World Trade Center Memorial







# Pedestrian Simulation Modeling

## Memorial Plaza





# Pedestrian Simulation Modeling

## Stakeholders

- National September 11 Memorial & Museum at the World Trade Center
- The Lower Manhattan Development Corporation (LMDC)
- Port Authority of NY & NJ
- New York City Department of Transportation
- New York City Transit
- New York City Department of City Planning



## Need for Pedestrian Simulation

- Physical design – queuing, ticketing, landscaping
- Visitor experience
- Operational efficiency
- Security and safety concerns
- A customized, fine grained analysis

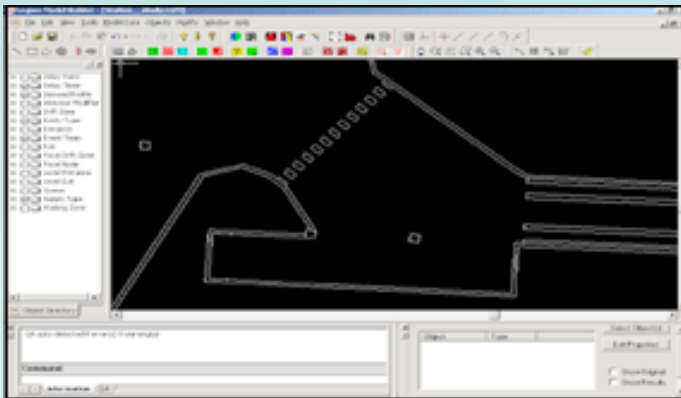


# Pedestrian Simulation Modeling

## How does the Program work?

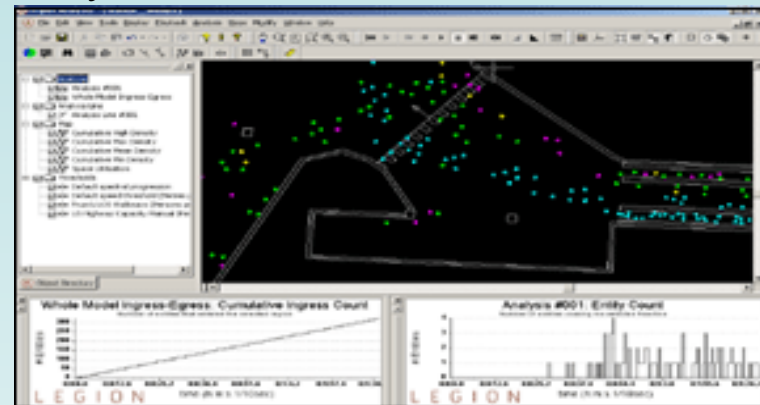
### STEP 1: THE MODEL BUILDER

Defines the environment



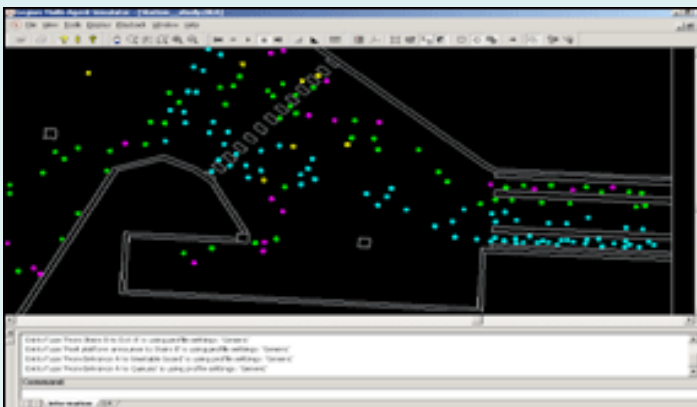
### STEP 3: THE ANALYSER

Plays the results



### STEP 2: THE SIMULATOR

Compiles the data and performs analysis







## Model Development Steps

- CAD Base Map – Site Design
- Operational Assumptions
- Pedestrian Origin/Destination Matrix
- Coding

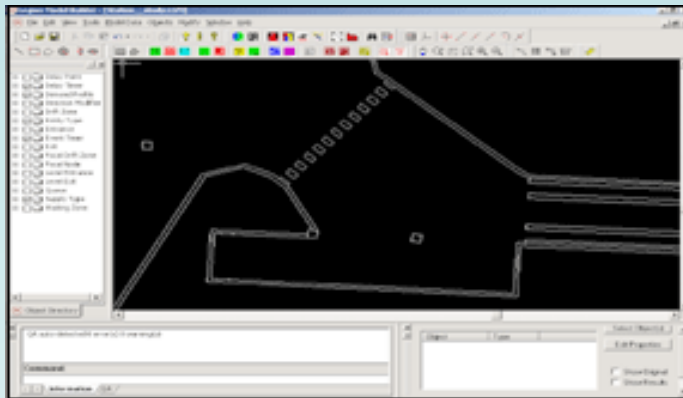


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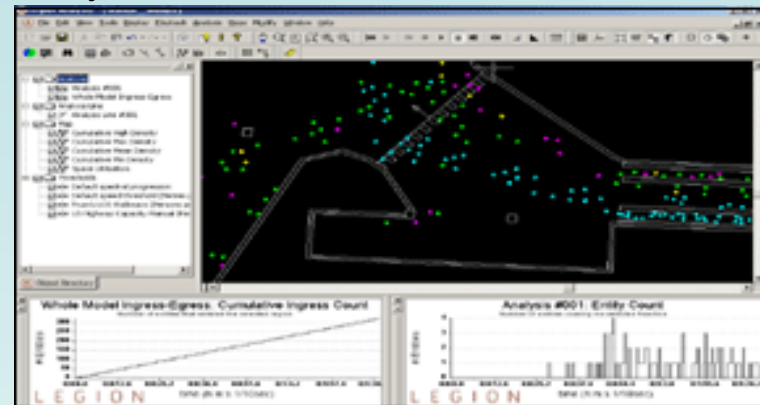
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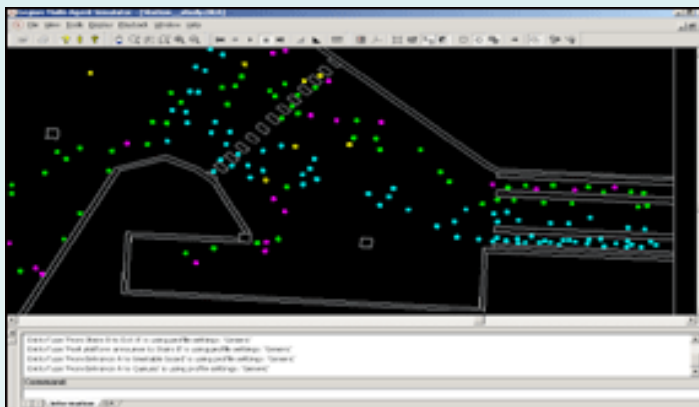
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## Key Model Analyses

- Plaza Level
- Queuing
- Security Screening
- Vertical Pedestrian Circulation
- Streetscape
- Activity Areas
- Delay Points
- Bus Operations
- Museum Space

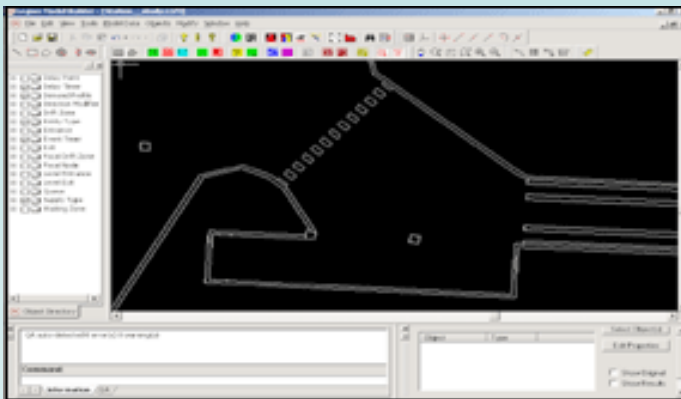


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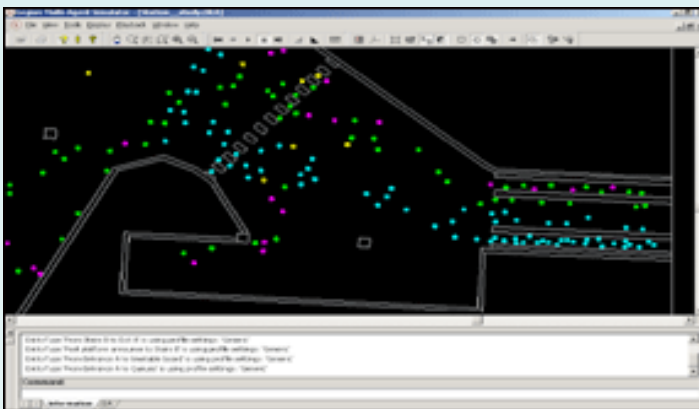
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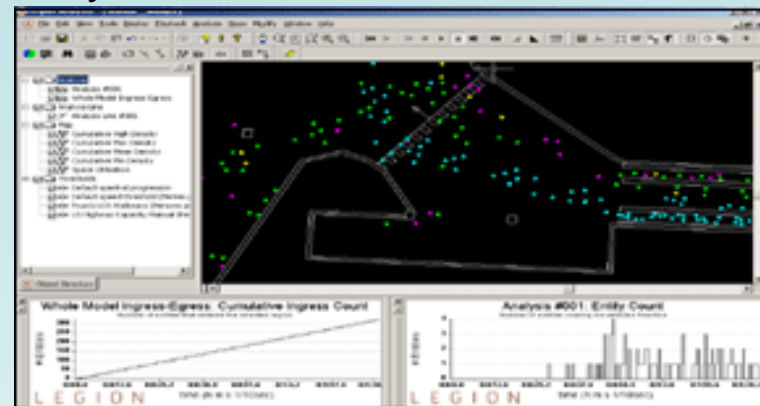
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### STEP 3: THE ANALYSER

Plays the results





## Pedestrian Model Outputs

- AVIs (Video):
  - Pedestrian Movements
  - Desire Lines
- Maps:
  - Density maps
  - Space Utilization
- Graphs:
  - Journey times
  - Waiting times/delay
  - Densities experienced
  - Satisfaction experienced

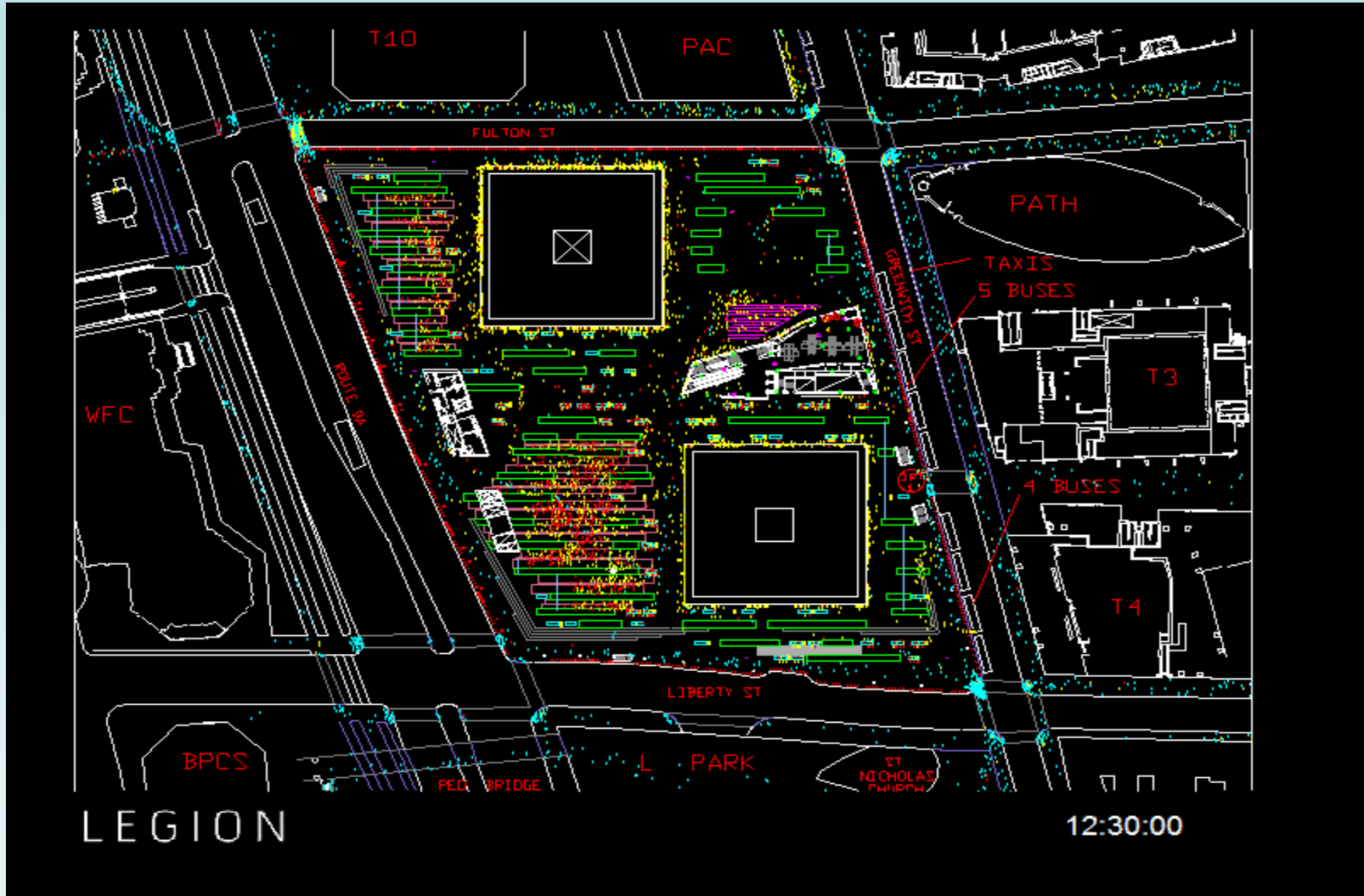


## Study Periods

- Peak Opening Year (summer)
  - Weekday Midday
  - Saturday Midday
- Stabilized Year (summer)
  - **Weekday Midday**
  - Saturday Midday



# Pedestrian Simulation Modeling



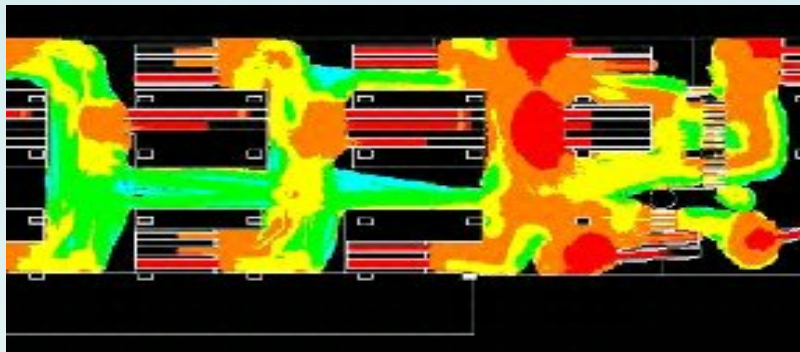
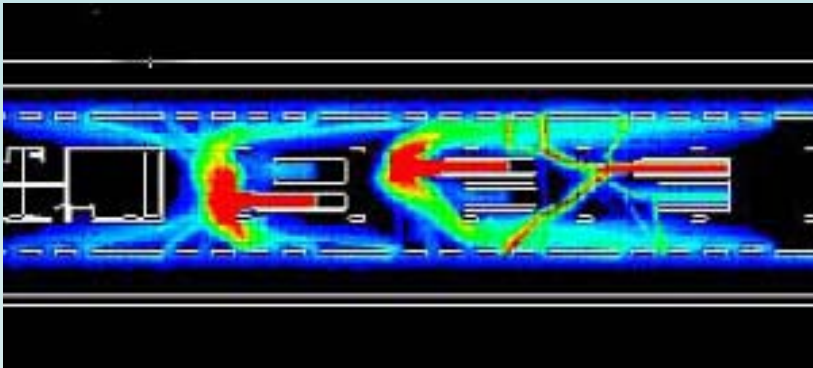
World Trade Center Memorial Site



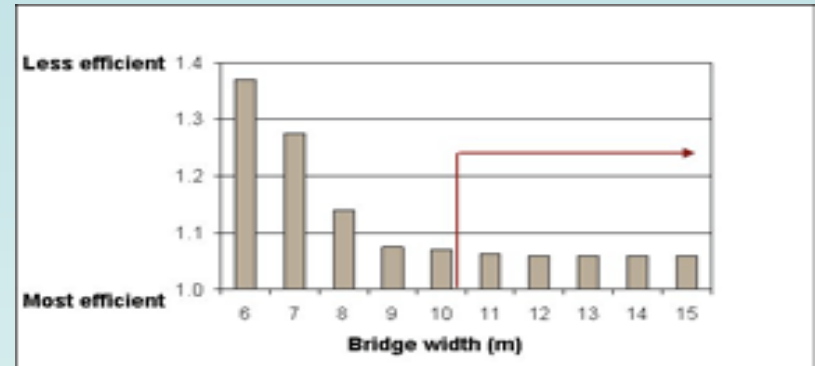
# Pedestrian Simulation Modeling

## Additional Model Outputs:

### MAPS

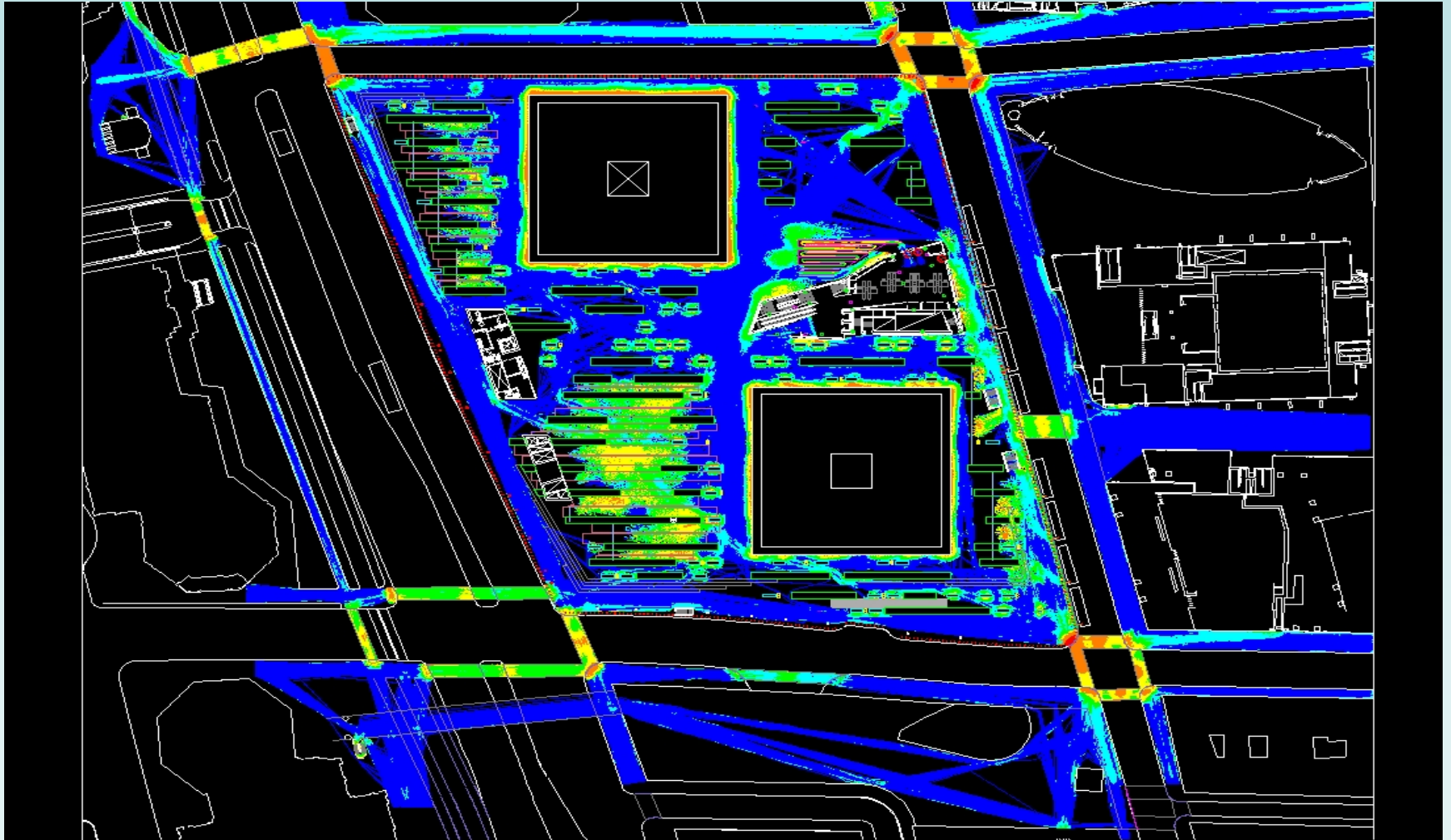


### Graphs





# Pedestrian Simulation Modeling

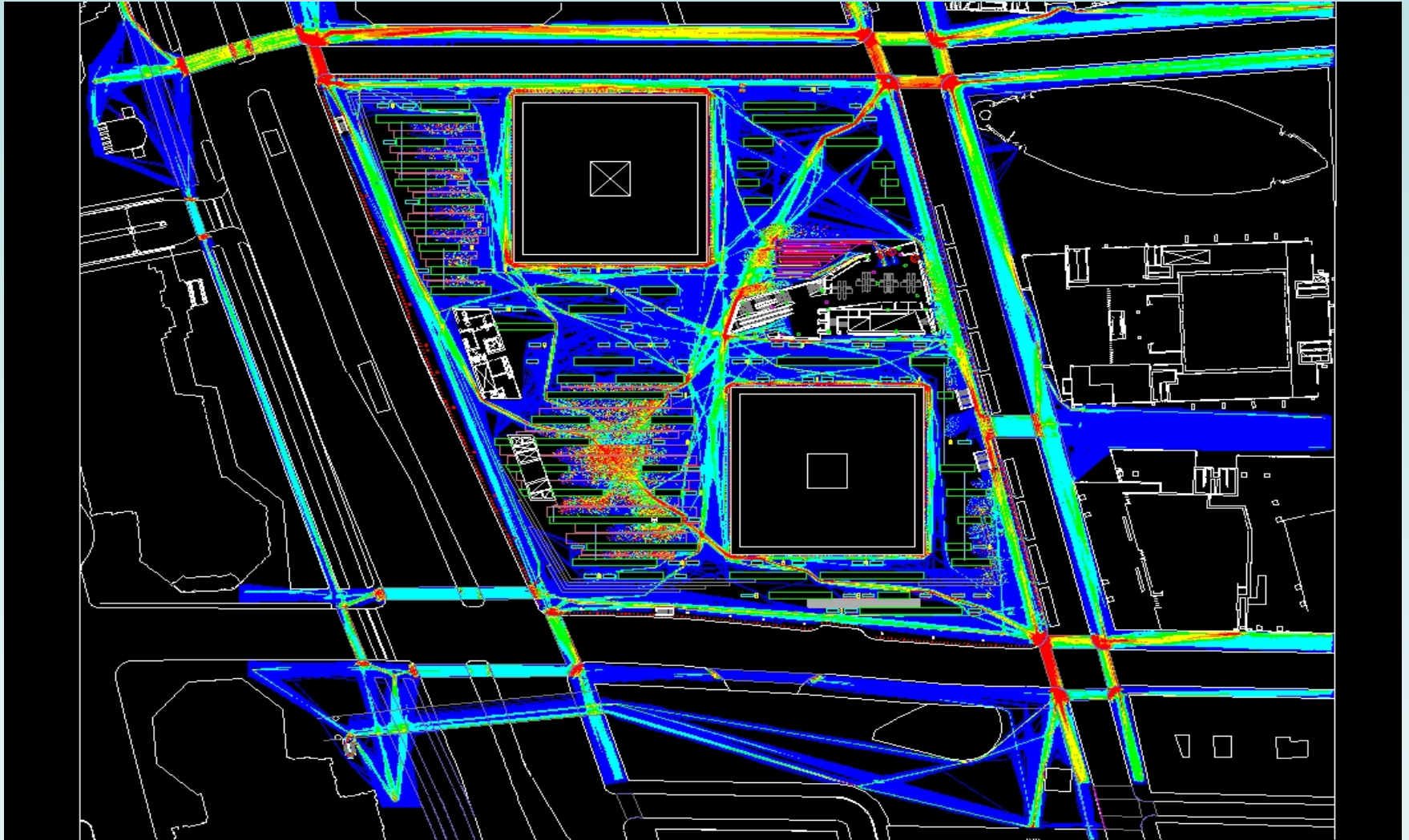


**Cumulative Mean Density (LOS) Map**





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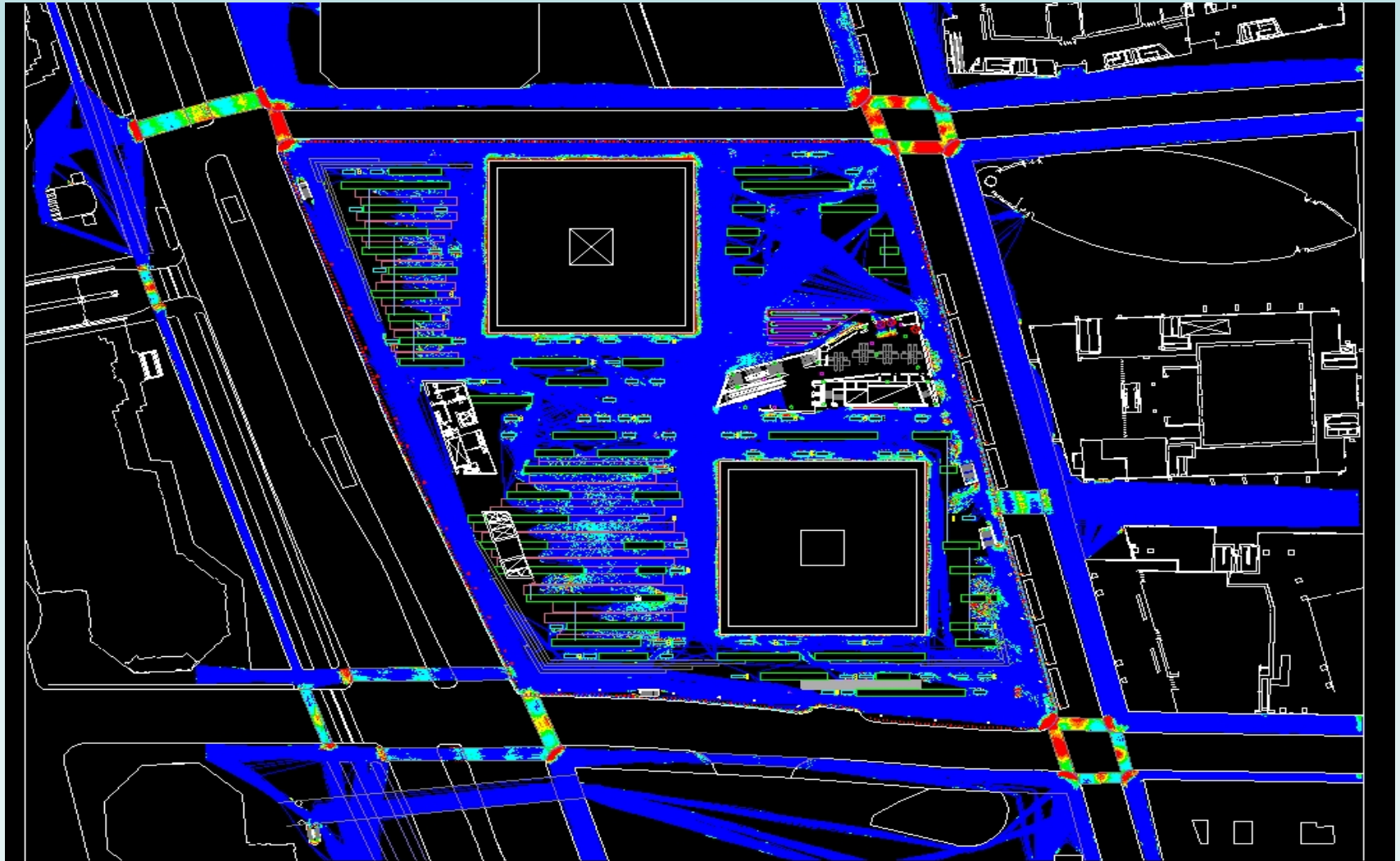


**Space Utilization Map**





# Pedestrian Simulation Modeling



Discomfort Map



# Pedestrian Simulation Modeling

- Study Results
  - Design
  - Operations
  - Validation



# Pedestrian Simulation Modeling

- Results - Design
  - Programming
  - Paths
  - Signage
  - Portal Locations
  - Building Size
  - Internal Space



- Results - Operations
  - Queuing
  - Security
  - Pools
  - Benches
  - Buses
  - Viewing Areas



# Pedestrian Simulation Modeling

- Results - Validation
  - Congestion
  - Space Utilization
  - Discomfort



## Applications of the Software:

- Transportation
- Recreation
- Retail
- Entertainment
- Security



# Pedestrian Simulation Modeling

**Questions????**