Pedestrian Simulation Modeling
World Trade Center Memorial

NYMTC Brown Bag Lunch
June 20, 2007

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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

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

Model Development Steps

- CAD Base Map – Site Design
- Operational Assumptions
- Pedestrian Origin/Destination Matrix
- Coding
- Model Output
- Recommendations
How does the Program work?

THE MODEL BUILDER
Defines the environment

THE ANALYSER
Plays the results

THE SIMULATOR
Compiles the data and performs analysis
Pedestrian Simulation Modeling

The World Trade Center Memorial

- NORTH POOL
- SOUTH POOL
- GLADE
- MUSEUM PAVILION
- WEST STREET
- GREENWICH STREET
- LIBERTY STREET
- FULTON STREET
- LIBERTY STREET
Need for Pedestrian Simulation

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

• Joint effort with LMDC, began August 2005
• Funded through project design budget
• Berger chosen for leadership in field, experience with site, and partnership with Legion
• Development of assumptions was educational
• Iterative process responded to design changes
• Results suggest the need for a district-wide, multi-modal study
Pedestrian Simulation Modeling

Memorial Quadrant
Key Model Analyses

• Plaza Level
• Queuing
• Security Screening
• Vertical Pedestrian Circulation
• Streetscape
• Activity Areas
• Delay Points
• Bus Operations
Pedestrian Model Outputs

• AVIs (Video):
  – Pedestrian Movements
  – Desire Lines

• Maps:
  – Density maps
  – Space Utilization

• Graphs:
  – Journey times
  – Waiting times/delay
  – Densities experienced
  – Satisfaction experienced
Simulation to be provided

World Trade Center Memorial Site
Simulation to be provided

World Trade Center Memorial Site:
Northeast Quadrant
Simulation to be provided

World Trade Center Memorial Site:
Southeast Quadrant
Simulation to be provided

World Trade Center Memorial Site: Southwest Quadrant
Simulation to be provided

World Trade Center Memorial Site:
Northwest Quadrant
Additional Model Outputs:

MAPS

Graphs
Map to be provided

Cumulative Mean Density (LOS) Map
Pedestrian Simulation Modeling

Map to be provided

Space Utilization Map
Map to be provided

Discomfort Map
Pedestrian Simulation Modeling

- Study Results
  - Design
  - Operations
  - Validation
• Results - Design
  – Programming
  – Paths
  – Signage
  – Portal Locations
  – Building size
• Results - Operations
  – Queuing
  – Security
  – Pools
  – Benches
  – Buses
  – Viewing Areas
• Results - Validation
  – Congestion
  – Space Utilization
  – Discomfort
Questions????