



JENSEN HUGHES

Advancing the Science of Safety

People Movement Modeling – Capabilities and Expansion of Current Models for Broader and More Robust Uses

Fire and Evacuation Modelling Technical Conference 2016

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Agenda

- Background
- Current Capabilities
- Non-Traditional Uses



Background

- People movement models traditionally developed for evacuation in emergencies, especially fire
- Needs and interest in non-traditional applications have grown with the models
- Expansion of uses increases functionality for existing building models



Current Capabilities

- Typical evacuation analysis:
 - Build geometry
 - Populate model
 - Occupants proceed to exit (sometimes with intermediate tasks)



Current Capabilities

- In general, primary goal is to exit
- Typically, some level of omniscience is inherent
 - Routes
 - Relative travel distance
 - Locked/unlocked status of doors



Ingress and Security

- Ingress into buildings or facilities with entrance procedures (security, ticketing) may incur significant delays



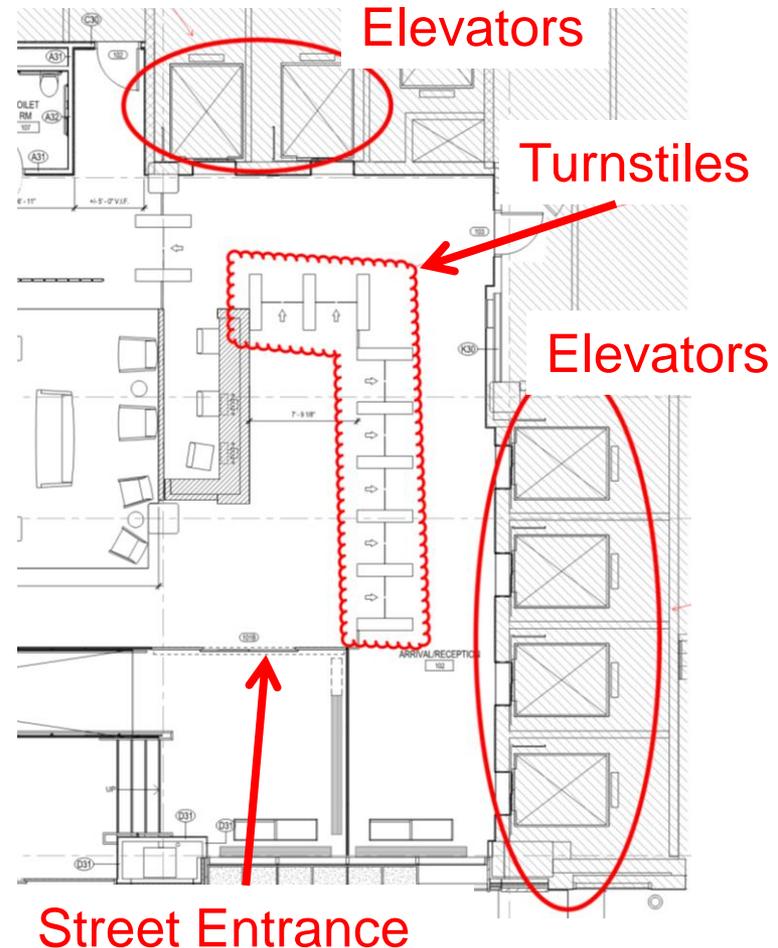
Ingress and Security

- People movement models can be used to:
 - Determine maximum arrival rate without congestion
 - Identify limiting factors (e.g., screening equipment, elevators)
 - Assess alternate approaches, arrangements, or equipment

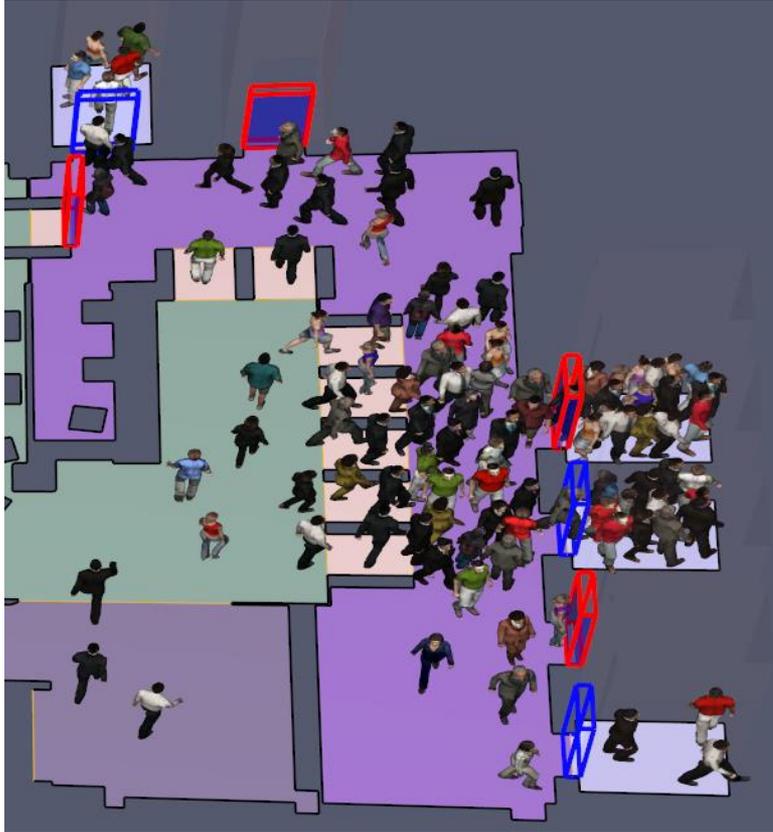


Ingress and Security

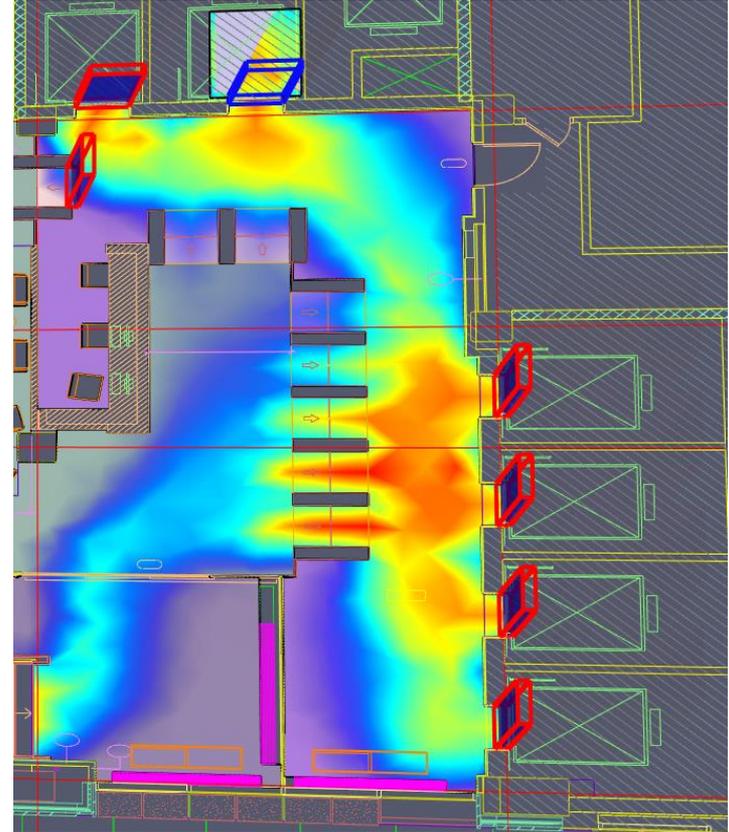
- Ingress into high-rise building
 - → Street Entrance
 - Lobby
 - Badge Scan/
Turnstiles
 - Elevators



Ingress and Security



- Queuing at Elevators



- Accumulated usage



Ingress and Security

- Alternate turnstile placement



Original



Alternate

Ingress and Security

- Detailed study of ingress w/badge scan and revolving door
- Field observations and modeling
- Lessons learned:
 - Card misread and door “kickback” led to slower flow rates than manufacturer data
 - Bursts and lulls in arrivals important to capture. Using averages may not be a good representation.



Ingress and Security

- Existing models generally well-suited to ingress
- May require some “outside the box” thinking
- Potential adaptations (existing in some models)
 - Turnstiles/ticket gates (fixed delay)
 - Source term for occupants
 - Final target/goal that is not an exit



Dynamic Signage

- Exit signs are so ubiquitous as to become easily overlooked “visual clutter” in emergencies
- In response, new exit signs have been developed that
 - Attract attention in emergencies
 - Provide dynamic information



Dynamic Signage

- Provides customized occupant egress routing and way-finding during an emergency exit
- Adjusts the egress path of occupants to mitigate exposure to hazardous areas



Galea, et al., 2015



Dynamic Signage

- People movement models used for development and use of adaptive dynamic signage systems
 - For intelligent systems: provide faster-than-real-time analysis for feedback to signs
 - For manually-controlled systems: run many scenarios for guidance in anticipated events



Dynamic Signage

- Models used for intelligent adaptive signage systems must be able to:
 - Receive/use information on the active scenario (environmental sensors, etc)
 - Run faster than real time
 - Output results in a way that can be interpreted and implemented



Active Wayfinding

- Existing models give occupants some level of omniscience with respect to
 - Egress routes
 - Travel distances
 - Exit availability
- May lead to a more idealized or optimistic result
 - No backtracking
 - Reduced counterflow



Active Wayfinding

- Redirection and signage limited in existing models
 - Tends to require manual redirection
- Full implementation requires dynamic redirection or re-tasking
- Receive information within the model from
 - Signage
 - Direct observation
 - Other occupants



Assisted Evacuation and Carrying Behavior

- Traditional uses of models consider:
 - Individual or group (some models) movement towards exit
 - Mobility impaired move more slowly and may not use stairs
 - Mobility aides (e.g., wheelchairs, walkers) increase size of occupants or not accounted for



Assisted Evacuation and Carrying Behavior

- In practice, assisted evacuation results in:
 - Complex staff itineraries
 - Varying speeds
 - Increased counterflow
 - Altered movement patterns due to use of mobility aides
 - Horizontal exiting or internal relocation



Assisted Evacuation and Carrying Behavior

- When pushing a bed/wheelchair or carrying large items, different shape/size profile affects:
 - Movement pattern
 - Queuing and door throughput
- Recent airport study:
 - Occupants w/roller bags reduced flow rate through doors by 33%.



Assisted Evacuation and Carrying Behavior

- Some existing models have a group feature that could be adapted
 - May not be practical for multiple trips for a single staff member
- In the case of internal relocation, a final goal that is not an exit may be needed
 - May be possible to force this behavior indirectly with existing models



Assisted Evacuation and Carrying Behavior

- New assisted evacuation function currently under development for Pathfinder



Thunderhead Engineering, 2016



DISCUSSION

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