Use of Pathfinder in the Study of Occupant Movement in Stairwells

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Overview

Empirical Egress Data (NIST)

Pathfinder Egress Model

Parameters for Evaluation

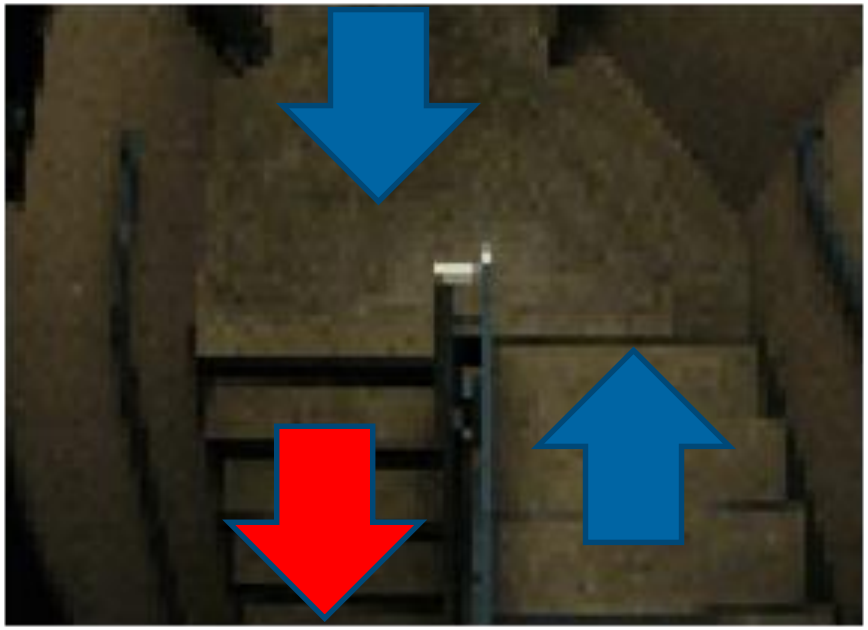
Comparison of Results

Empirical Egress Data

- Data taken from stairs within four different high-rise office buildings in the US
- Video recordings made on alternating stairwell landings
  - Entrance and exit time recorded for each occupant

Empirical Egress Data Merging of Occupants

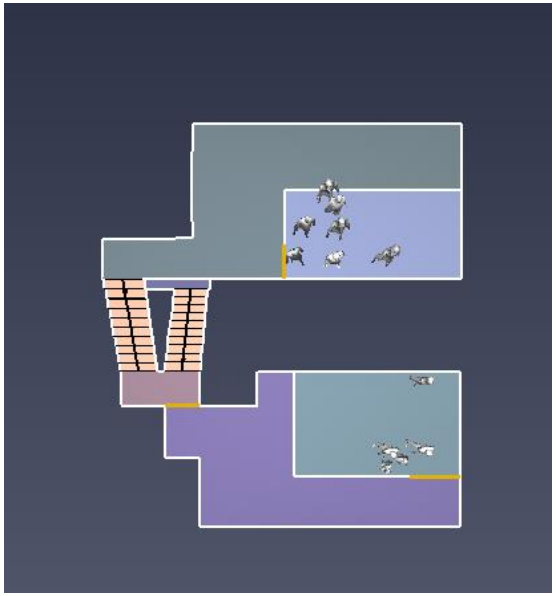
- In any building evacuation, a merging event takes place between two flows of occupants within the stairwell
- Stair flow and floor flow combine on the landing to form one outflow of occupants

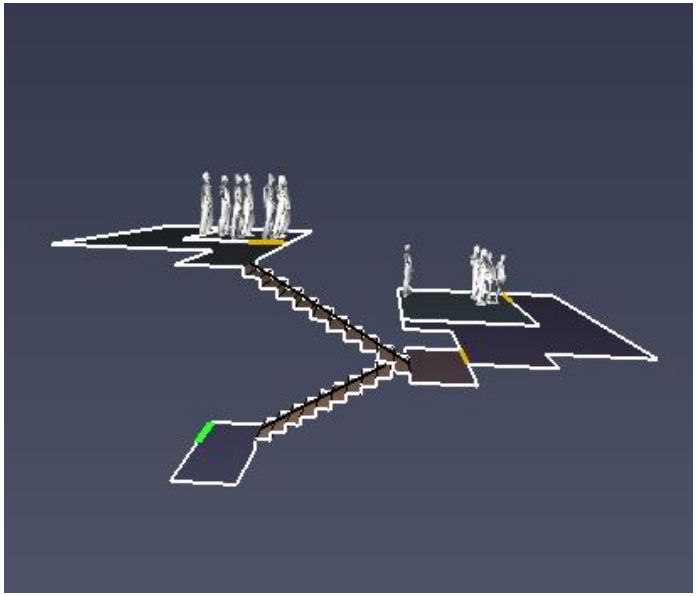


Pathfinder Egress Model

Pathfinder 2011

- Sample geometry created similar to that of empirical data
- Analysis conducted using steering mode





One of the principal references in egress modeling is the "Hydraulic Model," most recently described by Gwynne and Rosenbaum in the SFPE Handbook, 4th Edition.

Hydraulic Model Merging of Occupants

Specific to the merging of two or more flows of occupants, the hydraulic model gives the following equation:

$$F_{out} = \sum_{i=1}^{n} F_{in_i}$$

Where:

F_{out} = Outflow rate leaving the transition point

F_{in} = Inflow rate entering the transition point

N = Number of flows entering the transition point (In this case N=2)

Within stairwells, the outflow rate should equal the sum of the floor flow and stair flow rates.

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Generally, this is not the case.

Flow Ratio Merging of Occupants

Because the outflow rate is generally less than the sum of the inflow rates, the Flow Ratio parameter was developed:

$$FR = \frac{F_{out}}{\sum_{i=1}^{n} F_{in_i}} \times 100$$

Where:
FR = Flow Ratio
F_{out}= Outflow rate leaving the transition point
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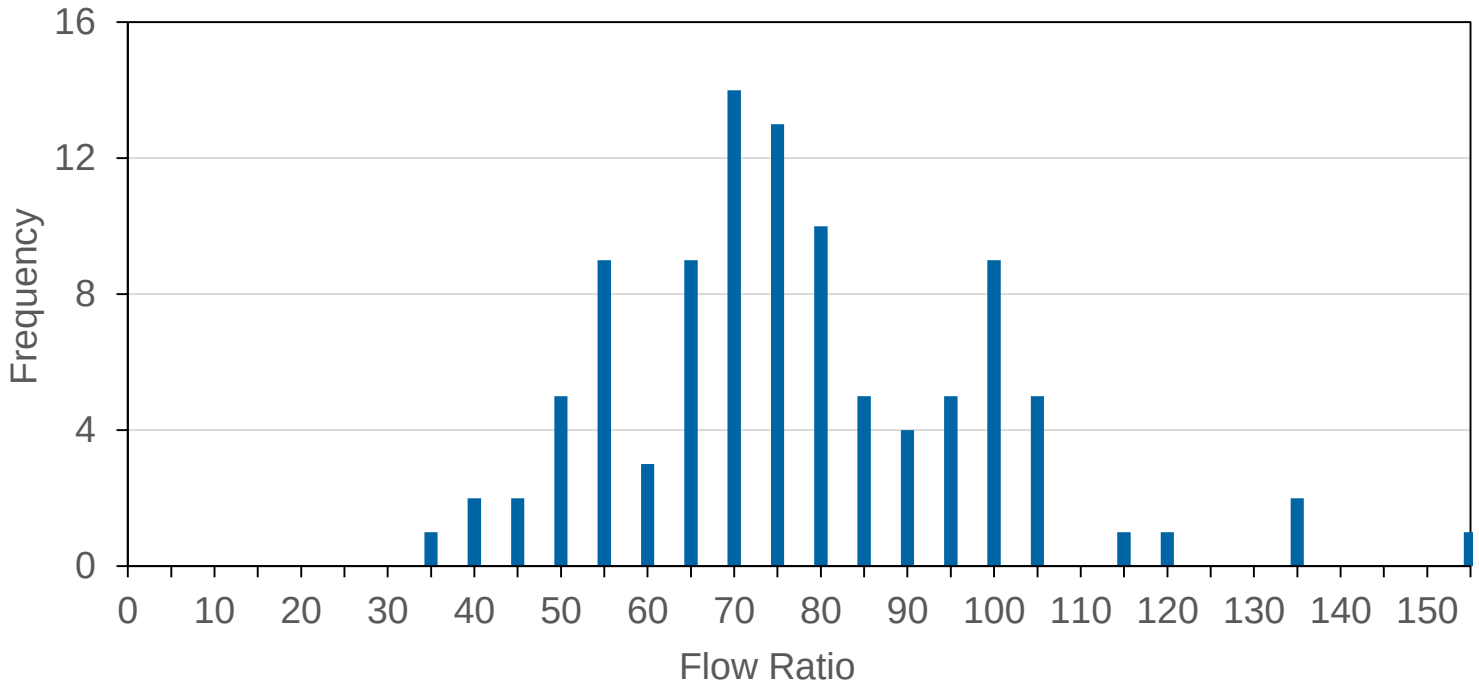
Flow Ratio Distribution of Empirical Data



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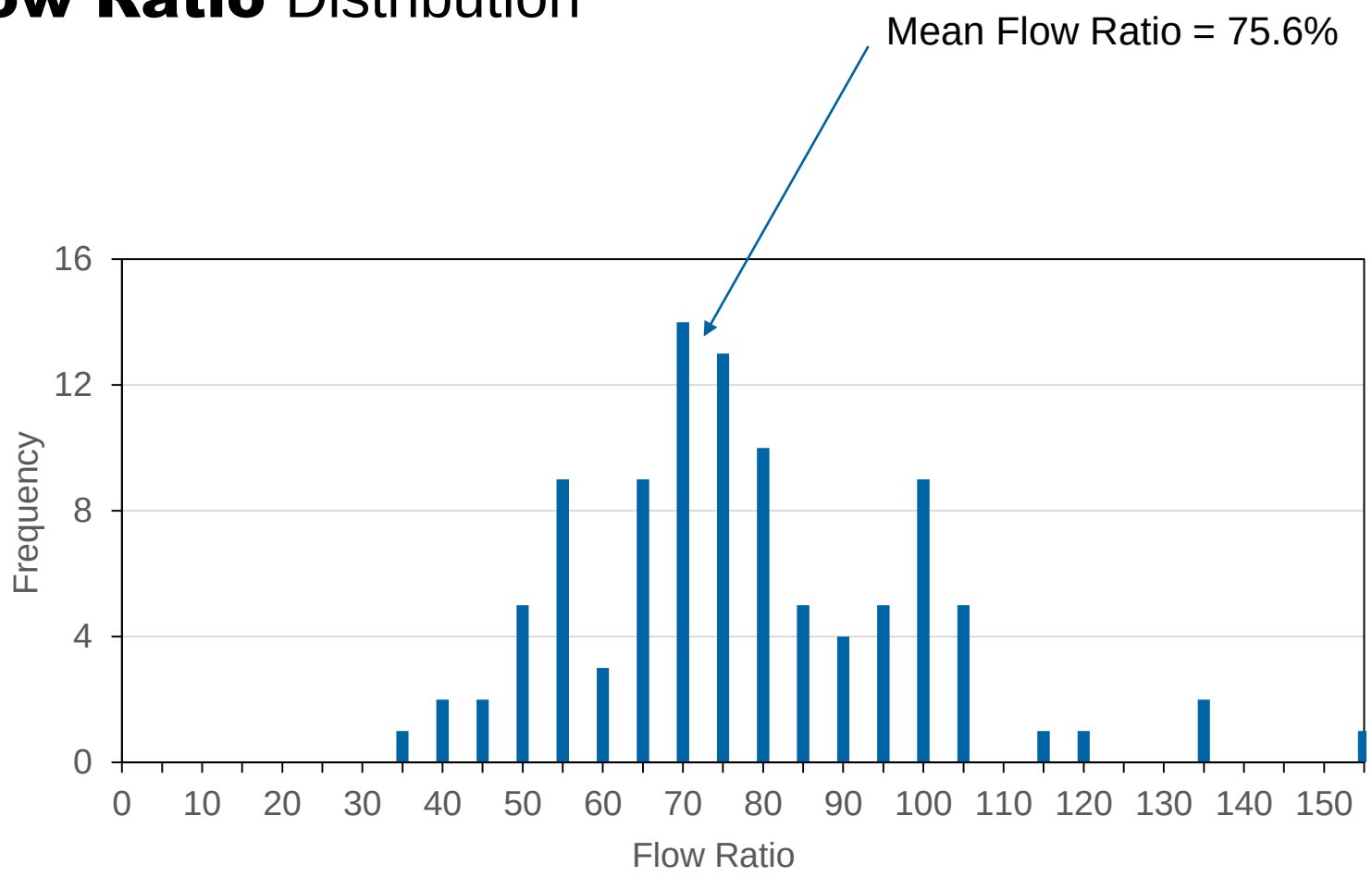

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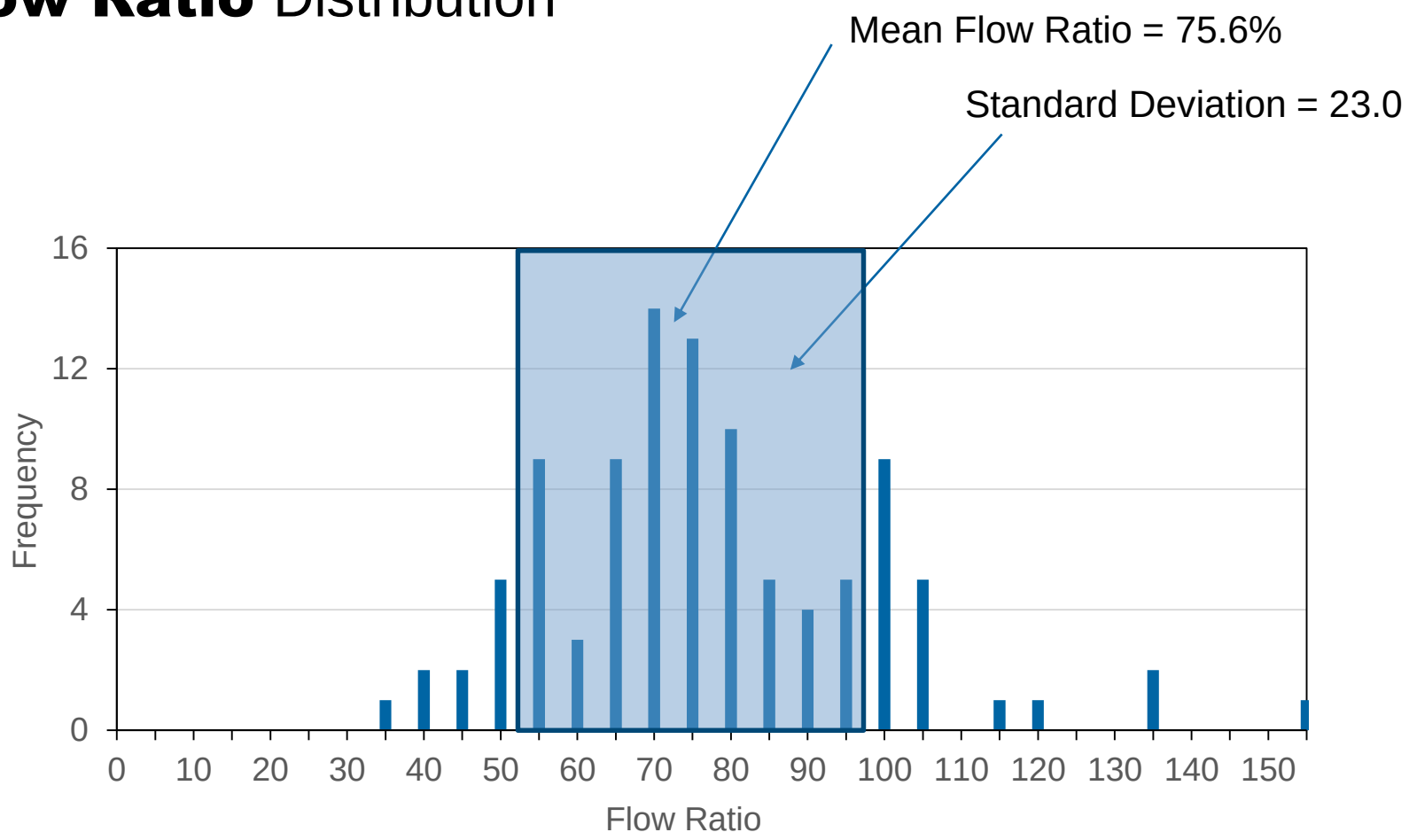
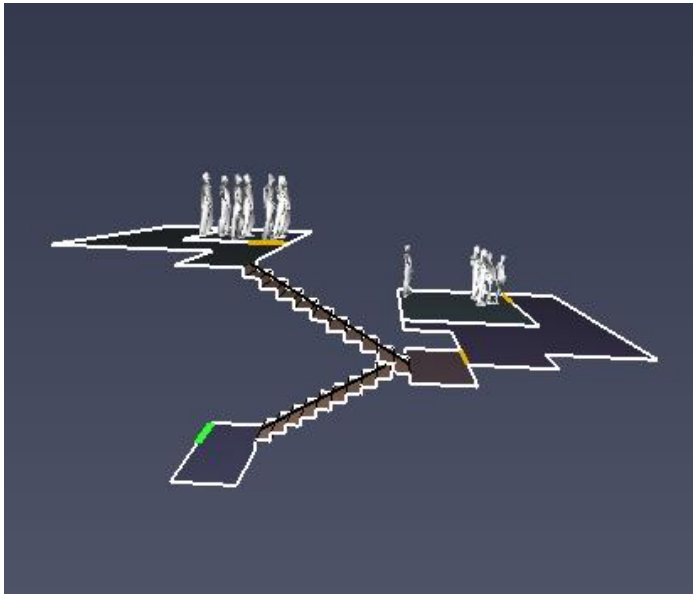


Pathfinder Egress Model



- 20 merging events run in Pathfinder with a varying number of floor and stair occupants
- Flows were limited to 7 occupants to prevent queuing

Flow Ratio Pathfinder Data

Event	Floor Occupants	Stair Occupants	Flow Ratio
1	6	5	68.18
2	2	3	52.00
3	5	3	65.85
4	4	6	112.96
5	5	4	80.39
6	3	2	86.84
7	5	5	72.41
8	6	3	64.44
9	7	7	72.84
10	3	6	76.92
11	3	5	102.27
12	6	2	97.30
13	5	6	85.19
14	7	6	76.81
15	3	6	76.60
16	6	4	82.98
17	2	2	76.19
18	5	2	91.67
19	2	7	84.21
20	3	3	94.87

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Mean Flow Ratio = 81.1
Standard Deviation = 14.2

Summary Comparison of Results

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- See thesis work by Leahy (2011) and Campbell (2012)

Questions?