

# Data for Evacuation Modeling

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Organizadores / Organizers



Madrid, 20 – 22 de Febrero de 2013  
Centro de Convenciones Mapfre

# Outline of presentation

- Role of evacuation analysis in engineered designs
- Data needs for evacuation analysis
- Overview of available data
- Available resources

# ROLE OF EVACUATION ANALYSIS IN ENGINEERED DESIGNS

Time available  
to escape



Time needed  
to escape



# DATA NEEDS FOR EVACUATION ANALYSIS

# Modeling evacuation behavior

## Components of evacuation behavior

- time to notification
- reaction time
- pre-evacuation activity
- travel time

# Modeling evacuation behavior

Data needed for model development OR use

- occupant characteristics
- delay times (pre-movement times)
- exit choice decisions
- travel speeds
- actions during evacuation
- effects of obstructions

# Delay times

Other terms for delay times:

- pre-movement time
- initial response time
- time to start

Can last from a few seconds to several minutes or more

People can ignore cues or might be engaged in pre-evacuation activities

# Factors impacting delay times

Variations can result from:

- effectiveness of different cues
- effectiveness of training
- time of day, weather, etc.

These factors are also related to the characteristics of the occupants.

# Movement speed

Data has been collected and reported in the literature for a long time.

Data is needed on speeds

- on horizontal paths
- on inclines (stairs and ramps)

for

- able-bodied and
- mobility-impaired subjects.

# Factors impacting movement speed

Variations can result from:

- crowd density
- mobility, age, and other occupant characteristics
- presence of family groups
- presence of smoke
- lighting and other design features

# OVERVIEW OF AVAILABLE DATA

# Sources of delay time data

Survey questionnaires  
(real incidents)

VS.

Videotaped observations  
(usually drills or experiments)

# Some of the available delay time data sets

- offices
- retail stores
- hotels
- apartment buildings

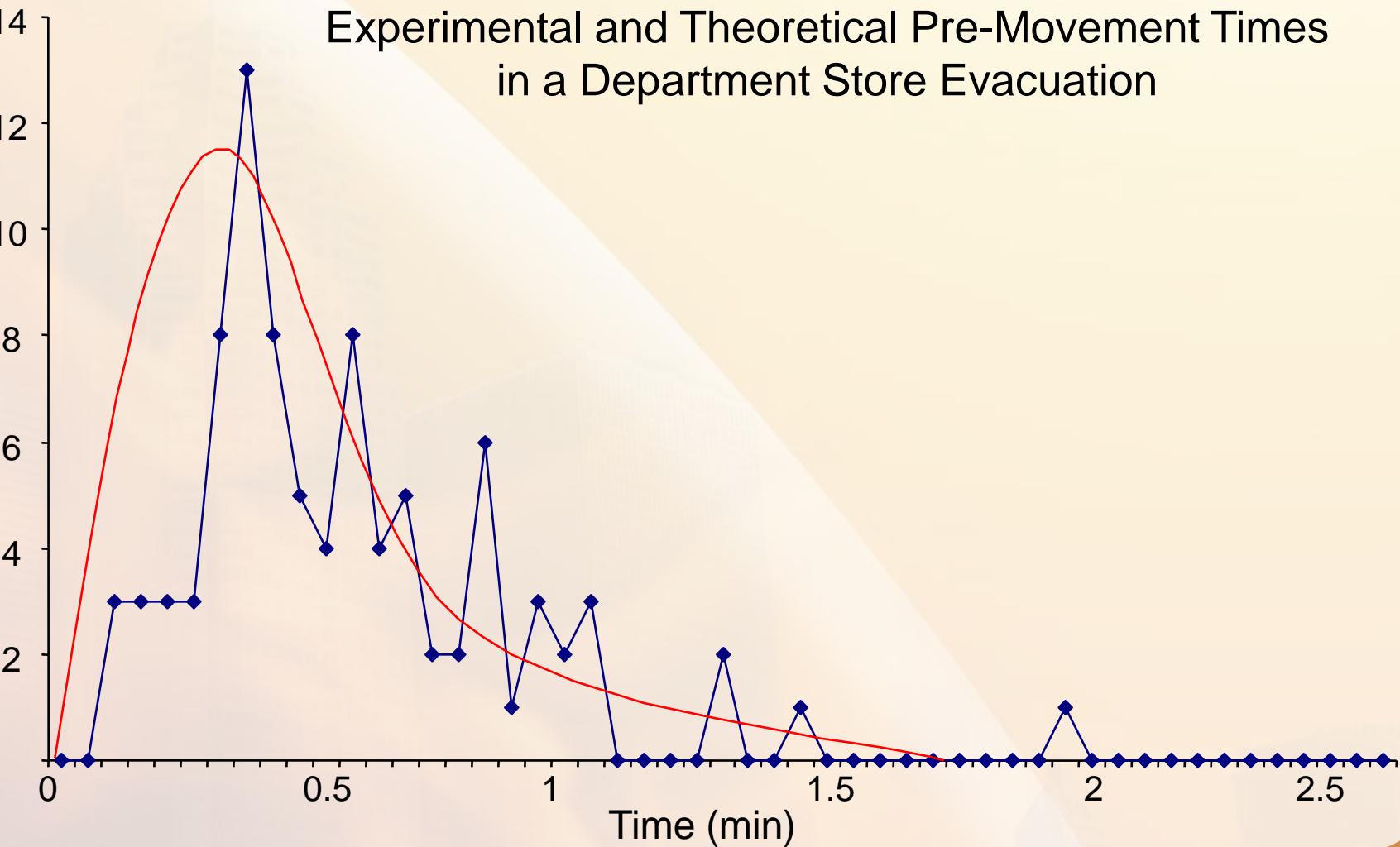
# Delay time examples

Delay Times Derived from Actual Fires and Evacuation Exercises  
Reported in the Referenced Literature (in Minutes)

Event Description	N	Min	1st Q	Median	3rd Q	Max	Mean	Factor
High-rise hotel	536	0	3.3	60.0	130.9	290	n/a	MGM Grand Hotel, no alarm notification, grouped data from questionnaires
High-rise office	85	0	2.0	5.0	10.0	245	11.3	World Trade Center explosion and fire, no alarm notification (building closer to explosion)
Mid-rise office	92	0	0.4	0.6	0.8	<4	0.6	Unannounced drill, good alarm performance; fire wardens; warm day
1-story Dept store	95	1	0.2	0.3	0.5	0.9	0.4	Unannounced drill; trained staff; data here derived from grouped data for 95 subjects
Mid-rise apartment	42	0.6	1.0	1.4	3.0	>14	2.5	Unannounced drill; good alarm performance
Training facility	566	<0.2	0.7	1.1	1.5	>5	n/a	Testing sleeping subjects at a training facility

Frequency

## Experimental and Theoretical Pre-Movement Times in a Department Store Evacuation



# Some of the available movement time data sets

- transport terminals
- apartment buildings
- assembly properties
- industrial buildings
- hotels
- able-bodied and mobility-impaired subjects

# Sample travel speed data

Transport terminals

265 ft/min on walkways (1.35 m/s)

Experiment with Disabled Subjects

On horizontal surface (m/s)

	Min	1st Q	3rd Q	Max	Mean
All disabled subjects	0.10	0.71	1.28	1.77	1.00
With locomotion disability	0.10	0.57	1.02	1.68	0.80
No aid	0.24	0.70	1.02	1.68	0.95
Cane	0.26	0.49	1.08	1.60	0.81
Unassisted wheelchair	0.85	--	--	0.93	0.89
Assisted ambulant	0.21	0.58	0.92	1.40	0.78
Assisted wheelchair	0.84	1.02	1.59	1.98	1.30

On upward incline

All disabled	0.21	0.42	0.74	1.32	0.62
Crutches	0.35	--	--	0.53	0.46
Unassisted wheelchair	0.70	--	--	--	--
Assisted wheelchair	0.53	0.70	1.05	1.05	0.89

Mid-rise apartment drill

0.47 m/s on stairs (ranged from 0.34 to 1.08 m/s among various adult age groups; one visually impaired person traveled at 0.31 m/s)

# Some additional types of relevant data

Presence of disabled people in the general population

Ability to use doors

Ability to locate and read exit signs

Effect of culture on evacuation (delays and walking speed)

# AVAILABLE RESOURCES

# We need to make data more available to engineers and designers

- develop a process for collecting and distilling peer-reviewed pre-movement and travel speed data into an accessible database.
- develop a format for that database.
- provide access, preferably via the internet, to all users.

NIST GCR 10-928

## Conventions in the Collection and Use of Human Performance Data

S. M. V. Gwynne  
*Hughes Associates, Inc.*

**NIST**  
National Institute of  
Standards and Technology  
U.S. Department of Commerce

# Excellent resource for information on all aspects of evacuation modeling:

<http://evacmod.net/>

- literature references
- evacuation models
- analysis tools
- discussion forum

 **Evacmod.net**

[Home](#) [Literature](#) [Forum](#) [Models](#) [News](#) [Survey](#) [Tools](#) [Events](#) [Video & Audio](#) [Links](#)

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**Upcoming events**

- [Tunnels Fire & Safety Forum 2013](#) (55 days)
- [NFPA Conference & Expo 2013](#) (117 days)
- [Interfilm 2013](#) (131 days)
- [Traffic and Granular Flow '13](#) (224 days)
- [more](#)

**Evacmod.net - Evacuation Modelling Portal**

This is the evacuation modelling portal for the simulation of human behaviour during emergency situations. The site is made by the evacuation modelling community for the evacuation modelling community.

Almost all content on the site is user generated (by users logging on and entering the information). It is Evacmod.net's aim to provide a platform for students, fire safety engineers, software engineers, behavioural scientists, researchers or any interested parties to communicate, and share their knowledge and experience. By providing such a platform it is hoped that the field of evacuation modelling will be further advanced. It is hoped a variety of perspectives are expressed in an environment that is free from political or commercial bias.

The site has undergone a number of significant developments. It now has a wider array of features that should benefit the users and better enable the sharing of thoughts and ideas. The website now includes several sections:

**1. Literature** - if you have a time uncertainty using polynomial chaos expansion  
**2. Forum** - if you want to ask a question, **3. Model Directory** - to view a list of recently written or read a simulation systems for tall buildings  
**4. Events Calendar** - if you want to advertise/let others know about an event related to evacuation modelling, then this can be posted on the Events page.  
**5. News** - to view a list of recent articles on evacuation modelling, then this can be posted on the News page.  
**6. Private Messaging** - if you would like to contact someone in the general who is registered with Evacmod.net, then you can use our private messaging system.

**Recent Forum Posts**

**Evacuation Incidents**  
 Scores killed in nightclub fire in Santa Maria, Brazil  
 Michael Knae 30 Jan '13 - 10:15

**General Discussions/Questions**  
 Evacuation experiment with revolving doors  
 axel\_jeena 08 Jan '13 - 07:20

**Evacuation Incidents**  
 Ivory Coast new year stampede kills dozens in Abidjan  
 Michael Knae 01 Jan '13 - 14:14

**DISCLAIMER:**  
 At Evacmod.net, we have attempted to insure that all information is accurate and up to date which is posted on the website. Indeed much of the content is user generated. Consequently Evacmod.net accepts no responsibility for inaccurate or out of date information. If you wish to quote information from the website then Evacmod.net urges you to confirm with the original source/author of the information directly if it is accurate and up to date. If you are an author of a piece of literature which is posted on Evacmod.net and you wish it to be removed, please send an email to [evacmod@gmail.com](mailto:evacmod@gmail.com) with the relevant details, then we would really like you to consider keeping it on the site as it contributes to helping others in the field.

**ADVERTISING:**  
 If you are an evacuation model developer/group/company and wish to advertise on Evacmod.net, then after logging on, send a private message to 'admin' to find out more information.

**Latest Video & Audio**

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- [Wayfinding Architectural Criteria for the Design of Complex Environments in Emergency Scenarios](#)
- [Legal and Technical Issues affecting Command and Control in Emergency Evacuation](#)
- [Accounting for Staff Response in Engineering Design](#)
- [Response of Building Evacues when Confronted with Blocked Stairways during Emergency Evacuation following Earthquake](#)
- [Automatic pedestrian tracking using discrete choice models and image correlation techniques](#)
- [Visual Crowd Surveillance is Like Hydrodynamics](#)
- [Evacuation analysis of 1000+ seat Blended Wing Body aircraft configurations](#)

- Updated material in next edition of *SFPE Handbook of Fire Protection Engineering*
  - includes a new chapter on data used in egress modeling
    - effectiveness in waking sleeping occupants
    - walking speeds on escalators
    - traffic flow on escalators and stairs
    - delay times by occupancy
    - travel speeds, with and without disability, on level and stairs, with and without assistance
    - crawling speeds

Gracias por su atención  
Thanks for your attention



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