

Data for Evacuation Modeling

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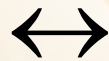
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Outline of presentation

- 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

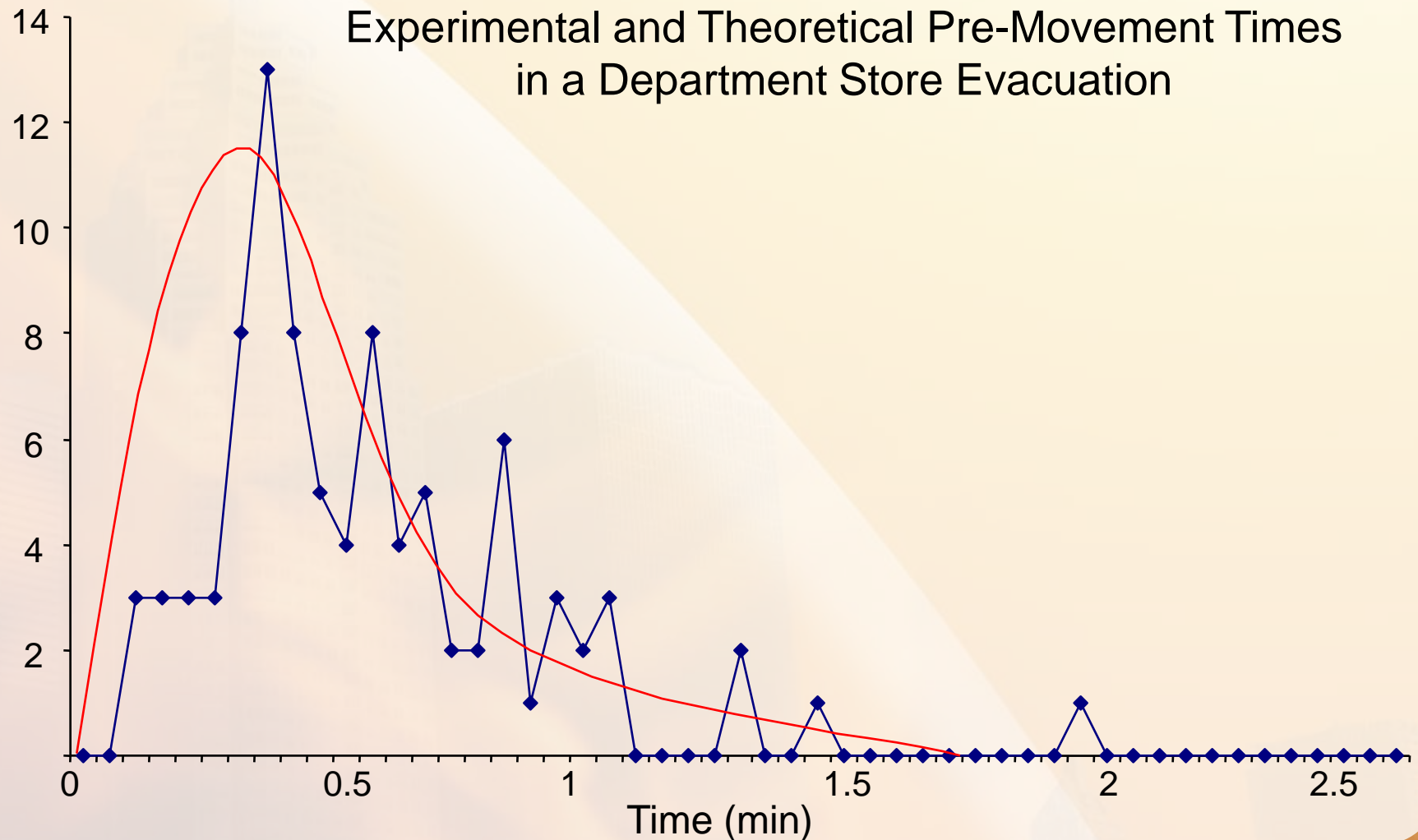
Delay time examples

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)

	<i>Min</i>	<i>1st Q</i>	<i>3rd Q</i>	<i>Max</i>	<i>Mean</i>
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

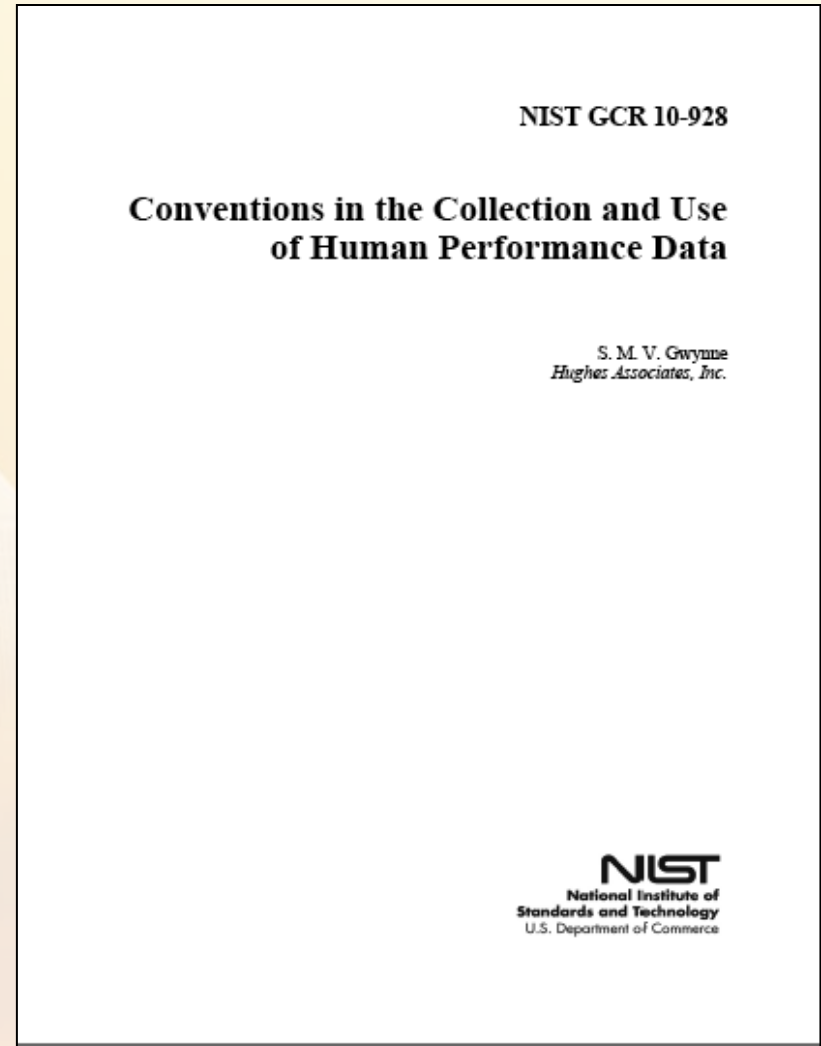
Ability to locate and read exit signs

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.



Excellent resource for information on all aspects of evacuation modeling: <http://evacmod.net/>

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

The screenshot displays the Evacmod.net website, which is dedicated to evacuation modeling. The site features a navigation bar at the top with links to Home, Literature, Forum, Models, News, Survey, Tools, Events, Video & Audio, and Links. A user login section is prominently displayed on the left, including fields for Username and Password, and links for 'Log in', 'Create new account', and 'Request new password'. The main content area is divided into several sections: 'New Literature' with links to total evacuation systems, treatment of evacuation time uncertainty, and simulation of pedestrian counter flow; 'Recent Forum Posts' listing discussions on evacuation incidents and general questions; and a 'Content' section with icons for literature, forum, and models. A 'Disclaimer' and 'Advertising' section are also visible at the bottom. The right sidebar includes a search bar, a calendar for February 2013, a list of upcoming events like 'Tunnels Fire & Safety Forum 2013', and a 'Latest Video & Audio' section with links to social physics, cost reduction, and evacuation scenarios.

- 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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ALAMYS

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