

Fire and Evacuation Modeling Technical Conference 2011
Baltimore, Maryland, August 15-16, 2011

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**The benefits of the application of a “Monte Carlo”
methodology to evacuation modeling**

Should perhaps have been

The role of randomly generated numbers in escape models

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Components of FDS

Are

**Heterogeneous rather than
Homogeneous**

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A Monte Carlo simulation uses repeated sampling to determine the properties of some phenomenon. It usually involves:

- Defining a domain of possible inputs.
- Generating inputs randomly from a probability distribution over the domain
- Performing a deterministic computation on the inputs.
- Aggregating the results.

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**A “Monte Carlo” analysis using randomly
generated numbers as inputs to escape
models will not account for peoples
behaviour in fire**

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People:

do not panic in a fire;

do not behave irrationally except when they have a mental handicap;

are forced to respond to a developing situation often with only limited information available to them;

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People:

unfamiliar with a building will usually attempt to leave using the means by which they entered;

losing normal visual references may become confused;

have an instinct for survival;

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People:

separated from family members instinctively seek to regroup;

respond better to simple verbal or visual messages than alarm sounders;

respond quickly to an imminent and obvious threat, by which time it may be too late;

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People:

are more reticent to evacuate when they are dining;

are strongly influenced by others around them

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Model	Country of Origin		Model	Country of Origin
AEA EGRESS	USA		EXITT(Part of Hazard 1)	USA
ALLSAFE	Norway		EXODUS	UK
ASERI	Germany		GRIDFLOW	UK
BGRAF	USA		Myriad II	UK
EGRESS	UK		PATHFINDER	USA
EGRESSPRO	Australia		PEDROUTE	UK
EESCAPE	Australia		SEVE_P	FRANCE
ELVAC	USA		SIMULEX	UK
EVACNET4	USA		STEPS	UK
EVACS	Japan		WAYOUT	Australia
EXIT89	USA			

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FDS + EVAC

Is a research tool

It is not an engineering tool

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Application of Monte Carlo technique to FDS+EVAC

The Technical Reference and Users Guide advocates the use of the technique as a means of examining the influence of physical characteristics and group interactions

It suggests the technique may be used to define the relative importance of a variation of the basic parameters to produce a series of rank correlation coefficients.

It does not provide a means for quantifying human behaviour.

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Ball Bearing Escape Model

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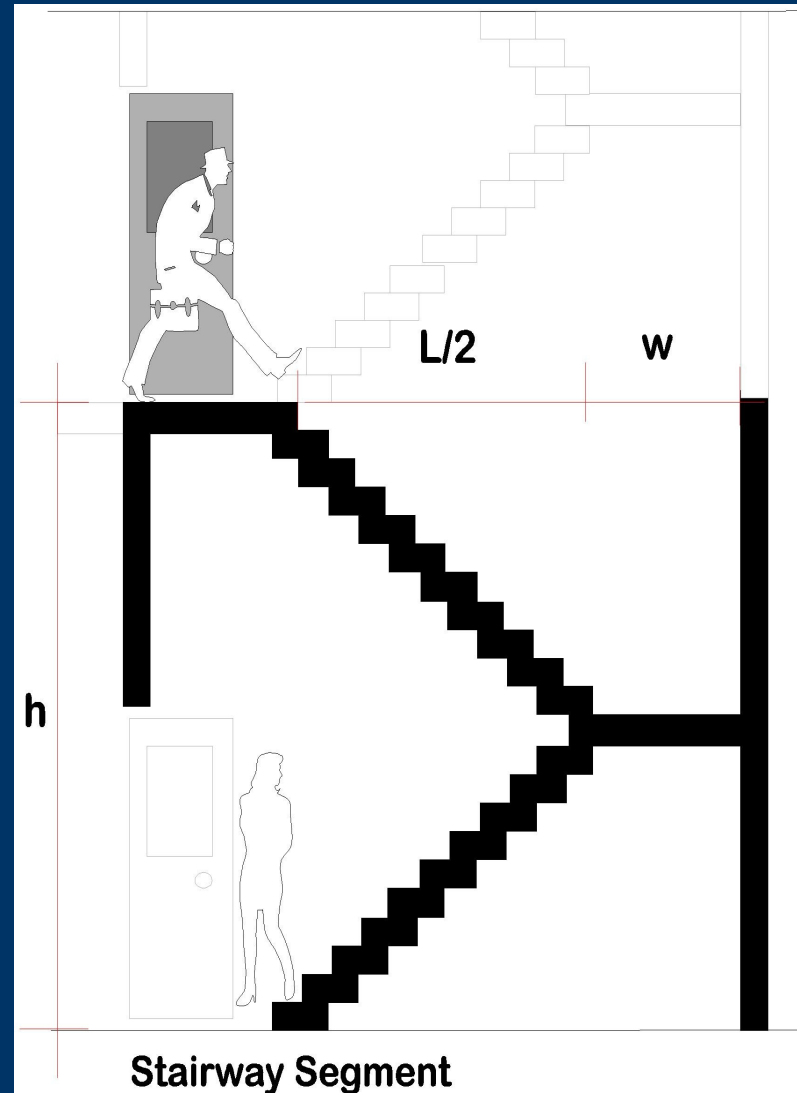
$$w = [P + 15n - 15]/[150 + 50n]$$

Where:

w is the width of the stair in metres,
P is the number of people, and
n is the number of storeys served

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Floor Level				5	4	3	2	1	Exit level
		Equation	Units						
Population of floor	P		No.	200	200	200	400	500	200
Floor exit width	e		Metres	1.10	1.20	1.20	1.80	3.60	1.20
Final exit width			Metres						5.00
Stair width	w		Metres	1.20	1.50	1.50	2.00	5.00	
Floor to floor height	h		Metres	2.80	2.80	3.00	4.00	6.00	
Rate of discharge through floor exit		$e \times 80$	People / minute	88	96	96	144	288	96
Standing capacity stair segment	Cs	$l \times w \times 3.5$ except final exit landing	No.	60	82	86	152	713	21
Time to fill stair segment	tf	$Cs \times 80w$	Minutes	0.682	0.854	0.896	1.056	2.476	0.219
Time for stair congestion		The lesser tf or tf for floor above	Minutes	0.682	0.682	0.854	0.896	1.056	0.219
No. who escape pre-congestion	P_{pre}		No	60	65	82	129	304	21
Yet to discharge into segment	P_{post}	$P - P_{pre}$	No	140	135	118	271	196	179
Rate of discharge through final exit			People / minute						400
Accumulative no. to escape through segment			no.	140	275	393	664	860	1039
Time to evacuate after congestion		$P_{post} \times [1 + \text{no of segments discharging below}] / 80w$	Minutes	0.350	0.688	0.983	1.660	2.150	2.598
Total time to evacuate			Minutes	1.032	1.369	1.837	2.556	3.206	2.816

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FDS+Evac	Ball Bearing model
integrates an escape model with a fire model	No fire model component
Utilises a series of randomly generated body shapes	Utilises a standard crowd density parameter based on established data
Takes no account of group gathering times but the developers are moving towards integrating this	Takes no account of group gathering times
Evaluates movement based on decision making parameters	Takes no account of decision making
Ignores queuing or congestion.	Is largely controlled by congestion
Scant regard for human behaviour	No regard for human behaviour

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Conclusions

The opportunity needs to be taken to extend the simplistic ball bearing model utilised in many Building Codes around the world to better reflect the forms of building.

Human behaviour and random behaviour are incompatible.

FDS users must always bear in mind that just because the output from a model looks real it may not actually reflect reality.