

# Mixed Ability Evacuation – Challenges for Design and Management

Karen Boyce  
Ulster University

*“buildings always have been, and always will be, geared to suit two-legged able-bodied people and not people propped on sticks or rolling about in chairs on wheels”*

(Designing for the Disabled, Selwyn Goldsmith, 1976)

# Content

- What society looks like now and in the future
- Real evacuation experiences including those with limited mobility
- Awareness and concerns of provisions
- Issues/challenges for design and management

# Disability (definitions vary..)

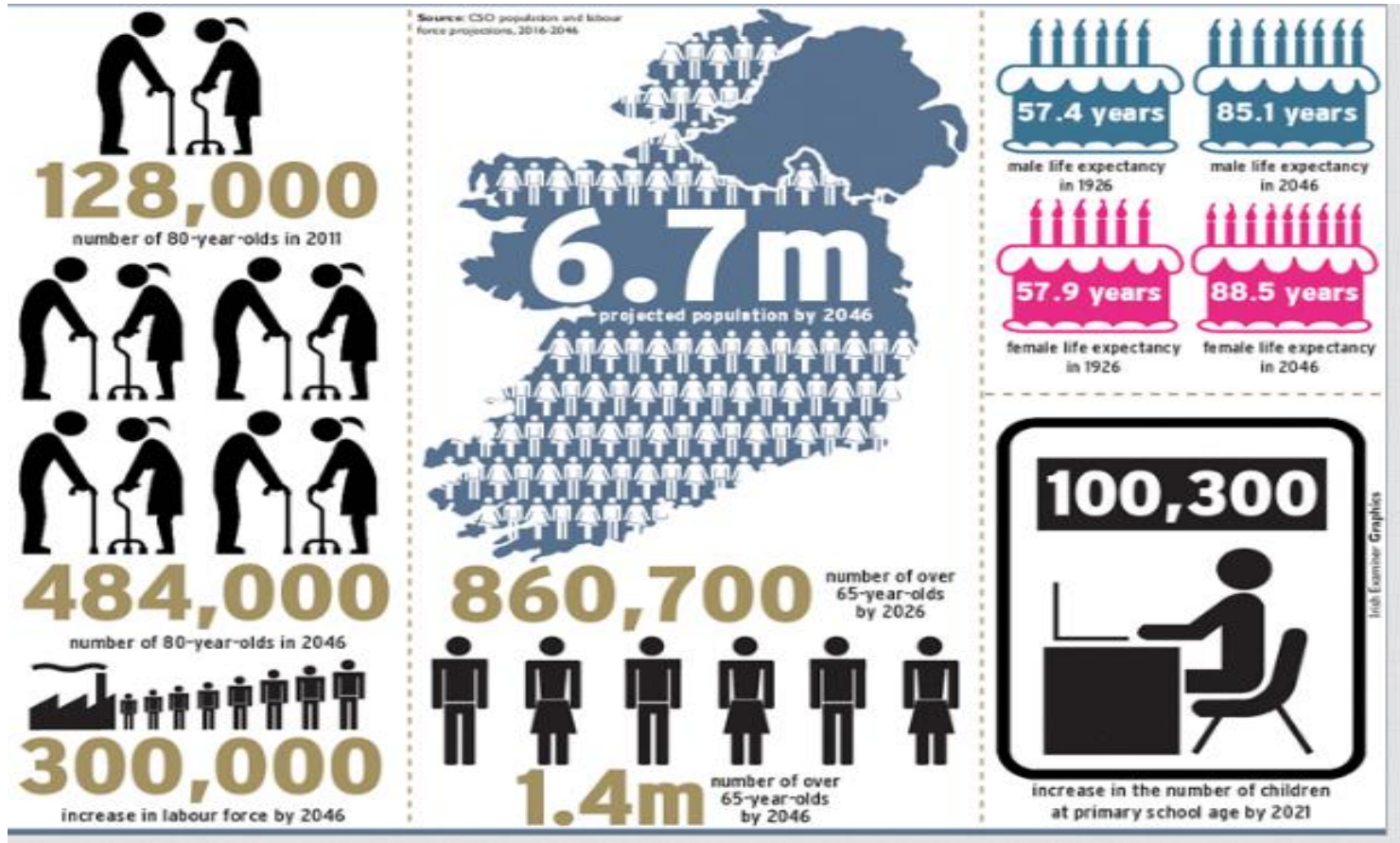
- “.. any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being” (World Health Organisation)
- “a mental or physical impairment that has a substantial and long-term adverse effect on the person’s ability to carry out normal day-to-day activities” (Equality Act, 2010)
- now recognise the social and environmental context – not just body functions and structure but the activity and the physical environment
- permanent or transitory and in reality a SPECTRUM OF ABILITY

# Estimated Prevalence of Disability Ireland (Central Statistics Organisation, 2008)

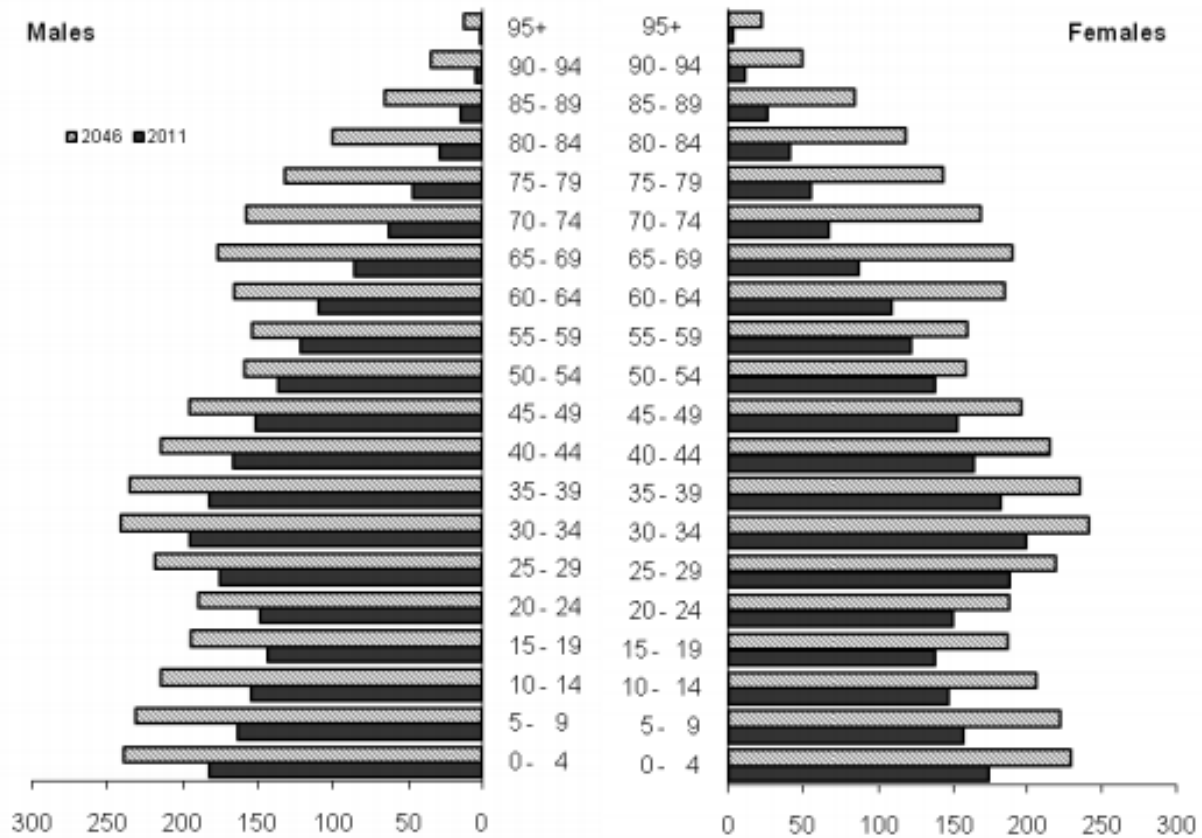
Disability Type	Rate per 1000
Seeing	27
Hearing	24
Speech	13
<b>Mobility and Dexterity</b>	<b>83</b>
Remembering and Concentrating	46
Intellectual and Learning	31
Emotional, psychological and mental health	48
Pain	86
Breathing	40
<b>Total persons with any disability</b>	<b>185</b>

Note: similar to England and Wales (18.2%), and NI (19.7%)

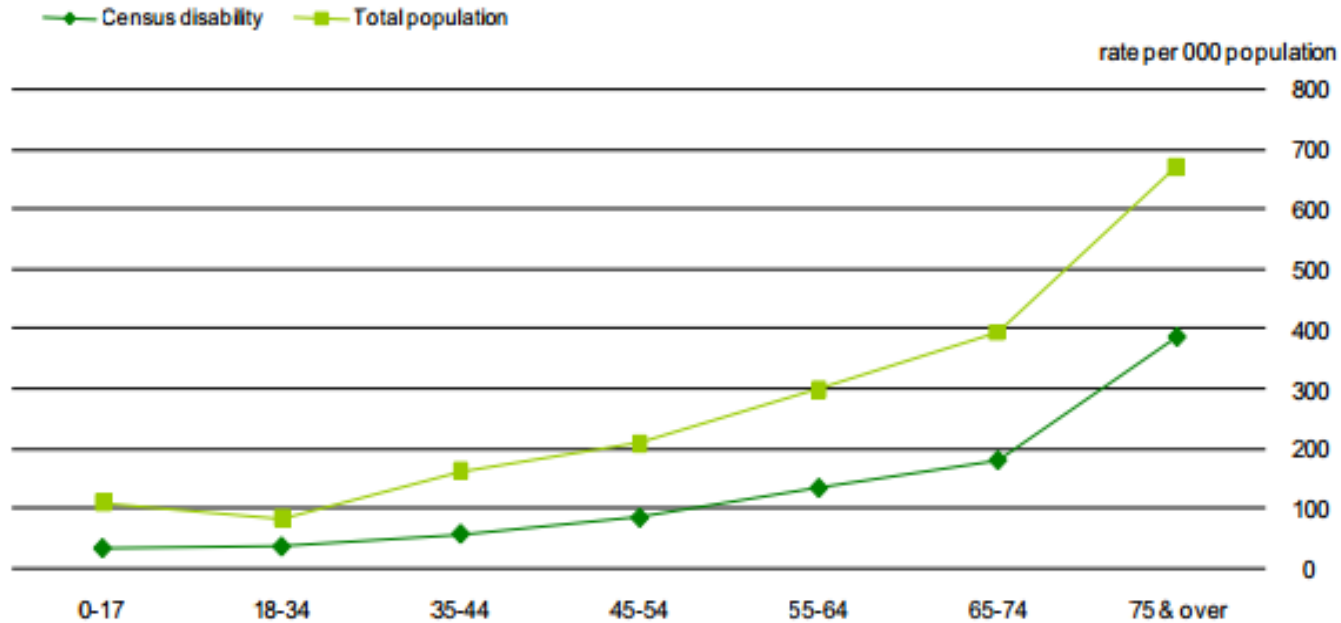
# We are an ageing society...



# Population Pyramid 2011 and 2046 (CSO, 2013)

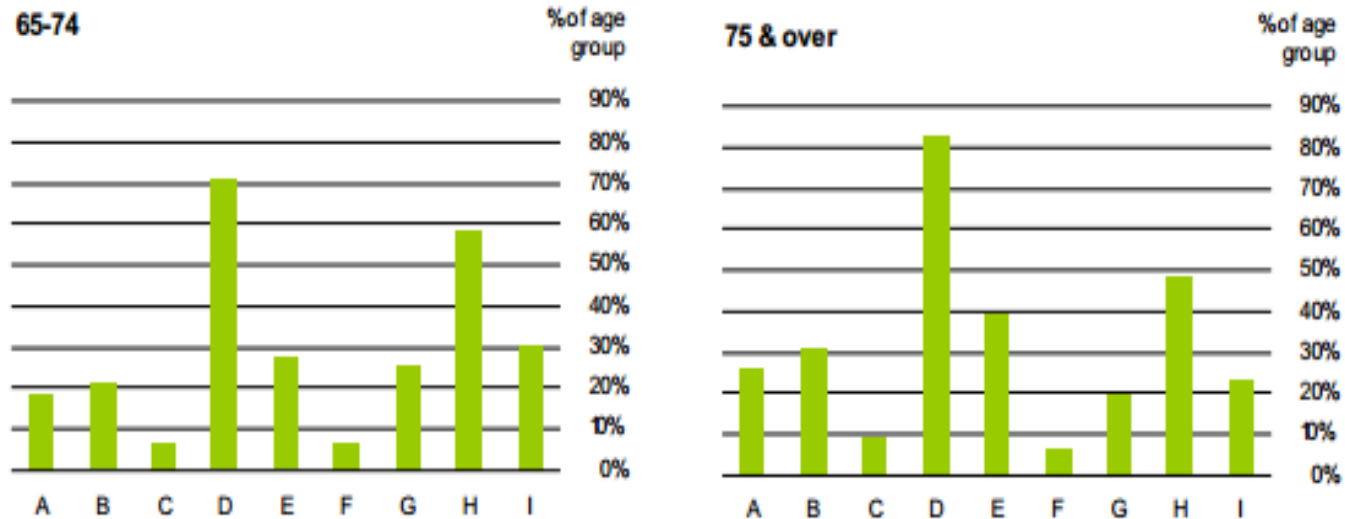


# Rate of Disability per 1,000 Population by Age Group (CSO, 2008)





# Prevalence of Disability in Older Persons (CSO, 2008)



A	Seeing	D	Mobility & dexterity	G	Emotional, psychological & mental health
B	Hearing	E	Remembering & concentrating	H	Pain
C	Speech	F	Intellectual & learning	I	Breathing

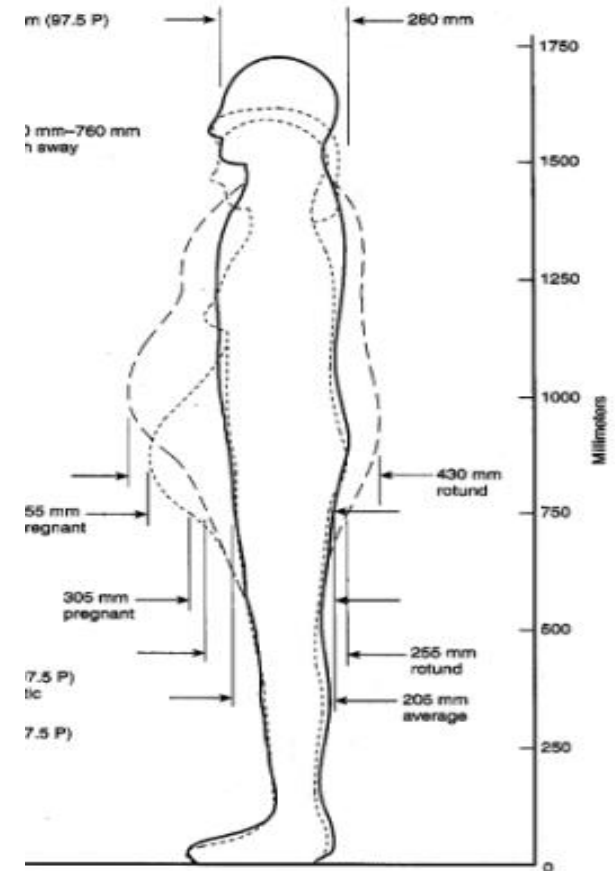
# We are a more obese society...

Gender	2010		2030	
	Overweight and Obese (%)	Obese (%)	Overweight and Obese (%)	Obese (%)
Men	76	24	91	48
Women	56	23	83	57

Source: IASO, 2008

Note: Overweight: BMI 25-29.9

Obese: BMI  $\geq$  30



# The Facts...

- we have more diverse and ever changing building populations which means increased difficulty, reduced performance:
  - **People with disability (stairs):** 0.33 m/s, range: 0.11-0.70 ; 98% seek support from handrails, 13% rested over 50 m (Boyce et al, 1996)
  - **Elderly (stairs) :** 0.60 m/s – 1.11 m/s (Fujiyama and Tyler, 2004)
  - **Obese:** reduced movement speed (Hulens et al, 2003), increased walking sway (He and Baker 2004)
- increased body sizes, space requirements (aids, assistors)
- changing evacuation dynamics

# Current Design Assumptions

- 2 groups of people – ‘able bodied’ and ‘wheelchair users’
- we size our exits assuming flows of 80 people/m/min (very optimum flow derived from narrow demographic)
- we offer alternatives (refuges, lifts) but we size for wheelchair users (one refuge 1400 mm x 900 mm in each protected stair at each level)
- we assume design **is sufficient, it will be used** (according to our assumptions), and that **it will work!**
- evacuation models often based on flow/speed/density relationships that are potentially outdated

# Real Evacuations

# WTC 9/11 (Shields and Boyce, 2009)

- 6 (2.2%) had self declared mobility impairment
- 5 had no real difficulties evacuating (including knee surgery, partially paralysed leg, sprained ankle)
- one participant ('Susan') located on 20th floor, WTC1:
  - had knee surgery and severe arthritis
  - could only walk short distances using stick, used scooter for longer distances



# WTC 9/11 - Susan's Story

- had no emergency plan but organised assistance from 3 colleagues
- *“we took up the whole stairway”*
- human cage - one male at the front and rear and female at the side - *“.... if she needed to she could move out and control people coming alongside of us”*
- stopped on every other landing because of her assistors - *“both had asthma - we had to stop so we would go over to a corner on the landing and huddle”*

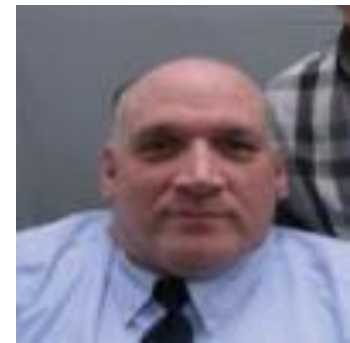


# WTC 9/11 (NIST, 2004)

- 6% limitation that impacted ability to evacuate
- 51% reported that presence of persons with disabilities impacted their evacuation negatively – they were a ‘*constraint to evacuation*’:
  - “ *she was walking down the stairs with assistance. We slowed down and came to a stop - we couldn’t get around them* ” (Interview 1000556)
  - “*we took up the entire width of the stairway and no-one could get around us until we came to a landing*” (Interview 1000093)



# WTC 9/11 - John's Story



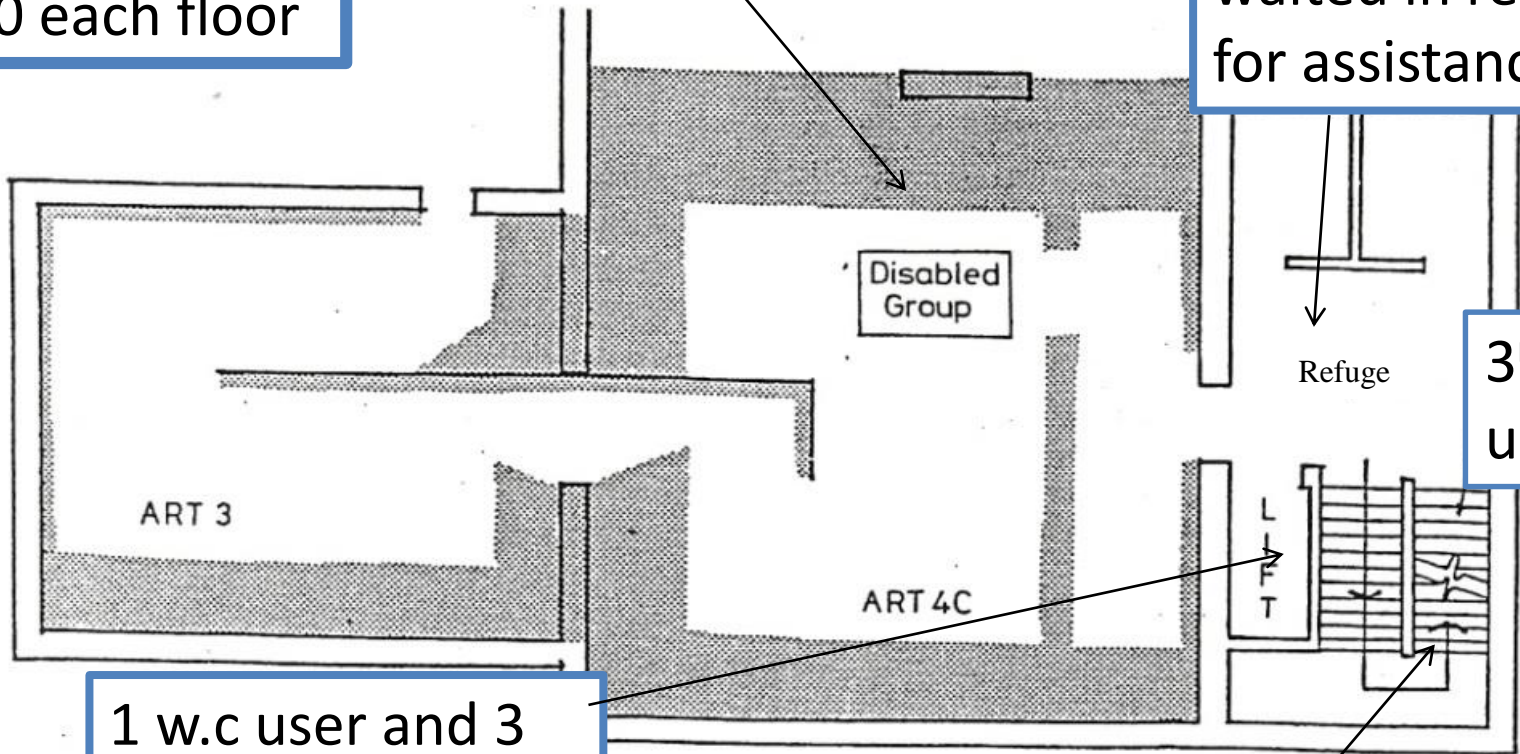
- quadriplegic (electric wheelchair user), 69th floor of WTC1
- evacuation (in evacuation chair) had been pre-planned
- evacuated approx 5-10 minutes before WTC1 collapse (1 hour 46 minutes from impact)
- assisted by 10 colleagues (2 at front, 2 at back in turn)
- highlighted advantages of evacuation chair (in 1993 took 6 hours in his own chair) but challenges pre-conceptions of resources required for assistance down stairs

**ULSTER  
MUSEUM, 1990**

1200 people,  
600 each floor

4 wheelchair users  
5 ambulant  
3 carers

3 w.c. users  
waited in refuge  
for assistance



3<sup>rd</sup> w.c.  
user?

1 w.c. user and 3  
others evacuated  
by lift

2 w.c. users assisted  
by staff down stairs

# Issues Arising (Museum)

- effective use of lifts (willingness to use)
- sizing of refuge was insufficient and caused considerable backup onto floor and considerable anxiety
- lack of staff training and poor communication with occupants





# Experience of Refuges (DCLG, 2008)

- *“No-one told us what was going on until I finally managed to ring on a mobile. No-one waited with me. I felt extremely unhappy and tried to make my way down the stairs after about 15 – 30 minutes, but had to give up. I would not be happy doing it again...it is always extremely stressful (6<sup>th</sup> floor hotel, DCLG, 2008)*
- *“Very isolating & upsetting to be expected to wait in such an area even if it is for safety reasons. Fire brings fear!!”*

# Experiences of Refuges (DCLG, 2008)

- *“No issues over using refuge areas provided building staff are well trained and we are informed of these specific areas”*
- *“I’ve used a refuge many times. I was on the 7th floor. I was happy using the refuge area and usually someone waited with me. I felt safe waiting there and would be happy to do it again” (DCLG, 2004)*

# End Users' Perspectives - Refuges (McConnell and Boyce, 2012)

- 207 participants (age 19-70) exploring level of awareness, understanding, willingness to use and potential concerns
- Of potential users of refuges\* :
  - 2.6% had never heard of the term 'refuge area' and 38.2% had wrong perceptions
  - 28.3% would not be willing to use
  - concerns about being forgotten (68.2%), being left alone (61.2%), safety of refuge (54.1%)

\*find it difficult/would not be able to descend one storey without assistance



# End User's Perspectives – Vertical Escape

- 'reasonably' or 'very confident' in using:
  - evacuation lift (73.5%); fears of failure power supply, doors opening on fire floor, overloading, being trapped
  - evacuation chair (63%)
  - own wheelchair (14.3%); fear of falling, being injured, putting others in danger

# Challenges Design and Management

# Challenges: Design of Stairs

- we will have people with a range of abilities using stairs
- reduced speeds, more space, may stop for rests (fatigue) and will certainly impact evacuation dynamics
- is our stair capacity sufficient for mixed ability populations?
- cost implications of increasing escape capacity?

# Challenges: Design Refuge areas

- is **sizing** of refuge areas sufficient? Users are not just wheelchair users but others who have difficulty using stairs (Boyce et al suggests 5%)
- is guidance regarding **communication** being adopted consistently?
- we need to anticipate needs but how do we do this with confidence?
- what are the implications if not (Ulster Museum?)

# Challenges: Management

- *“mobility impaired occupants not universally accounted for by existing evacuation procedures”* (NIST, 2004)
- *“management of evacuation procedures including refuges and their alternatives requires a major overhaul”* (DCLG, 2008)
- are we really prepared for managing evacuation of mixed ability populations?

# Challenges: Assisted Escape

- is consideration being given to most efficient methods and assistive devices? (not all methods suitable for all)
- when do we initiate that assistance (prior to, during, or after evacuation of others)?
- how do we identify those who need assistance?
- do we have staff in sufficient numbers and appropriately trained?

# Challenges: Overcoming User's Concerns

- users are concerned!
- will person with a disability use/continue to use a refuge?  
Will they become fearful – having to wait while others evacuate past them?
- how can we increase confidence in the use of refuges and other aspects of evacuation?
- what are the implications if we don't?

# Accessible Environment

*“ facilitates equal opportunity independently to participate in the full range of activities and responsibilities which define our society.. free of barriers which **exclude, endanger or inconvenience** those with acquired or inherited physical impairments”*

(M<sup>c</sup> Gough 1994)





# To Finish....

- *“buildings always have been, and always will be, geared to suit two-legged able-bodied people and not people propped on sticks or rolling about in chairs on wheels”  
(Goldsmith, 1976)*
- how far have we come?
- can we cope with the here and now never mind the future?
- are we really providing ‘accessible’ means of egress for all?

# THE END

Thank you for your attention!