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**Egressibility: L'esodo delle persone
in una societa' che invecchia**

La persona al centro

Impatto dei comportamenti umani nei progetti finalizzati alla salute e sicurezza delle persone
evento in ricordo di Antonio Zuliani


Ferrara, 09 ottobre 2025




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Outline

- Egressibility
- Models of disability
- An inclusive evacuation design
- Evacuation modelling and egressibility
- Conclusions



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Acknowledgements



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Ongoing cooperation on the topic of Egressibility with a multi-disciplinary team based at Lund University

Public Health
Björn Slaug



Psychology
Steven Schmidt



Occupational therapy
Gunilla Carlsson



Gerontology
Giedre Gefenaite



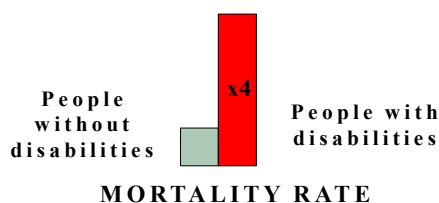
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Egressibility



DISASTERS DISCRIMINATE

>100,000,000 people with disability in the EU, ageing population



MORTALITY RATE
UN Office for Disaster Risk Reduction

“Individuals with disabilities are disproportionately affected in disaster, emergency, and conflict situations due to inaccessible evacuation” (UN)



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Egressibility



Egressibility

- “Egressibility means the possibility of leaving a building or reaching an area of safety in case of an emergency” (Proulx, 1995)
- While providing equal opportunities to access a building, similar provisions should be made for exiting from a building in case of emergency, i.e., providing accessibility during evacuation [...]. The latter can be described using the term egressibility. (Smedberg et al., 2021)
- The concept has relevance for all of us, but as with accessibility, it is especially relevant for people with functional limitations.



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Egressibility



- Prevalence of functional limitations increasing (ageing population)
- Accessibility is increasing



EGRESSIBILITY

Accessibility to means of evacuation



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Models of disability



Conceptual models of disability

- The perspective on disability has an effect on our efforts in addressing evacuation.
- Three main conceptual models:
 - Medical model
 - Social model
 - Biopsychosocial model



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Models of disability

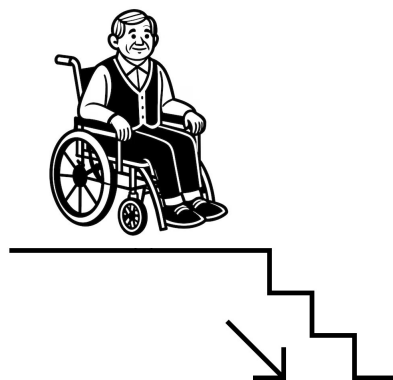


Medical model of disability

- Disability is an issue of the individual.
- Managing disability focuses on finding a "cure" to diminish or correct the disability.

"Her **impairment** is the problem! Rehabilitation is needed so she can walk".

Medical Model



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Models of disability

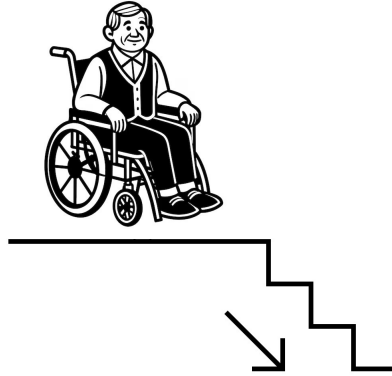


Social model of disability

- Disability is a socially created issue.
- Managing disability focuses on modifying the environment to ensure full participation through political response.

“The **stairs** are the problem! There should be a ramp.”

Social Model



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Models of disability

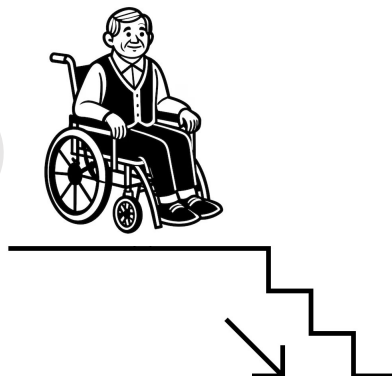


Biopsychosocial model of disability

- Integrating the medical and social models

“She has an impairment and is restricted in walking in stairs. A holistic approach is needed to support her mobility”

Biopsychosocial Model



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Models of disability



Biopsychosocial model of disability

- Disability is the interaction between individuals with a medical condition and personal factors (attitudes etc.) and environmental factors (inaccessible environments etc.)
- Managing disability demands both social and medical response.
- International Classification of Functioning, Disability and Health (ICF) utilizes this model (WHO, 2001).



World Health Organization. (2001). International classification of functioning, disability and health: ICF. World Health Organization.



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An inclusive evacuation design



Egressibility

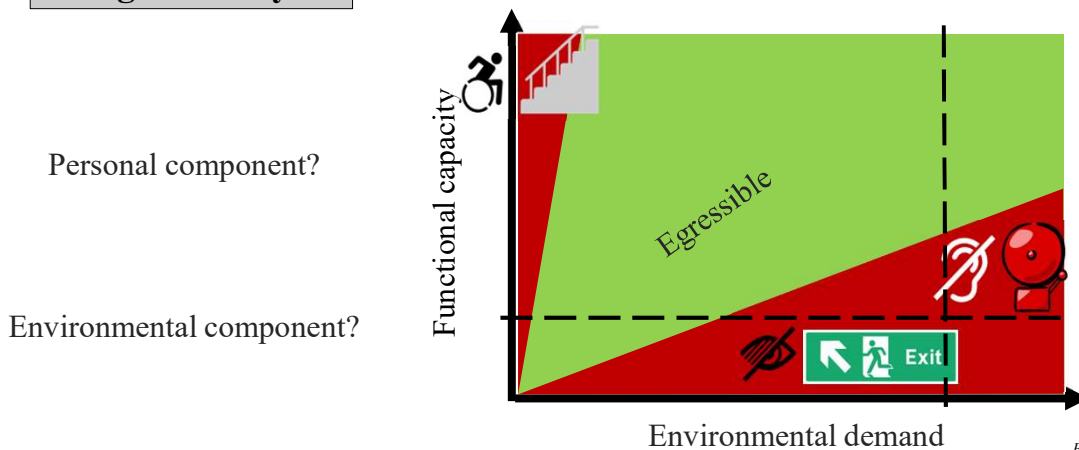
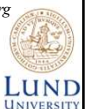


Figure by Smedberg



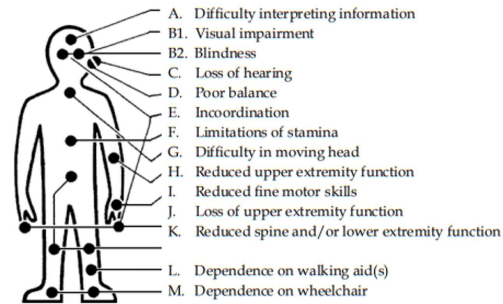
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An inclusive evacuation design



The personal component

- The functional capacity in the individual
- Functional limitations such as visual impairment, poor balance, dependence on wheelchair, etc.



Iwarsson, S., & Slaug, B. (2010). Housing Enabler—A method for rating/screening and analysing accessibility problems in housing. Manual for the complete instrument and screening tool. Vetén & Skapen HB & Slaug Data Management.



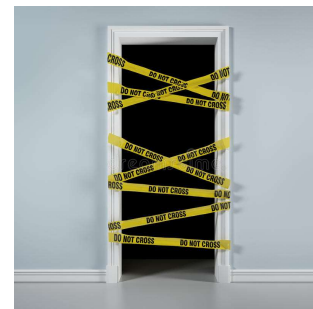
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An inclusive evacuation design



The environmental component

- Barriers in the environment
 - Small doors
 - Unaccessible information
 - Stairs
 - Etc.
- Smoke, crowding, loud alarms
- Personal component × Environmental component = Disability



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An inclusive evacuation design



Universal Design and Evacuation

There are many examples when the **environmental load** during evacuation could be too high. There are **solutions** that can be made to increase the egressibility.

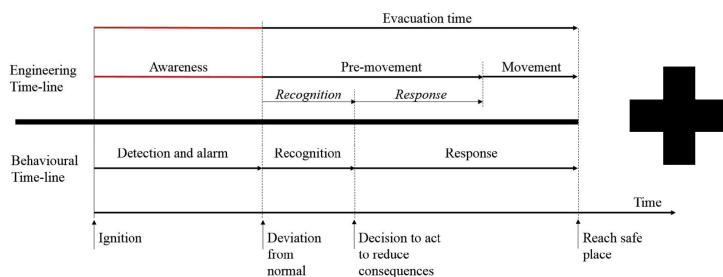


An inclusive evacuation design

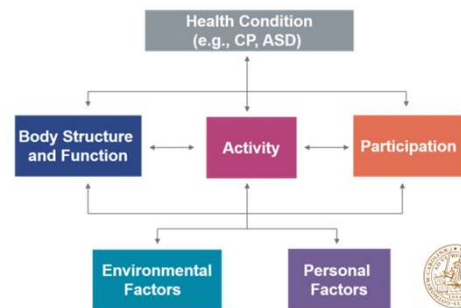


Literature review on evacuation of people with functional limitations (and related accessibility research)

Evacuation timeline



International Classification of Functioning, Disability and Health (ICF)



An inclusive evacuation design



Coupling functioning according to ICF with evacuation activities



Table 1
Evacuation activities linked to ICF classification and functional limitations with listed references

Evacuation activity [phase] ^a	Predominant activity in terms of ICF—block	Predominant activity in terms of ICF—category	Visual limitation	Hearing limitation	Mobility limitation	Upper extremities limitation	Cognitive limitation	Other functional limitations ^b
Hearing alarm [A,P]	Purposeful sensory experiences	Listening		[27, 31, 43, 53]				
Smelling emergency cues [A,P]	Purposeful sensory experiences	Other purposeful sensing ^c						Research gap ^d
Seeing emergency cues [A,P]	Purposeful sensory experiences	Watching	[34]					

Systematic categorisation of functional limitations in the evacuation context

O. Bukvic, G. Carlsson, G. Gefenaite, B. Slaug, S. M. Schmidt, and E. Ronchi, "A review on the role of functional limitations on evacuation performance using the International Classification of Functioning, Disability and Health," *Fire Technol*, Sep. 2020, doi: 10.1007/s10694-020-01034-5.



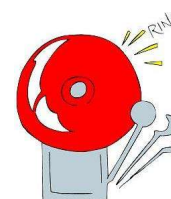
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An inclusive evacuation design



Fire alarms

- Fire alarms
 - People with **hearing impairments**, especially older people, may have issues hearing sound above 2000 Hz (Proulx, 2002). Age-related hearing loss is the most common cause of hearing loss (1/3 of people over 65y).
 - People who are hard of hearing or deaf do not wake up effectively from regular fire alarms or flashing beacons (Bruck & Thomas, 2007a), neither do people who are impaired from alcohol (Bruck & Thomas, 2007b).
 - Temporary and situational impairments
 - In a loud environment, even people without functional limitations may have difficulties hearing alarms.
 - People using headphones etc.



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An inclusive evacuation design



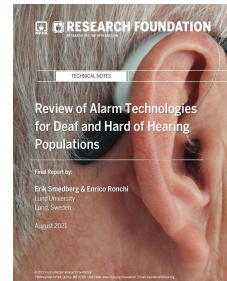
Fire alarms

Dedicated solutions for people who are hard of hearing such as bed/pillow shakers, strobe lights, vibrating wristbands, etc.



<https://www.nfpa.org/News-and-Research/Data-research-and-tools/Detection-and-Signaling/Review-of-Alarm-Technologies-for-Deaf-and-Hard-of-Hearing-Populations>

Technology	Primary stimulus afforded	Description	Current use and availability	Effectiveness (references)	Undesirable consequences
Phone under pillow	Tactile	Regular cell phone installed under the pillow. Vibrates when activated and functions as a pillow shaker	Widely used, but not for emergency alarm purposes and awakening	Research is limited [34]	Potential fire hazard
Pillow shaker	Tactile	Vibrating device installed under the mattress. Often connects to the fire alarm via sound recognition	Widely used in the deaf and hard of hearing community	Effective. Maybe less effective for older people [12-14]	Not identified
Vibrating wristband	Tactile	Wearable device that vibrates when activated. Could listen to the fire alarm	Widely used, but not for emergency alarm purposes and awakening	Research is limited [32, 34]	Some might find it uncomfortable to sleep with such a device and might therefore take it off
Strobe light	Visual	Lights that are activated by the fire alarm and flashes. Often hardwired to the fire alarm system	Widely used	Limited effectiveness, but very dependent on installation distance from the occupant [12, 13, 16, 17, 14, 18, 30]	Depending on the flashing frequency, it could cause epileptic seizures or disorientation



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An inclusive evacuation design



Vertical evacuation



- Vertical evacuation relies mostly on the use of **stairs** → **not everyone can use them**. Access is normally provided via elevators.
- **Refuge areas** are offered as an alternative but are not always well accepted by the individuals that are asked to use them (Andrée et al., 2015).
- **Occupant evacuation elevators** are seen as an inclusive means of vertical egress, but we need to make sure that people are okay with using them (Mossberg et al., 2020)



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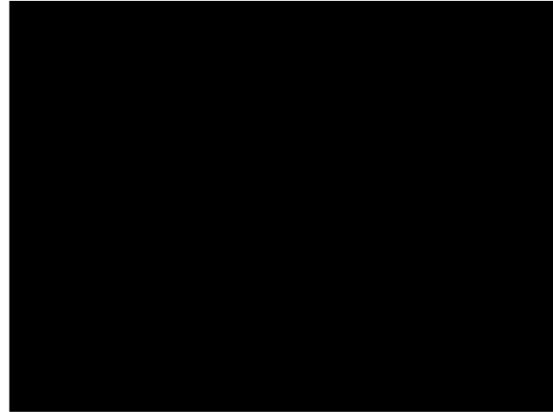
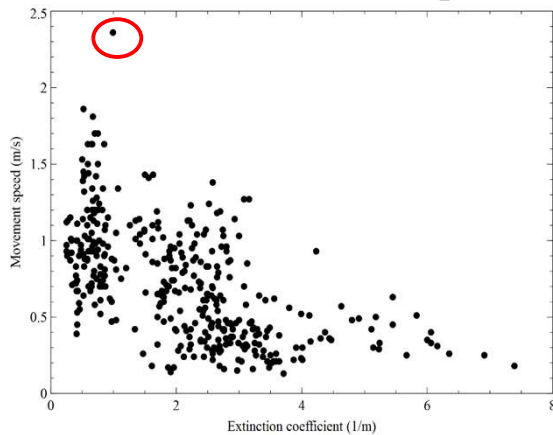
An inclusive evacuation design



Way-finding

Evacuating through **smoke** (situational impairment) is in a way similar as the evacuation of a person with visual impairment.

The tunnel evacuation experiment paradox



Ronchi, E., Fridolf, K., Frantzi, H., Nilsson, D., Walter, A. L., & Modig, H. (2018). A tunnel evacuation experiment on movement speed and exit choice in smoke. *Fire safety journal*, 97, 126-136.



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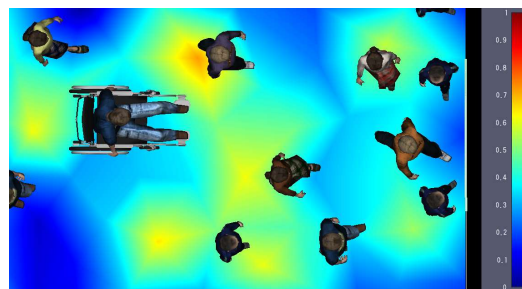
Evacuation modelling and egressibility



Representing different occupant profiles

- Simulation tools mostly focus on mobility limitations, e.g., walking speeds

Example of represented groups: wheelchair users, older people, etc.



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Evacuation modelling and egressibility

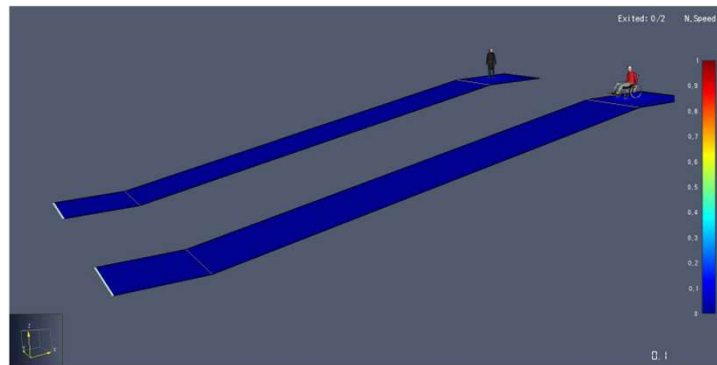


Representing different occupant profiles

Self rescue vs assisted evacuation

Use of egress components (stairs vs ramps, elevators)

Georg et al. (2019) recently compiled available data for egress models in next SFPE Handbook



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Conclusions



Main research gaps

Cognitive limitations



Difficult to collect data due to ethical issues



Smell

Limited research on ability to smell smoke!

Upper/lower extremities



Most research is about lower mobility, need to study upper extremities



Temporal dimension

Accessibility does not look at "how long it takes"






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Conclusions


Need for a **paradigm shift** in evacuation design → Need to link research in the health science domain with building design!

Foundation for a **new stream** of research → Egressibility



Future? Large 5-year 2 million eur EU project on Egressibility funded by the European Research Council just started October 1st!

Evacuation




Egressibility





Conclusions


Planned research



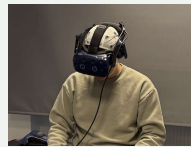
REAL WORLD EMERGENCIES




INTERVIEWS



VIGNETTE EXPERIMENTS




MULTI-SENSORIAL VR WITH PHYSIOLOGICAL MEASUREMENTS




INCLUSIVE MACHINE LEARNING
Fairness of AI
THE EGRESSIBILITY MODEL





THE EGRESSIBILITY OPEN DATABASE



Before alarm



After alarm

Contacts

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