MINISTERO DELL'INTERNO

VIGILI DEL FUOCO · CORPO NAZIONALE

per una SICUREZZA INCLUSIVA | HELP FOR ALL
A cura dell'Osservatorio Nazionale sulla Sicurezza e il Soccorso alle Persone con Esigenze Speciali del Corpo Nazionale Vigili del Fuoco

Nuove modalità di approccio alla sicurezza inclusiva con i metodi della Fire Engineering

Enrico Ronchi

Senior Lecturer, Department of Fire Safety Engineering, Lund University, Svezia

CONVEGNO INTERNAZIONALE
Corpo Nazionale Vigili del Fuoco

INTERNATIONAL CONFERENCE
National Fire Service

Istituto Superiore Antincendi
ROMA Giovedì 5 aprile 2018

Outline

- Evacuation modelling
  - *What are evacuation models*
  - *What results do we get?*
  - *How can we use them for inclusive fire safety?*
- Modelling vulnerable groups
- For which buildings/scenarios can we apply evacuation models?

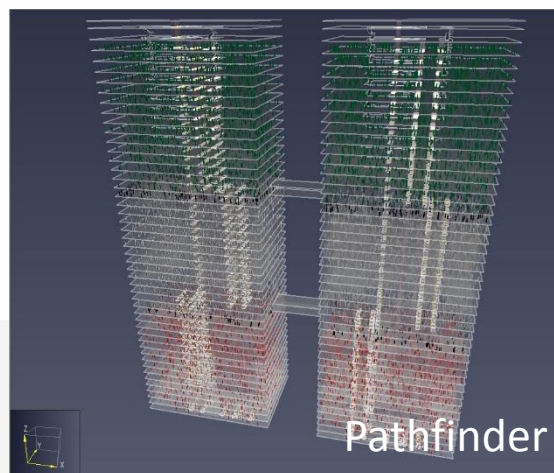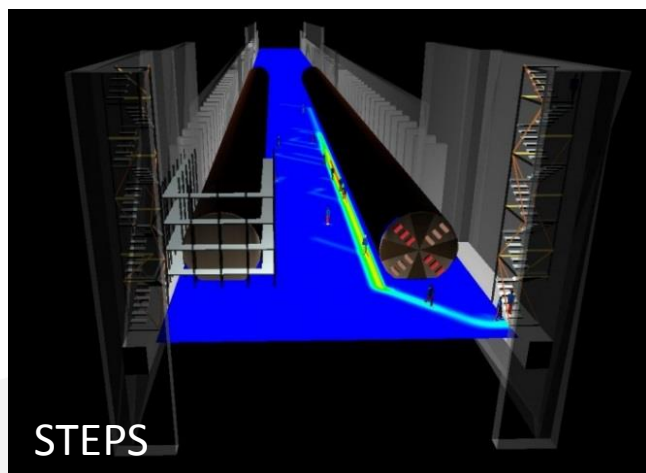# Evacuation modelling

What are evacuation models?

Computer modelling (research and commercial) FSE tools for the representation of human behaviour and people movement during fire emergencies

Movement (equation-based/agent-based)

- Hydraulic model in the SFPE handbook,
- Social force model
- Steering model, ecc.

Behaviours (generally agent-based)

- Time-line model (sequence of actions)
- Decision making

STEPS

Pathfinder

Evacuation modelling

What are evacuation models?

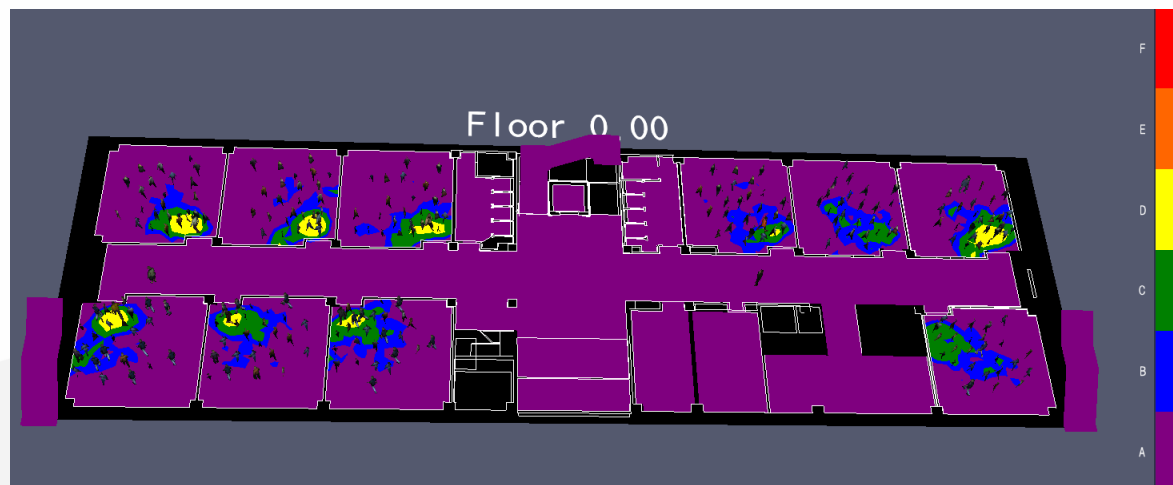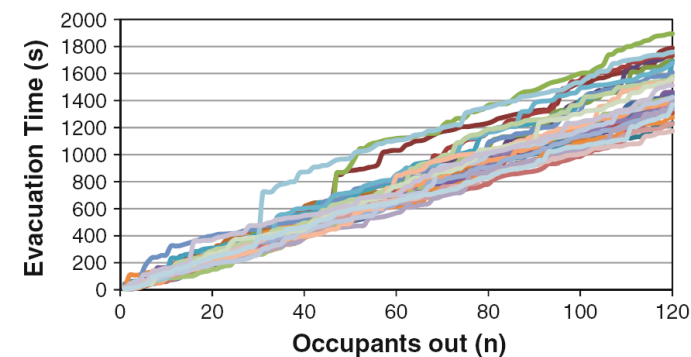Are evacuation models able to predict behaviours?

DATA ←——————→ THEORY

Evacuation modelling

What results can we get from evacuation models?

- Total evacuation times
- Occupant-evacuation time curves
- Prediction of congestion levels (comfort and safety) and other emergent behaviours
- Toxicity assessment in case of fire-people interaction (Purser's FED model)

Evacuation modelling

> **How can we use of evacuation models for inclusive fire safety?**

- # Fire evacuation design

  Assessment of escape routes (quantity, dimensions, etc.)

- # Emergency management

  Evacuation strategies

  Use of egress components

Modelling vulnerable groups

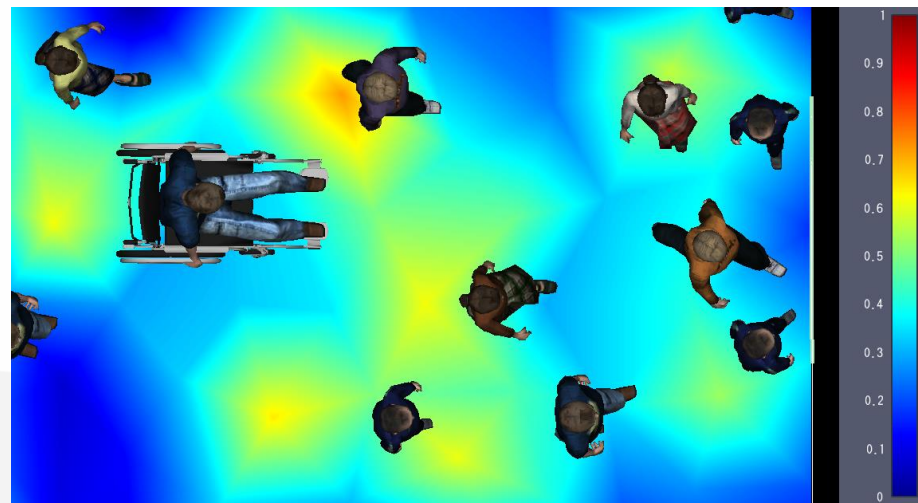**Representing different people types**

- ## Walking speeds

  Example of vulnerable groups: wheelchair users, children, elderly people, etc.

- ## Space usage during egress (safety/comfort)

  Needed space

  vs

  Available space
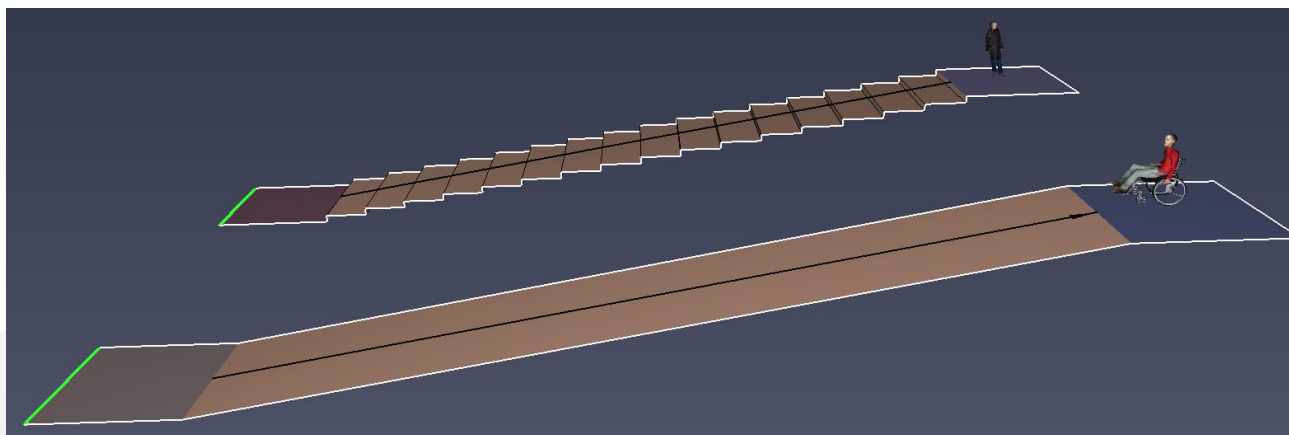
Modelling vulnerable groups

Representing different people types

- Egress abilities

  Self rescue vs assisted evacuation

  Use of egress components
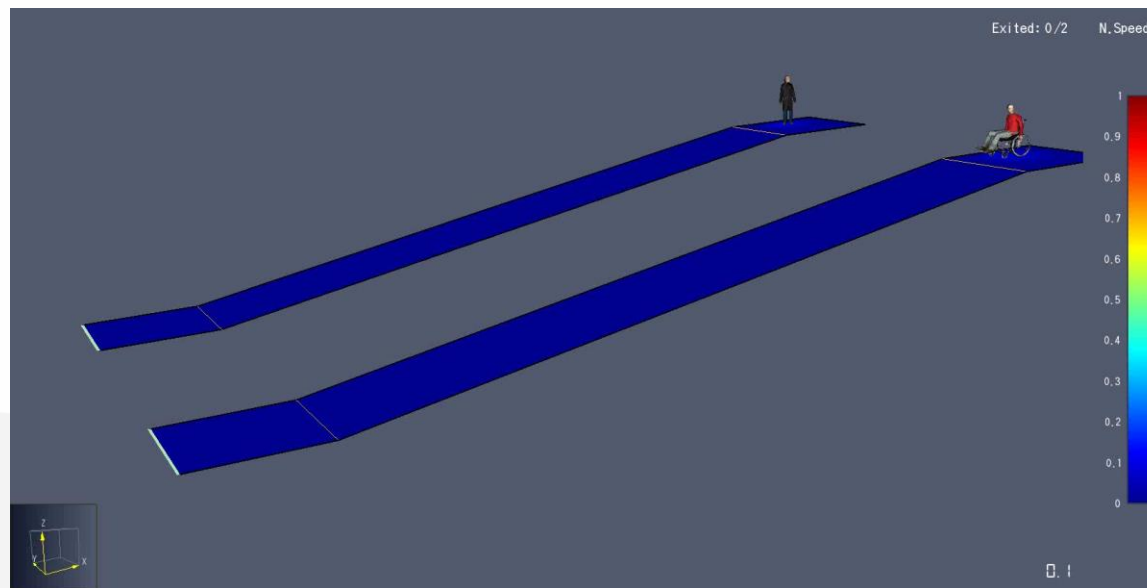
  (stairs vs ramps, elevators)

Modelling vulnerable groups

Representing different people types

- Egress abilities

Several people variables can be customized (e.g. walking speeds)

Modelling vulnerable groups

Representing different people types

- Assisted evacuation procedures

For which buildings/scenarios can we apply evacuation models?

- Analysis of evacuation procedures of vulnerable groups (both self rescue and assisted)

- Study of refuge floors/areas

- Elevators for evacuation

For which buildings/scenarios can we apply evacuation models?

Examples of building types

- Transportation terminals (e.g. underground)
- High-rise buildings
- Schools
- Health care facilities (hospitals)
- Retirement houses, etc.

For which buildings/scenarios can we apply evacuation models?

Application of evacuation models for buildings with vulnerable populations

NOT ONLY FOR "SPECIAL BUILDINGS"!

Every building fire evacuation design should account for vulnerable populations!

Conclusions

- Evacuation models can be a useful tool to design inclusive safety
- Models allow to represent different behaviours and use of egress components
- Great potential for FSE design

Outline

- Evacuation modelling
  - *What are evacuation models*
  - *What results do we get?*
  - *How can we use them for inclusive fire safety?*
- Modelling vulnerable groups
- For which buildings/scenarios can we apply evacuation models?

Contact information

Enrico Ronchi, PhD
enrico.ronchi@brand.lth.se

References

Alonso-Gutierrez, V., & Ronchi, E. (2016). The simulation of assisted evacuation in hospitals. Malaga, Spain: Thunderhead Engineering.

Carattin, E., Lovreglio, R., Ronchi, E., & Nilsson, D. (2016). Affordance-based evaluation of signage design for areas of refuge. In *14th International Conference and Exhibition on Fire Science and Engineering*. Royal Holloway College, University of London, UK: Interscience Communications.

Cuesta, A., Ronchi, E., Gwynne, S. M. V., Kinsey, M. J., Hunt, A. L. E., & Alvear, D. (2016). School egress data: comparing the configuration and validation of five egress modelling tools. *Fire and Materials*. https://doi.org/10.1002/fam.2405

Najmanova, H., & Ronchi, E. (2017). An Experimental Data-Set on Pre-school Children Evacuation. *Fire Technology*, *53*(4), 1509–1533. https://doi.org/10.1007/s10694-016-0643-x

Ronchi, E., & Nilsson, D. (2016). Basic Concepts and Modelling Methods. In A. Cuesta, O. Abreu, & D. Alvear (Eds.), *Evacuation Modeling Trends* (pp. 1–23). Cham: Springer International Publishing. Retrieved from http://link.springer.com/10.1007/978-3-319-20708-7_1

Ronchi, E., & Kinsey, M. (2011). Evacuation models of the future: Insights from an online survey on user's experiences and needs (pp. 145–155). Presented at the Advanced Research Workshop Evacuation and Human Behaviour in Emergency Situations EVAC11, Santander, Spain: Capote, J. et al.

Ronchi, E., & Nilsson, D. (2014). *Assessment of total evacuation systems for tall buildings*. New York: Springer.

Ronchi, E., & Nilsson, D. (2014). Modelling total evacuation strategies for high-rise buildings. *Building Simulation*, *7*(1), 73–87. https://doi.org/10.1007/s12273-013-0132-9

Ronchi, E., Reneke, P. A., & Peacock, R. D. (2014). A Method for the Analysis of Behavioural Uncertainty in Evacuation Modelling. *Fire Technology*, *50*(6), 1545–1571. https://doi.org/10.1007/s10694-013-0352-7