Fire Engineering in Timber Buildings: Safety & Sustainability

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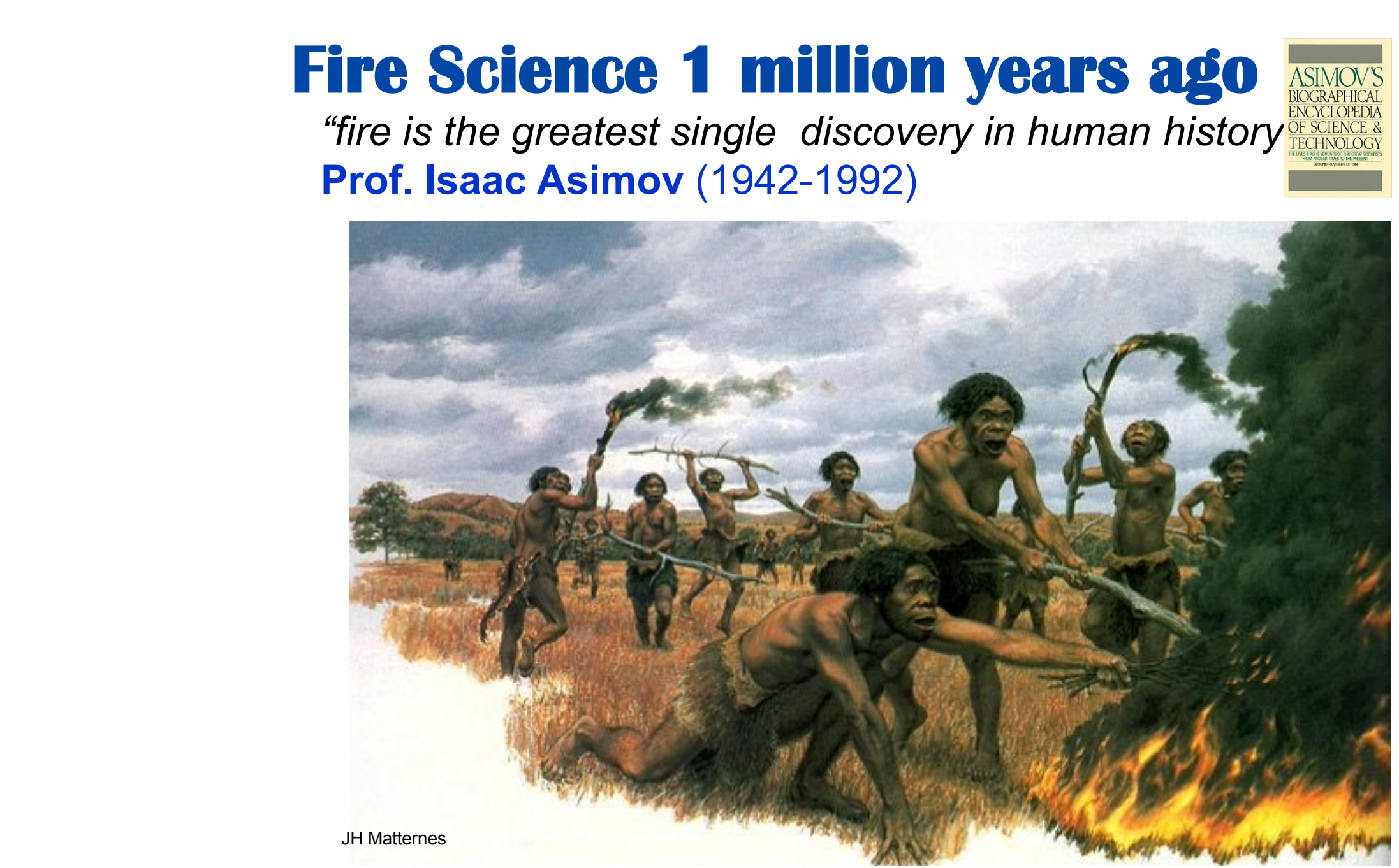
Fire Science 1 million years ago

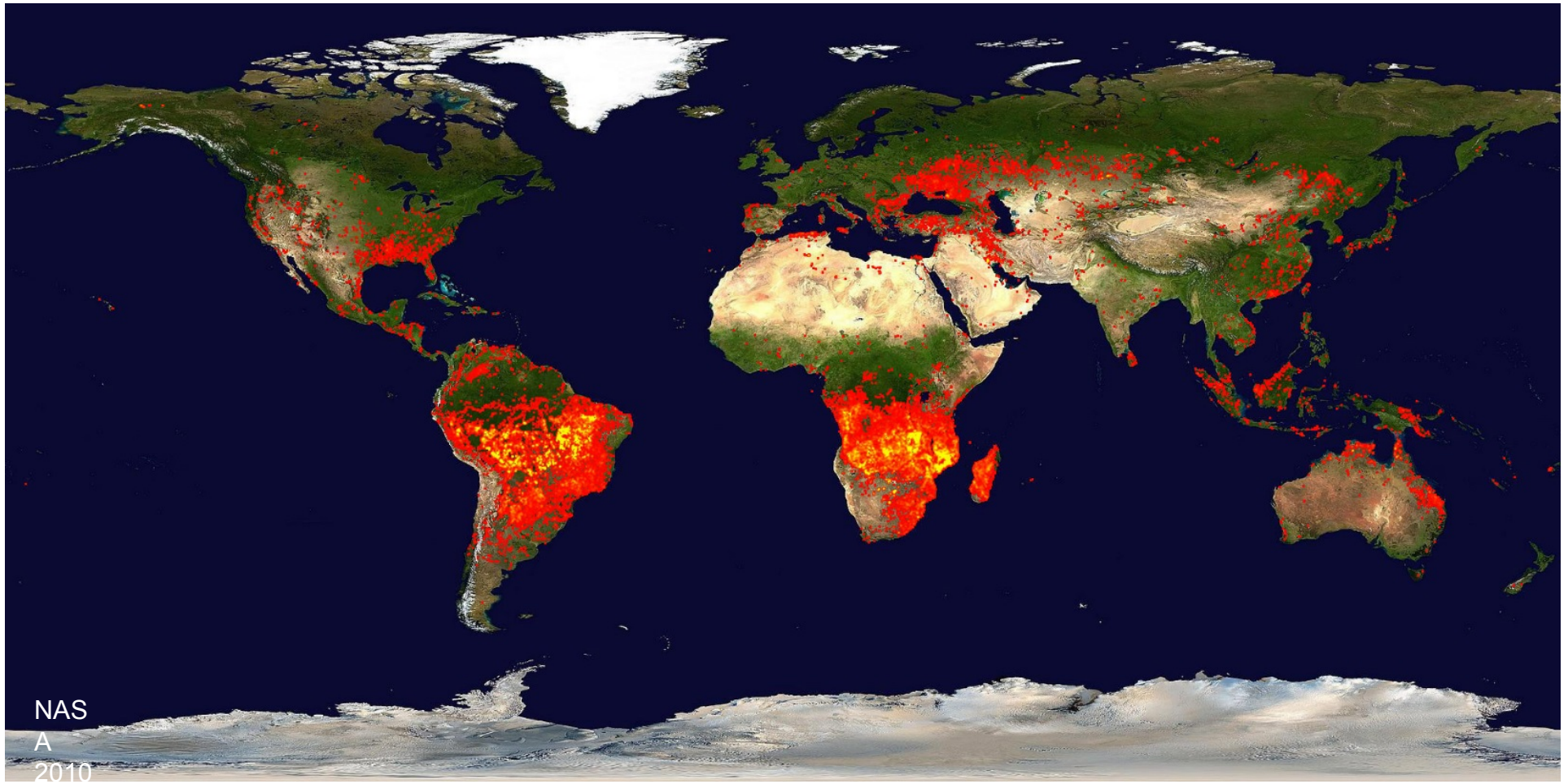
"fire is the greatest single discovery in human history

Prof. Isaac Asimov (1942-1992)



JH Matternes

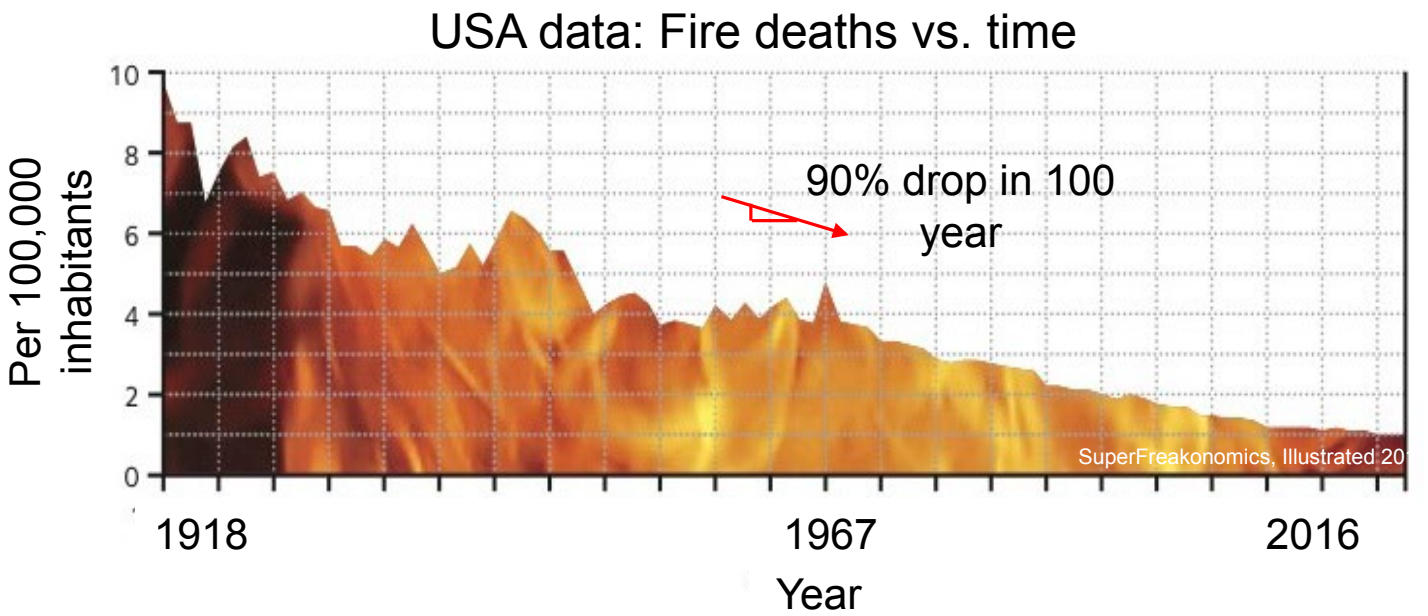
Planet Earth is also planet Fire



Fire Matters

We have done well protecting the life of citizens but at a tremendous cost.
In UK: **fire claims annually 320 lives (as many as drowning) but costs £7b**

Building Fires



- Despite tremendous progress in protecting lives from fire, it is still causing 5% of injury-related deaths worldwide (war causes 2%).
- Fighting fires is costly (UK £7 billion/yr).

Protection of Buildings

Fire Engineers make the world safer from fire: protect people, their property, business and the environment.

Layers of Protection

(after Prof Drysdale):

1. **Prevention**
2. **Detection**
3. **Evacuation**
4. **Compartmentation**
5. **Suppression**
6. **Structural Resilience**

*Not all layers must be present in a building, but all must be considered as least.
*Not all layers contribute equally or cost equally.

“The Titanic complied with all codes. Lawyers can make any device legal, only engineers can make them safe"

Prof Vincent Brannigan, University of Maryland

Cartoon by Floris Oudshoorn @MySwampThing (Comic House, 2018).

Driver of change: Performance Based Design

PBD – prescribed the safety goals, not the design method

- Designers must **demonstrate (not assume)** compliance with requirements.
- **Game Changer, globally.**
- **True engineering**, built on top of accumulate wisdom of prescriptive codes.
- It creates need for more well prepared fire protection **engineers**.

Driver of change: Environmental Protection & Sustainability

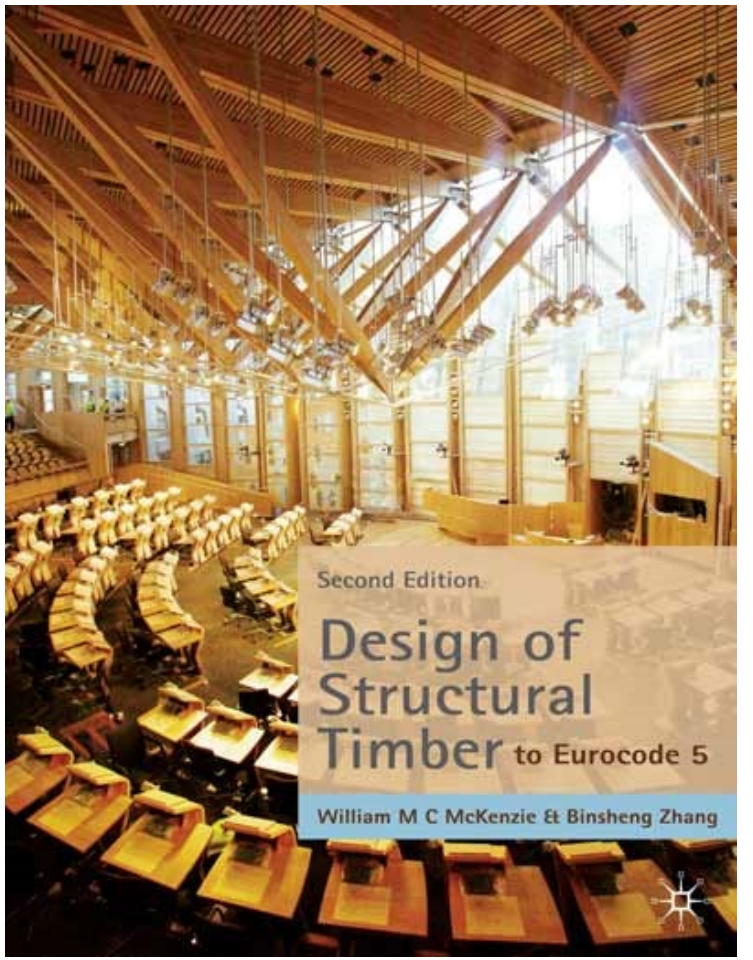
Sustainability – eliminate negative environmental impact

- Designing the **life cycle** of the system according to principles of social, economic, and ecological sustainability (eg, energy, waste, carbon footprint).
- **Impact ⚠:** Responding to modern ethos in society.
- **Impact ⚠:** Green buildings bring fire challenges.

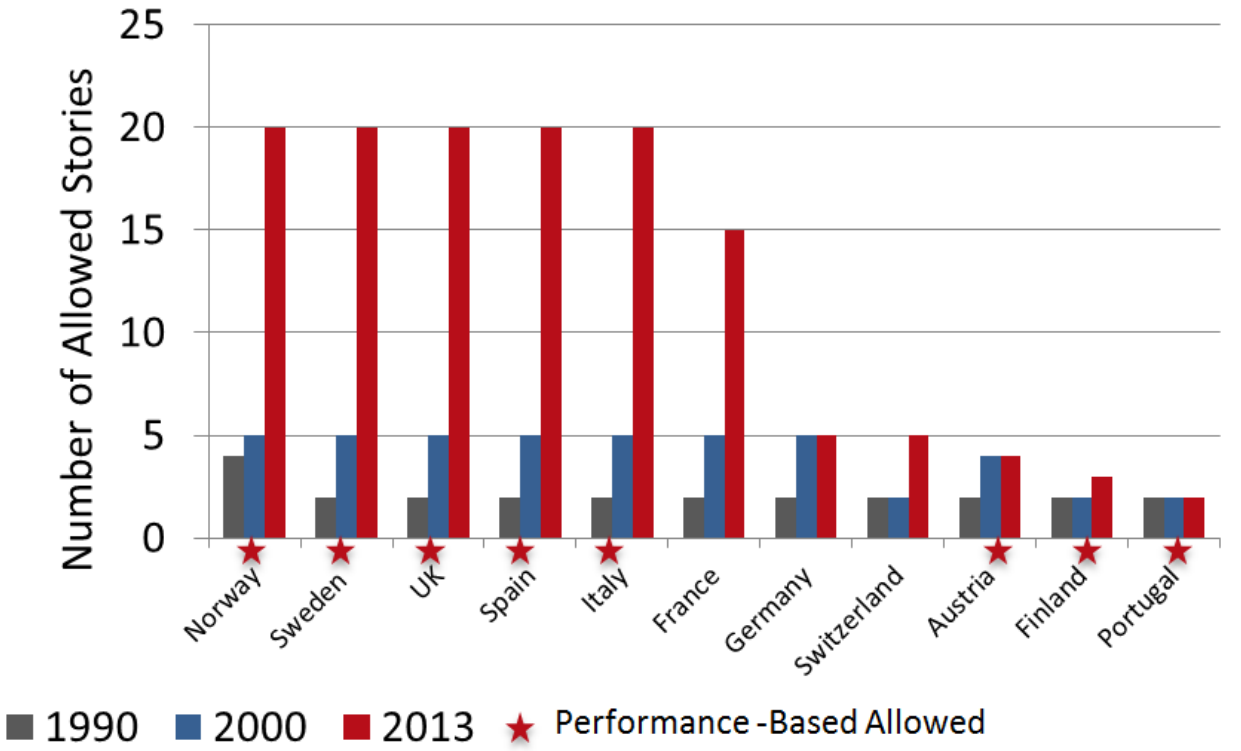
Wood and Fire Safety Engineering

Drivers: Sustainability & Novel Architecture

- Engineering timber allows design of more **sustainable and taller** buildings.
- Big market barrier to tall timber construction because of the fire **risk borne from the structural material** (vs. risk borne from contents)
- **Very little research** on the topic when compared to other materials like steel or concrete.



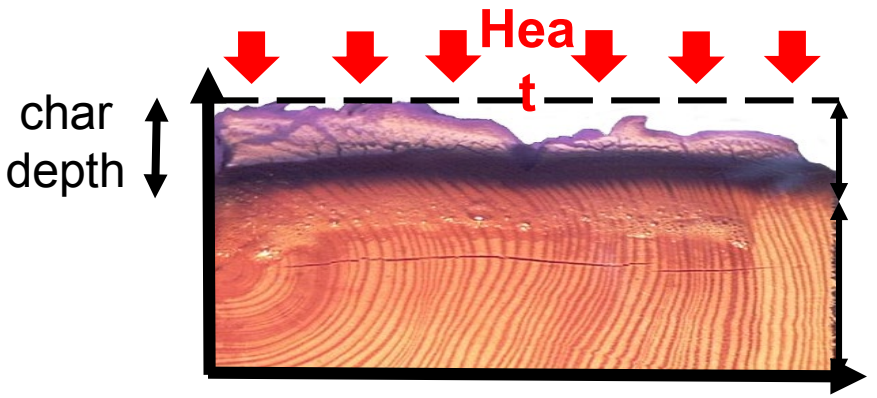
Timber high-rise buildings?



Evolution of allowable number of stories in timber constructions in Europe (Naccache *et al.* 2015)

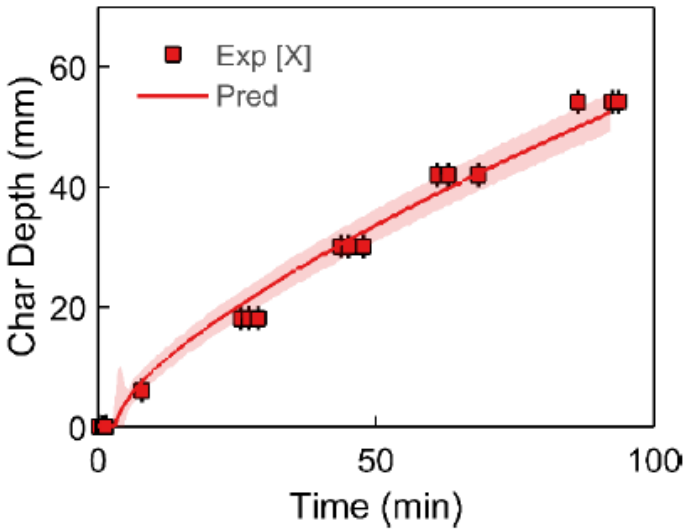
What we do for engineering

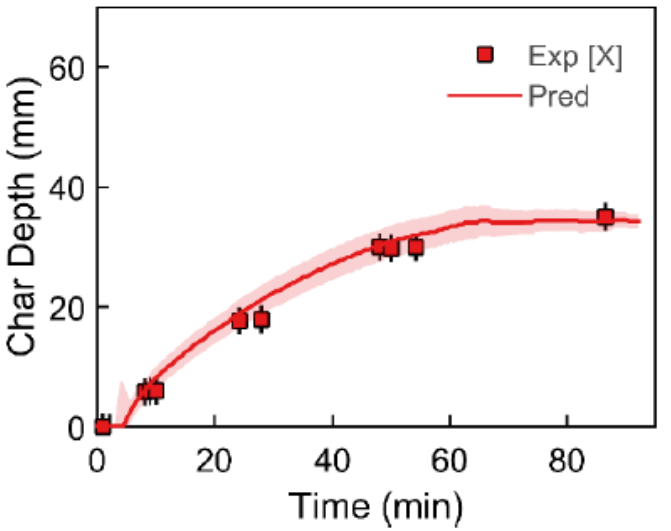
Accurate calculations of timber charring allow better design of timber high-rises.



$$\frac{\partial(\bar{\rho} Y_i)}{\partial t} = \dot{\omega}'''_{fi} - \dot{\omega}'''_{di}$$

$$\frac{\partial(\bar{\rho}\bar{h})}{\partial t} = k\frac{\partial}{\partial z}\left(\frac{\partial T}{\partial z}\right) + \dot{\omega}'''_{fi}(-\Delta H_i)$$





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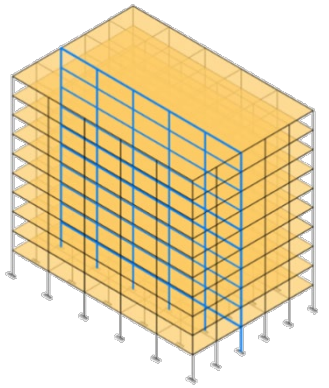
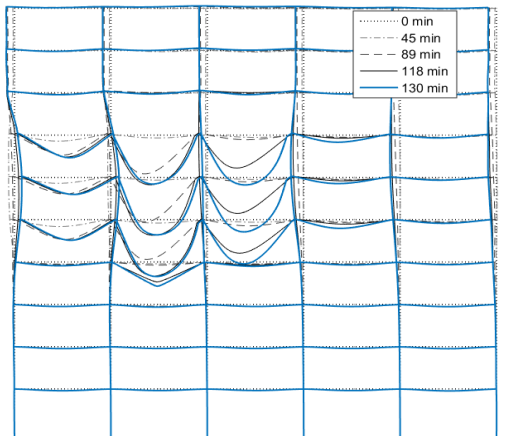
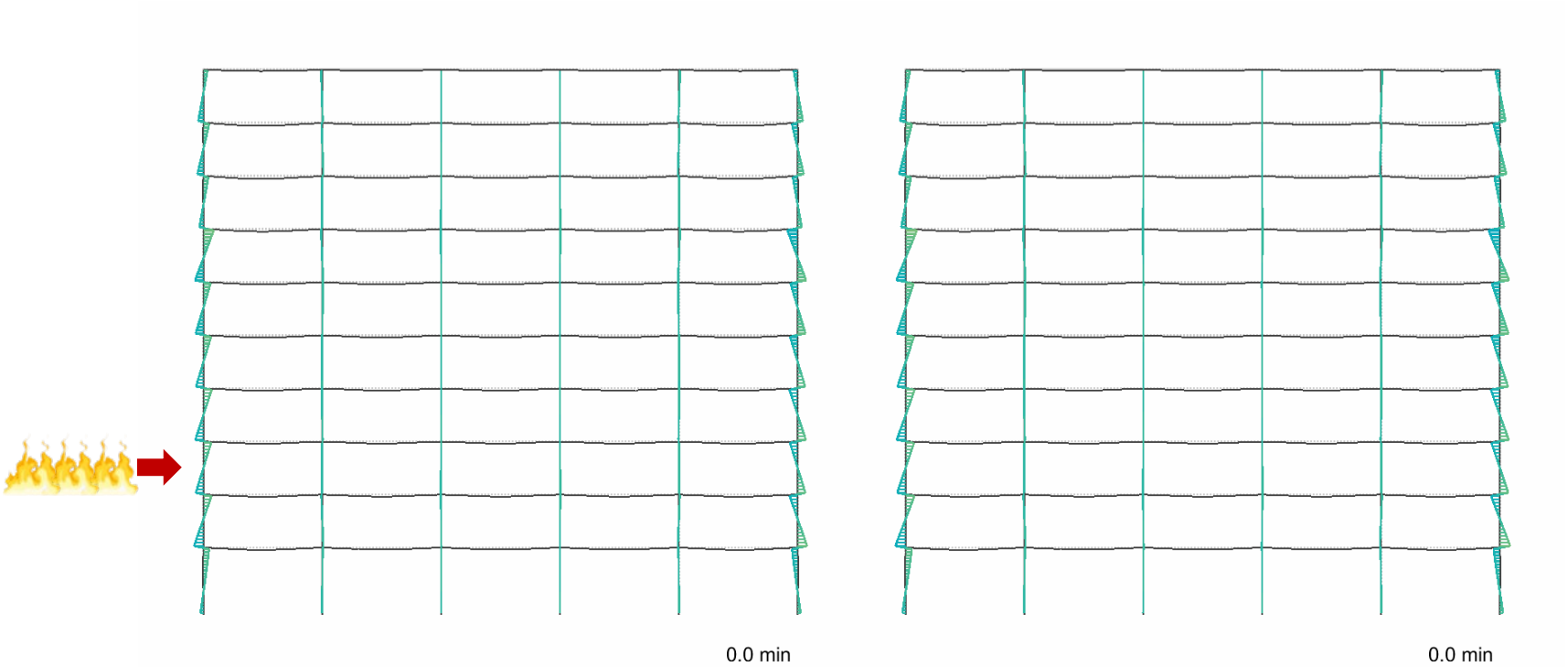
What we do for engineering







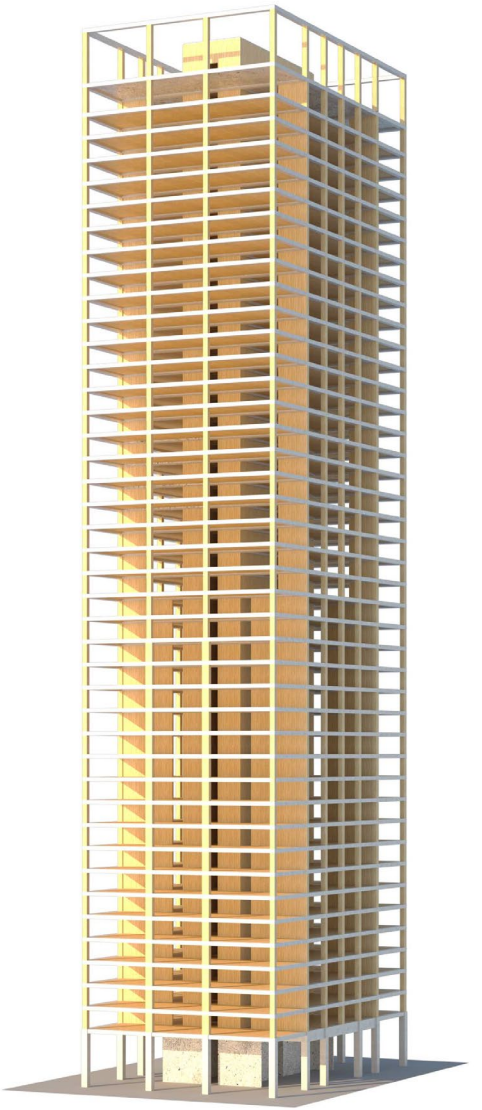
10% travelling fire

Eurocode long cool fire

Scale factor - 5

Conclusion

- Engineered wood allows for tall timber buildings: **sustainable**, fast, beautiful, sought after…
- Fire safety uncertainties are a barrier to progress. Engineers are resolving them.
- Design of tall timber falls outside prescriptive codes so **performance based design** is needed.
- Despite 1.5 million years burning wood products, we still do not understand well enough how burns.
- Help engineers and scientists unlock timber's potential as an engineering material.



Skidmore, Owings & Merril LLP

Thank you for listening

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Engineering A Fire Safe World

ARUP

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