How to Evacuate a Railway Terminal
A Passenger Simulation Case Study
Why passenger simulation?

Real-world, operational and strategic problems: inefficiencies, high densities, bottlenecks etc.

Evaluation and implementation: design change, re-routing, scheduling change etc.

Computer simulation experiments and optimization
What is state of the art in simulation?

- Microsimulation: every passenger is simulated as a separated, single person
- Virtual passengers have properties (age, size, gender etc.), goals and behaviors
- Agents move realistically and continously in space
- All transport objects (trains, cars etc.) as well as operational objects (escalators, stairs, elevators etc.) can be integrated into a simulation scenario
- Current software allows 2D as well as 3D visualization and analysis
What is special about evacuation modeling?

- Movement: passengers move at the same time fast and reluctant, „complex“ depending on information about the danger

- Behaviour: Less goal driven than in normal flow where specific destinations exist (reaction time)

- Complexity of environment: Complex environments are more significant for escape behavior than for normal flows

- In railway terminals more complex environment (exit routes), complex reaction times than in building evacuation

- Psychology: what is panic?
Why passenger simulation?

Results and benefits of evacuation simulation

- Evacuation time: how long does it take for all passengers to reach safe areas?

- Escape routes: Given a certain kind of hazard, are possible escape routes efficient and able to evacuate passengers?

- Design verification: Is the general terminal design able to cope with different hazard scenarios and evacuate the passengers safely?

- Hazard management: What operational actions (information, signage etc.) are beneficial for evacuating passengers in a given time?
Case Study
Evacuation Of Two Main Railway Station Designs
What's the basis of simulations in Germany?

- There is no law in Germany which makes microsimulations mandatory in approval processes.

- But there are more and more recommendations for using these techniques as part of proofs for fire safety in the process of approval.

- Technical specifications and standards are being developed.

- Until now, the full abilities of these models are not yet being used.

- Besides simulations, also capacity calculations are possible for estimating evacuation time.

- Models basing on cellular automata are very common.
Basis for simulations of railway stations

- RiMEA - Richtlinie für mikroskopische Entfluchtungs-Analysen
- vfdb - Leitfaden für Ingenieurmethoden
- Standards of DB Station & Service
- DB AG Richtlinie 813 „Personenbahnhöfe planen“
- Eisenbahn-Bau- und Betriebsordnung (EBO)
- Allgemeines Eisenbahngesetz (AEG)

Recommendations for standardised reports

Recommendations for engineering methods in fire safety

Makes further specifications concerning simulations as engineering method for fire safety

Technical standard of DB AG references in Module 81304 to specifications of DB Station & Service

EBO references to generally accepted rules of technology (anerkannte Regeln der Technik)

§ 4 Abs.1 AEG: Railways are obliged to build and hold a safe and secure infrastructure

It is in the responsibility of the owner to assure fire safety of his planned building.
Multiple views...

Everybody has its own ideas what's important and how she or he abstracts the world for the model.
Bring the expert's knowledge on one table

The simulation model is an aggregate for transforming the virtual world in the heads of the experts to a viewable model in the real world.

- Safety
- Traffic
- Management
- Visualisation
- Results, Decisions
- Architects
- Contractors

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The case study: motivation

- Scientific study on micro-simulation of Stuttgart main station(s) (Kopfbahnhof and Stuttgart 21)

- Several scenarios from the approval process of the new station from 2002 and 2003 and a passenger analysis from 1998 were available => good basis for making comparable tests

- Recent studies didn‘t compare planned station layout with actual station design and didn‘t incorporate the simulation of disabled or handicapped persons (had been criticised)

- Impact of architectural changes (staircases) on the evacuation time

- Challenge to find scientific answers with this micro-simulation and potentially comparation with cellular automata
Scenario Stuttgart 21
Scenario Stuttgart 21
Simulation of 4 platforms and 8 trains

960 Persons per train and 1500 per platform
Case: Effect of the architecture

- on the right: congestion on the upper platform
- in the middle: congestion on the way to the exit
Example video
Scenario Stuttgart recent main station
Scenario Stuttgart recent main station
Indicating a possible bottleneck
Case: simulating “stressing scenarios”

- 960 passengers per train and 1500 per platform
- People shall use in this case mostly the northern exit in order to produce a congestion
- In reality, they would mostly go into one direction from the right to the left
What’s important in modeling?

• Use actual train stations as test beds

• Be aware of possible bottle-necks— they should be simulated in the model

• Think also about very unlikely cases – people are acting very often irrational!

• Once a model is established, complexity could be raised every time

• For this, consider different experts with different points of view as an advantage for your project

• Take enough time for validation and let different parameters be tested in order to get good and valuable results
What’s also important in modeling?

- Mind the demographic change and also accessibility
- Think of special cases e.g. sports events or concerts
- Incorporate known bottle necks
- WYMIWYG: what you model is what you get – not the “real world”
- Tools and models do not substitute experience
Can one model help for multiple problems?

- approval and acceptance
- benefit and income during life-cycle
- costs

Can you go further with a simulation model and your experts?

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Possibilities...

• Use one model for multiple purposes in the whole life-cycle

• Once built-up you can use during approval, building, facility management

• Assure safety with the model during construction or maintenance

• Cooperation with traffic planners and center management (shopping mall): model as part of an overall system-view

• Station design has impact on the transfer time and so on the minimum dwell time – this can be scrutinised with the same model
Conclusion

• Train stations are very complex structures. With simulations, impacts on passenger behaviour could be seen and examined, that simple calculations don’t allow you.

• Not only the experience, but also seeing the station with all its facets, help to improve the results. This is also dependent on the input from other experts.

• A simulation model does not replace the expert’s knowledge, but could help to visualize the different points of view, increasing its benefit.

• The today’s technology allows to use one model for multiple purposes e.g. traffic planning, safety concepts or center management.

• One should differ between the approval process and the opportunity for raising your own knowledge level in order to make better decisions.
Thank you for your attention

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