

# Crowd Simulations Beyond Evacuation Applications: A Use Case Study for Departure Scenarios at Major Events

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**Abstract** We present an interdisciplinary work that brings together crowd simulations and safety planning. Crowd simulations were used to assist in planning of major events in Düsseldorf, Germany, with a particular focus on departure scenarios after the events have ended. This work describes the challenges of modeling these types of scenarios and how the results have been incorporated into safety planning.

**Keywords** Crowd simulations, Scenario modeling, Departure process, Major events, Crowd Management

## Extended Abstract

Crowd simulations are an established method in fire safety engineering for investigating the effectiveness of escape routes and identifying congested areas for evacuation scenarios. The simulation scenarios are based on a variety of assumptions and model-specific parameters that are decisive for the simulation results and thus for the added value for practitioners. After defining a relevant scenario in terms of type of use and time of observation, several parameters must be determined for the input categories geometry, population (including the initial distribution of agents and individual characteristics such as free walking speed) and routes [2].

Scenario modeling becomes even more complex when it comes to modeling other types of processes, such as the departure of major events. Usually, the departure routes extend over a wide area to various transportation hubs (private and public transportation). The spatial start and end of the simulation area must be selected in such a way that the relevant dynamics of pedestrian streams can be represented and at the same time sufficient assumptions can be made for the parameters in this area. In addition to detailed modeling of the geometry, which can be particularly challenging in outdoor areas, assumptions must be made about the timing of the departure process. The spawned agents must be distributed to the destinations associated with the visitors' expected choice of transportation mode. In addition, there are often several available routes and crowd management measures on the way to a destination, which must be considered.

All assumptions made for modeling the scenario as well as model-related simplifications and restrictions (e.g. waiting behavior) must be taken into account when interpreting the simulation results to derive suitable measures for crowd management. The process of modeling such a simulation scenario and deriving findings for safety planning is a complex and iterative process, as illustrated in Figure 1, that requires close cooperation between simulation experts and safety planners at the respective event.

The authors have accompanied the planning of several major events in Düsseldorf, Germany. In the planning phase of the events, specific questions were identified that were to be answered with the help of crowd simulations. These questions were transformed into various scenarios and simulated using the research software JuPedSim [1]. The simulation results were interpreted in the context of crowd management. This was an iterative process, so that after the results were evaluated, changes were made to the scenario based on corrections and the updated planning status. An example of a simulation scenario examined is shown in Figure 2. The simulation results have helped to answer specific questions (e.g. what flow can be expected in that corridor after 30 minutes?) and to derive specific measures for crowd management, such as the routing to the various destinations. In addition, the visualization of the pedestrian streams helped to create a common planning basis that is also easier to understand for other stakeholders such as authorities.

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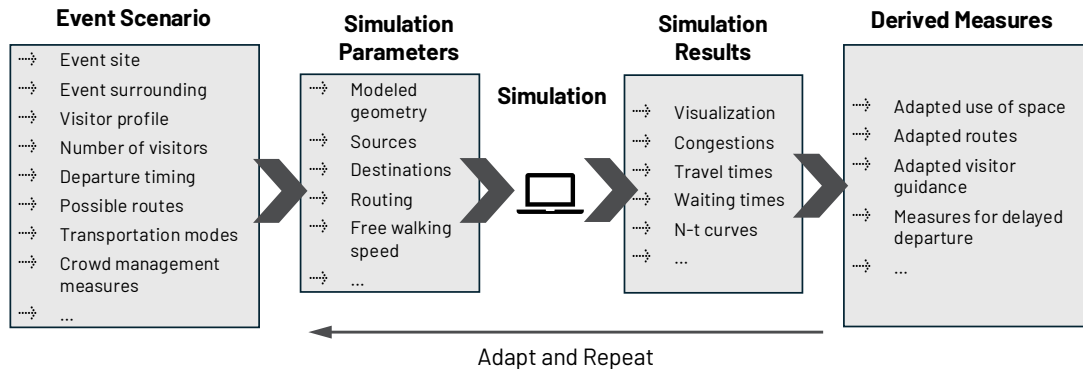


Figure 1: Schematic representation of simulation-aided planning starting from an event scenario to deriving measures.

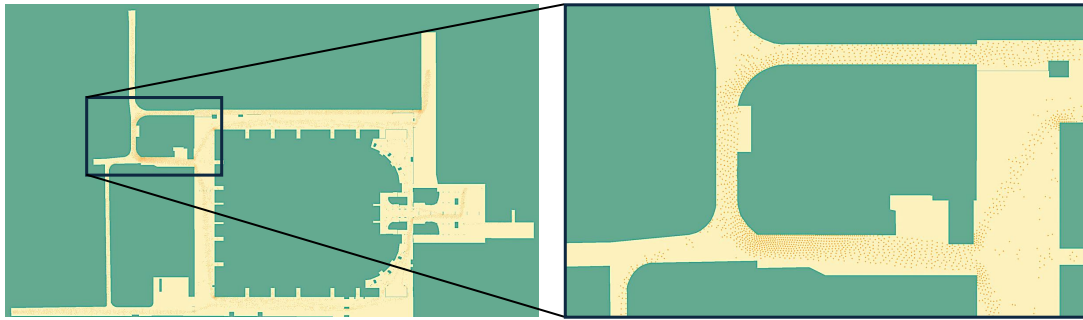


Figure 2: Snapshot of a simulation scenario that was created for the departure from the arena in Düsseldorf. For this scenario, for example, the choice and weighting of different routes in the surroundings of the arena were examined using simulations.

The proposed work provides an overview of the modeling process and the role of incorporation in the planning process of major events. It discusses the challenges and the use of the powerful tool of crowd simulations for scenarios beyond evacuation processes.

## References

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