### Analysis sent to:
email@rimea.de

### Email subject:
Analyse

<table>
<thead>
<tr>
<th><strong>Sender</strong></th>
<th></th>
</tr>
</thead>
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<td><strong>Date:</strong></td>
<td>26. Mär. 2020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Software</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name:</strong></td>
<td>crowd:it</td>
</tr>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>accu:rate GmbH</td>
</tr>
<tr>
<td><strong>Version:</strong></td>
<td>1.8</td>
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1 Introduction

1.1 Introduction to RiMEA

The results of the analysis of software crowd:it by accurate GmbH are summarized below. Test cases were developed by the RiMEA project Richtlinie für mikroskopische Entfluchtungsanalysen [RiM14].
2 Test 1 – Maintain the specified walking speed in a corridor

2.1 Test description

An agent in a 2m wide and 40m long corridor with a defined walking speed will cover the distance in the correct time period [RiM14].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor length [m]</td>
<td>40</td>
</tr>
<tr>
<td>Corridor width [m]</td>
<td>2</td>
</tr>
<tr>
<td>No. of agents</td>
<td>100</td>
</tr>
<tr>
<td>Speed [km / h]</td>
<td>[Wei92]</td>
</tr>
</tbody>
</table>

Table 1: Test specifications [RiM14]

2.2 Simulation model

The corridor and walking speeds were modelled according to the specifications (see Table 1). One agent was generated per simulation run, eliminating the side-effects of other agents.

2.3 Documentation

Figure 2 confirms that in each of the 100 simulation runs, an agent does not exceed its prescribed speed.

The test verifies that agents can and do travel at predefined walking speeds, when specified.
Figure 1: Agent travel time for each simulation run
Figure 2: Comparison between prescribed travel time and actual travel time for each simulation run
3 Test 2 & 3 – Maintain the specified walking speed up and down stairs (Staircase Model)

3.1 Test description

An agent in a 2m wide and 10m long (measured along the slope) staircase with a defined walking speed will cover the distance in the correct time period [RiM14]. We amalgamate Tests 2 and 3 and consider Scaled Areas and the Staircase model separately. Here, first, the crowd:it staircase model.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staircase length [m]</td>
<td>10</td>
</tr>
<tr>
<td>Staircase width [m]</td>
<td>2</td>
</tr>
<tr>
<td>No. of agents</td>
<td>100</td>
</tr>
<tr>
<td>Speed [km / h]</td>
<td>[Wei92]</td>
</tr>
</tbody>
</table>

Table 2: Test specifications [RiM14]

3.2 Simulation model

Staircases are modelled as in [GK15]. The scenario was modelled as prescribed in Table 2. Staircases were modelled with 26 treads of length: 260mm, 270mm, 280mm, 290mm and 300mm [DIN15].

3.3 Documentation

Figure 3 confirms that the staircase model decelerates agents by a degree that is dependent on the tread lengths of the respective staircase. Note: The staircase model decelerates agents non-uniformly. Those travelling faster are decelerated more [GK15].
Figure 3: Agent speeds in comparison to their desired speeds for different stair types

Figure 4: Screenshot of the simulation
4 Test 2 & 3 – Maintain the specified walking speed up and down stairs (Scaled Area)

4.1 Test description

An agent in a 2m wide and 10m long (measured along the slope) staircase with a defined walking speed will cover the distance in the correct time period. [RiM14]. Here, we consider Scaled Areas, which are areas in which agents are slowed by a predefined factor.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staircase length [m]</td>
<td>10</td>
</tr>
<tr>
<td>Staircase width [m]</td>
<td>2</td>
</tr>
<tr>
<td>No. of agents</td>
<td>100</td>
</tr>
<tr>
<td>Speed [km / h]</td>
<td>[Wei92]</td>
</tr>
</tbody>
</table>

Table 3: Test specifications [RiM14]

4.2 Simulation model

Scaled Areas take the agent’s desired walking speed as input, and reduce the agent’s speed to a fraction of this input. Here we test factors: 0.5, 0.6 and 0.7. That is, the agent is slowed to \( \frac{1}{2} \), \( \frac{2}{5} \) and \( \frac{7}{10} \) of its desired speed respectively.

4.3 Documentation

Figure 5 demonstrates the effectiveness of Scaled Areas on agent speed.
Figure 5: Agent speeds in comparison to their desired speeds for different Scaled Areas types
5 Test 4 – Measurement of the fundamental diagram

5.1 Test description

We test whether the effect of density on the speed of agents in the simulator matches that suggested by the fundamental diagrams. Given a corridor filled with varying numbers of agents, average speeds of the agents are measured within the prescribed areas and plotted against agent density to reproduce the fundamental diagrams.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor length [m]</td>
<td>1000</td>
</tr>
<tr>
<td>Corridor width [m]</td>
<td>10</td>
</tr>
<tr>
<td>Measurement tile dimensions [m × m]</td>
<td>2 × 2</td>
</tr>
<tr>
<td>Time of measurement [s]</td>
<td>50</td>
</tr>
<tr>
<td>Agent density [Agent / m²]</td>
<td>0.5, 1, 2, 3, 4, 5, 6</td>
</tr>
</tbody>
</table>

Table 4: Test specifications [RiM14]

5.2 Simulation model

The scenario was modelled according to the specifications (see Table 4). Several simulations were carried out with varying agent densities. The following measurements were carried out:

- Speed in the direction of travel (x-direction): \( v_x \)
- Flux through the corridor (x-direction): \( v_x \times \cdot \rho \)

Individual values are calculated in three different measurement tiles: as an averaging over all agents in each tile for each time-step.

5.3 Documentation

Density is calculated as follows: Agents are considered as soon as they cross the tile threshold and the proportion of their body crossing the threshold is what is included in the measurement.

The average speed \( v_x \) was calculated as follows: for each time-step, every agent within the tile (relative to measurement type A or B) produces an average speed
over the previous five time-steps in the x-direction. These values are used within the $v_x$ calculation. Thus, each data point shown in Figure 6 is an averaging of all values over the entire measurement period of 50 seconds (after a 10 second transient phase).

For comparison, the Weidmann curve [Wei92] is drawn over our data points:

$$v = 1.34 \cdot \rho \cdot (1 - e^{-1.913\left(\frac{1}{\rho} - \frac{1}{5.4}\right)})$$

(1)

**Figure 6: Fundamental diagram**

Walking speeds decrease once density exceeds more than 2 persons per square meter. crowd:it can consider large densities and simulate the resulting agent deceleration correctly. The results of crowd:it follow the Weidmann curve. At high enough densities, the walking speeds of agents tend to zero.
6 Test 5 – Pre-movement times

6.1 Test description

Agents in an 8m wide and 10m long room (with a 1m wide exit) will start moving at the appropriate time, given a distribution of pre-movement times across all agents [RiM14].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of agents</td>
<td>10</td>
</tr>
<tr>
<td>No. of agents</td>
<td>10</td>
</tr>
<tr>
<td>Pre-movement time [s]</td>
<td>$U[1, 100]$</td>
</tr>
<tr>
<td>Room size [m × m]</td>
<td>8 × 5</td>
</tr>
<tr>
<td>Exit width [m]</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Test specifications [RiM14]

6.2 Simulation model

The room size and pre-movement times were modelled according to the specifications (see Table 5).

Figure 7: Screenshot of the scenario
6.3 Documentation

Figure 8 suggests uniformity in the agent pre-movement times, as prescribed by the model. To verify this is the case, a Kolmogorov-Smirnov test was carried out, which can be used to test whether a set of data fit a given distribution.

![Reaktionszeit / Reaction time](image)

Figure 8: Pre-movement times

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pValue</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Table 6: Results

The p-value for a Kolmogorov-Smirnov test against the null hypothesis that the reaction times are evenly distributed is approximately 0.65. Therefore, crowd:it passes: it is possible to prescribe pre-movement times for agents, which are followed. (If the p-value were below 0.05, we would have a strong argument against the null hypothesis.)
7 Test 6 – Movement around a corner

7.1 Test description

Twenty agents moving towards a corner that turns to the left will successfully go around it without passing through walls [RiM14].

![Construction of the scenario](image)

Figure 9: Construction of the scenario [m] [RiM14]

7.2 Simulation model

The corridor was modelled according to the specifications (see Figure 9). The origin for the agents is at the end of the corridor (blue). Agents are generated over twenty seconds.

7.3 Documentation

Figures 11a, 11b and 11c confirm that agents do not move through walls.
Figure 10: Model of the corridor
Figure 11: Screenshots of the simulation
8 Test 7 – Allocation of demographic parameters

8.1 Test description

The walking speeds of 50 agents were distributed according to Figure 12:

![Figure 12: Horizontal walking speeds against agent age [Wei92]](image)

Using these specifications, agents will walk with speeds compatible with Weidmann [Wei92].

8.2 Simulation model

The corridor (70m × 20m) and walking speeds were modelled according to the specifications (see Figure 13). Agents were generated over time, mitigating congestion. Agent speed distributions are described specifically in Table 7.

8.3 Documentation

Walking speeds are calculated by dividing the total distance travelled (over every time-step) by the total travel time.
Figure 13: Screenshot of the scenario

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of agents</th>
<th>Min. [m/s]</th>
<th>Max. [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20y.o.</td>
<td>10</td>
<td>1.60</td>
<td>1.64</td>
</tr>
<tr>
<td>30y.o.</td>
<td>10</td>
<td>1.52</td>
<td>1.56</td>
</tr>
<tr>
<td>40y.o.</td>
<td>10</td>
<td>1.46</td>
<td>1.50</td>
</tr>
<tr>
<td>50y.o.</td>
<td>10</td>
<td>1.39</td>
<td>1.43</td>
</tr>
<tr>
<td>60y.o.</td>
<td>5</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>70y.o.</td>
<td>5</td>
<td>1.07</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Table 7: Given Walking speed of each age group [RiM14]

Figure 14 demonstrates that crowd:it simulates agents correctly, according to the Weidmann documentation [Wei92].

Figure 14: Walking speed of agents
9  Test 8 – Allocation of demographic parameters

9.1  Test description

A three-storey building will be evacuated and the corresponding time of evacuation analysed according to changes in agent parameters.

Changes in a parameter of interest will occur independently of all other parameters. Parameters can vary in two ways, either:

- a parameter is deterministically set.
- a parameter is non-deterministically set according to a predefined distribution.

9.2  Simulation model

The scenario is constructed as below [RiM14]: Note: The second floor distinguishes itself from the first by providing no staircase upwards to the higher floor.

The **Standard** settings are as follows:

- Walking speed $\nu$: min: 0.46m/s, max: 1.61m/s, Standard deviation: 0.26
- Perception radius: 2.0m
- Torso radius: 0.2m
- With Groups: false
- Stair-tread depth: 0.25m

![Figure 15: Construction of the scenario [m]](image)
Perception radius describes the radius of the area within which an agent can perceive other agents (and consequently behave in a way that minimizes the possibility of collision with them).

\( \nu \) can be both determinsitic and non-deterministic. Both are considered here.

With groups considers agents who move in groups of two or three alongside agents who move alone. The distribution of these groups is as follows:

- Individuals: 34%
• Groups of two: 33%
• Groups of three: 33%

9.3 Documentation

Figure 17 provides an overview of evacuation times according to the respective parameter alteration.

The scenario with groups do not have a significant influence over the evacuation time.

The Perception radius and Stair-tread depth has little influence over the evacuation time.

Naturally, the smaller the Torso radius, i.e. the smaller the agents, the quicker agents exit the scenario.

The higher $\nu$ the smaller evacuation times.

This test demonstrates the influence over agent parameters within crowd:it. In this way, a personalized version of the software can be sought by the user.
Figure 17: Evacuation times according to the varied agent parameter
10 Test 9 – Crowd of people leaving a large public space

10.1 Test description

Agents exiting a room with four doors exit more quickly than a room with only two doors [RiM14].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor length [m]</td>
<td>30</td>
</tr>
<tr>
<td>Corridor width [m]</td>
<td>20</td>
</tr>
<tr>
<td>Exit width [m]</td>
<td>1</td>
</tr>
<tr>
<td>Distance between wall and origin [m]</td>
<td>2</td>
</tr>
<tr>
<td>No. of agents</td>
<td>1000</td>
</tr>
<tr>
<td>Speed [km / h]</td>
<td>[Wei92]</td>
</tr>
<tr>
<td>Reaction time distribution [s]</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 8: Test specifications [RiM14]

The evacuation time between each scenario should be observed and compared. The expectation is that the scenario with four doors takes approximately twice as long to complete as the scenario with only two doors. [RiM14]
10.2 Simulation model

The room and walking speeds were modelled according to the specifications (see Table 8).

![Screenshot of the scenario with 2 doors](image1)

![Screenshot of the scenario with 4 doors](image2)

Figure 19: Screenshots of Test 9

10.3 Documentation

<table>
<thead>
<tr>
<th>Szenario</th>
<th>Evakuierungszeit [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 doors, dynamic floor field calculation</td>
<td>134.36</td>
</tr>
<tr>
<td>2 doors, dynamic floor field calculation</td>
<td>274.51</td>
</tr>
<tr>
<td>4 doors, static floor field calculation</td>
<td>136.46</td>
</tr>
<tr>
<td>2 doors, static floor field calculation</td>
<td>264.50</td>
</tr>
</tbody>
</table>

Table 9: Test scenarios [RiM14]

With a dynamic floor field calculation, an evacuation of the room with 4 doors takes 49.0% the time of a scenario with 2 doors. Without a dynamic floor field calculation, an evacuation of the room with 4 doors takes 52.0% the time of a scenario with 2 doors.

For this test, both a dynamic and static floor field calculation was considered. The dynamic floor field calculation is computationally more effortful, however the agents can, using it, react to changing environments more appropriately.

The test confirms that the effect of having two doors instead of four does indeed approximately double the time of evacuation for crowd:it agents.
11 Test 10 – Allocation of escape routes

11.1 Test description

Agents, provided with an exit to use when escaping from a building, will choose the correct exit.

Figure 20: Construction of the scenario [m]

Figure 20 describes where agents should be generated and which exit they should take. Agents from rooms 1, 2, 3, 4, 7, 8, 9 and 10 use the main exit. The remaining agents use the second exit.

11.2 Simulation model

The rooms, agent occupation and exit assignment were modelled according to the specifications, with the exception of room 3, which contains 2 agents instead of the prescribed 1. No pre-movement time was assigned and walking speeds were set according to [Wei92].

11.3 Documentation

Figures 21a to 21d demonstrate that agents correctly use the exits they were assigned.
Agents within the crowd:it simulator correctly use the routes they are assigned.
12 Test 11 – Choice of escape route

12.1 Test description

Provided with a choice of two exits, agents will generally select the closer of the two, causing congestion.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of agents</td>
<td>1000</td>
</tr>
<tr>
<td>Pre-movement time [s]</td>
<td>0</td>
</tr>
<tr>
<td>Walking speed [m/s]</td>
<td>[Wei92]</td>
</tr>
<tr>
<td>Room size [m × m]</td>
<td>30 × 20</td>
</tr>
<tr>
<td>Exit width [m]</td>
<td>1</td>
</tr>
<tr>
<td>Distance between the walls and origin [m]</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 10: Test specifications [RiM14]

12.2 Simulation model

The scenario was modelled according to the specifications (see Table 10). In order to highlight the difference between a dynamic and static floor field, tests were carried out on both.
12.3 Documentation

![Figure 23: Screenshots of the evacuation](image)

(a) Screenshot of the evacuation after 30 seconds  
(b) Screenshot of the evacuation after 60 seconds  
(c) Screenshot of the evacuation after 120 seconds

Table 11: Results for dynamic decision making

<table>
<thead>
<tr>
<th>Exit</th>
<th>No. of agent using exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>529.00</td>
</tr>
<tr>
<td>2</td>
<td>471.00</td>
</tr>
</tbody>
</table>

Table 12: Results for non-dynamic decision making

<table>
<thead>
<tr>
<th>Exit</th>
<th>No. of agent using exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>611.00</td>
</tr>
<tr>
<td>2</td>
<td>389.00</td>
</tr>
</tbody>
</table>

With a dynamic floor field, agents make dynamic decisions when selecting an optimal route. That is, they select where to move next based on the current conditions. However, this feature is optional. When unused, agents select a route that would be optimal if no one else existed in the scenario.

Figures 23a, 23b and 23c demonstrate the results of a dynamic floor field. As is clear, when dynamic decision making is selected, fewer agents choose the left-most exit, as they recognise that this is crowded and seek a less crowded route.
13 Test 12 – Effect of bottlenecks

13.1 Test description

Given a room that is connected to another room via a corridor, congestion will occur only in the room that contains an agent origin [RiM14].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of agents</td>
<td>150</td>
</tr>
<tr>
<td>Pre-movement time [s]</td>
<td>0</td>
</tr>
<tr>
<td>Corridor size [m × m]</td>
<td>1 × 5</td>
</tr>
<tr>
<td>Walking speed [m/s]</td>
<td>[Wei92]</td>
</tr>
</tbody>
</table>

Table 13: Test specfications [RiM14]

![Figure 24: Construction of the scenario [m]](image)

13.2 Simulation model

The rooms, corridor and walking speeds were modelled according to the specifications (see Table 13). The destination was set outside of the room.

13.3 Documentation

The screenshots in Figures 26a through 26d demonstrate that the correct behaviour was observed: due to the narrowness of the corridor, the flow rate of agents into the second room is much smaller than it otherwise might be, causing congestion in the first room. (In the heatmap, the red and black signifies the reduced walking speed of the agents.)
After exiting the corridor, agents walk freely to the exit, given the reduced flow-rate of agents into the second room. This matches the expectations of the test [RiM14].
<table>
<thead>
<tr>
<th>Polygon</th>
<th>Time inside the polygon [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (before the corridor)</td>
<td>21.50</td>
</tr>
<tr>
<td>2 (before the exit)</td>
<td>5.07</td>
</tr>
</tbody>
</table>

Table 14: Results
14  Test 13 – Congestion in front of a flight of stairs

14.1  Test description

Given a room connected to a staircase passageway (see Figure 27), congestion will occur at the room’s exit as agents have restricted space to exit. Meanwhile, at the foot of the stairs a small queue will form that grows over time as the flow via the stairs is smaller than it is through the corridor [RiM14].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of agents</td>
<td>150</td>
</tr>
<tr>
<td>Pre-movement time [s]</td>
<td>0</td>
</tr>
<tr>
<td>Corridor size [m × m]</td>
<td>2 × 12</td>
</tr>
<tr>
<td>Walking speeds [m/s]</td>
<td>[Wei92]</td>
</tr>
</tbody>
</table>

Table 15: Test specifications [RiM14]

Figure 27: Construction of the scenario [m]

14.2  Simulation model

The corridor and walking speeds were modelled according to the specifications (see Table 15).

14.3  Documentation

The screenshots in Figures 29a through 29e demonstrate that the correct behaviour was observed: due to the narrowness of the exit, congestion forms in the room.
There is a reduction in walking speed on the stairs (most clearly seen on the heatmap), however this does not have a large impact on the walking speed of agents in front of the staircase.

To validate the supposed congestions, three evaluation polygons (see Figure 28) were placed in the scenario to ascertain how much agents were slowed in each of the three areas. The results are shown in Table 16.
<table>
<thead>
<tr>
<th>Polygon</th>
<th>Time in the polygon $\Delta t$ [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polygon 1</td>
<td>6.02</td>
</tr>
<tr>
<td>Polygon 2</td>
<td>5.30</td>
</tr>
<tr>
<td>Polygon 3</td>
<td>6.31</td>
</tr>
</tbody>
</table>

Table 16: Results
15 Test 14 – Choice of route

15.1 Test description

Agents are placed in a scenario that contains a destination at the end of a corridor. There are two routes to this destination: around a long U-shaped corridor, and up and down a set of stairs that take agents directly to the destination. Agents should select reasonable routes given their prescribed behavioural heuristic [RiM14].

15.2 Simulation model

The scenario was set-up according to Figure 30.

![Figure 30: Construction of the scenario [m]](image)

Agents are generated in the origin over the first ten seconds. In each case, agents are provided one of two behavioural tendencies: take the shortest route or take the fastest route.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of agents</td>
<td>150</td>
</tr>
<tr>
<td>Pre-movement distributions [s]</td>
<td>0</td>
</tr>
<tr>
<td>Walking speed [m/s]</td>
<td>[Wei92]</td>
</tr>
<tr>
<td>Deceleration factor (for stairs)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 17: Test specification [RiM14]
15.3 Documentation

The first scenario considers agents who opt for the fastest route. This causes some agents to walk around the longer corridor, due to the mass of agents on the stairs. See Figures 31a, 31b and 31c.

![Figure 31: Screenshots of the simulation](image)

The second scenario considers agents who opt for the shortest route. This causes no agent to walk around the longer corridor. See Figures 32a, 32b and 32c.

![Figure 32: Screenshots of the simulation](image)

In crowd:it behavioural heuristics can be set. If a "fastest route" heuristic is set, agents react to congestion and take a longer route if it means avoiding other agents. If a "shortest route" heuristic is set, agents ignore the slowing effect of congestion and take the shortest route regardless of the crowd.
<table>
<thead>
<tr>
<th>Heuristic</th>
<th>Path</th>
<th>No. of agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fastest Path</td>
<td>shorter route</td>
<td>130</td>
</tr>
<tr>
<td>Fastest Path</td>
<td>longer route</td>
<td>20</td>
</tr>
<tr>
<td>Shortest Path</td>
<td>shorter route</td>
<td>150</td>
</tr>
<tr>
<td>Shortest Path</td>
<td>longer route</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 18: Results
16 Test 15 – Movement of a large crowd of pedestrians around a corner

16.1 Test description

Agents will not be so affected by a corner that they are slowed too much, nor will they be so unaffected that a corner has no effect on agent evacuation times.

![Figure 33: Test geometry specifications [RiM14]](image)

The expectation is that the shortest evacuation time occurs for the scenario with the shortest, straight corridor; the longest evacuation time occurs for the scenario with the longest, straight corridor; and the scenario with a corner has an evacuation time lying between these other two evacuation times.

16.2 Simulation model

Agent walking speed is distributed according to [Wei92]. No pre-movement time was included. The scenario’s geometry was modelled according to Figure 33.
16.3 Documentation

Figures 35a through 37e display the behaviour of agents in each scenario.

![Evacuation times / Räumungszeiten](image)

**Figure 34: Evacuation times per scenario**

(a) Screenshot of the simulation after 25 seconds  
(b) Screenshot of the simulation after 45 seconds  
(c) Screenshot of the simulation after 70 seconds  
(d) Screenshot of the simulation after 80 seconds

**Figure 35: Screenshots of the cornered corridor scenario**

Figure 38 shows the evacuation time for each agent per scenario. crowd:it adheres to the expectation. The short, straight corridor is the fastest, the longest corridor takes the longest, the corner scenario times lie in between.
Figure 36: Screenshots of the short, straight corridor scenario
Figure 37: Screenshots of the long, straight corridor scenario
Figure 38: Evacuation times
References


