NO_PANIC. "Escape and Panic in Buildings." - Architectural basic research in the context of security and safety research.

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Summary. The increasing number of reported fires or other catastrophes (see Table 1) occurring in large events leads to the interesting question of why preventive design-related and organisational measures have not been taken. It also confirms the need to rethink existing building codes and safety concepts, as well as inclusion of new ways to optimise buildings and event sites. This research project "KEINE_PANIK" – "NO_PANIC" deals with planning criteria in regards to orientation in public buildings (such as airports, train stations, meeting halls or areas, concert halls, stadiums, etc.) during high-stress situations and its influence on the right choice of evacuation routes. The potentials of simulation-data optimizing the safety of persons in buildings must be included to the planning process, the same as the results of the different research groups should be applied in the three dimensional procedure of architectural design.

Keywords: Architecture, Panic, Escape.

Year	City	Location	Casualities
2006	Manila-Pasig	Philsports Arena TV Show	88 dead, 600 injured
2004	Buenos Aires	Nightclub	169 dead, 375 injured
2003	Chicago	Event Hall	21 dead, 100 injured
	Rhode Island	Nightclub	96 dead, 187 injured
2001	Volendam, NL	Discotheque	10 dead, 130 injured
2000	Lissabon	Nightclub	7 dead, 65 injured
	Roskilde, DK	Rock Festival	9 dead, 26 injured
1999	Innsbruck	Bergisel Stadium	5 dead, 25 injured
1989	Sheffield	Hillsborough Stadium	96 dead, 200 injured
1985	Brussels	Heysel Stadium	38 dead, 400 injured

Table 1: Timeline of recent catastrophes

1 Motivation

Recent series of catastrophes gave us reason to think about *crowd dynamics* under stress and panic. What puzzles us is that even so there is a long time of research of *pedestrian dynamics*, preventive measures concerning building and organizations of mass gathering have not caught yet. It is our opinion that it is necessary for architects and planners to investigate three dimensional space in terms of the interaction of crowds under spatial constraints.

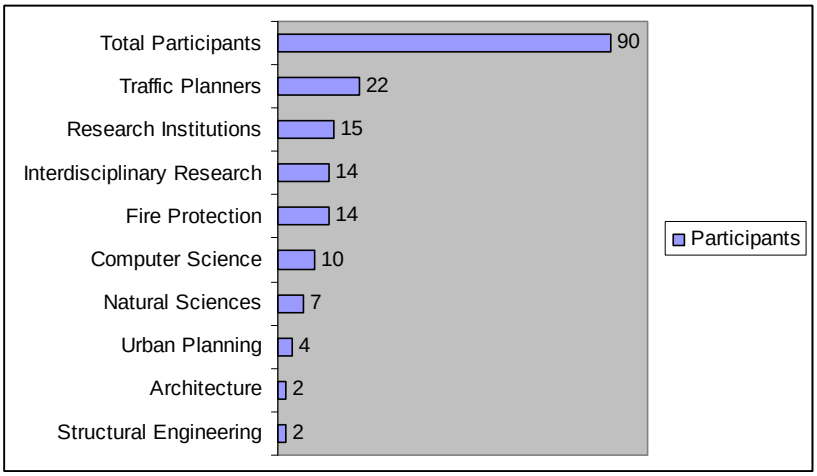


Figure 1: Participants from PED 2005 in Vienna

The number of participating architects in PED 2005 (see Figure 1) clearly shows that egress planning is not a well-established research field in architectural sciences. Yet panic and stress originate in spaces, being the natural action field of architects. We therefore argue for the need to translate the results from egress simulation and stress analysis into the language of architects and planners. It is their responsibility to consider these results in the planning process, and thus make building design safer.

2 The Five Dimensions of Architecture

As we have previously shown [1], architectural space can be described by five dimensions (also refer to Figure 2):

- the first three dimensions (1D, 2D, 3D) build up the architectural form in space
- the fourth dimension, time, lets us perceive movements
- the fifth dimension describes the interaction between humans in time and space

Architectural solutions which try to mitigate the effects of panic must take into account all of these dimensions in order to work. For example, there is a recent debate whether people behave differently in a crowd than they do in free space, or as G. Keith Still puts it: “The ideas of a *group think* provokes heated debate among the psychologists. There are many psychological factors

which influence human behaviour, both in free space and in a crowd." [2] Clearly, this takes the fourth and fifth dimension into account; however, it fails to include the actually implemented architecture.

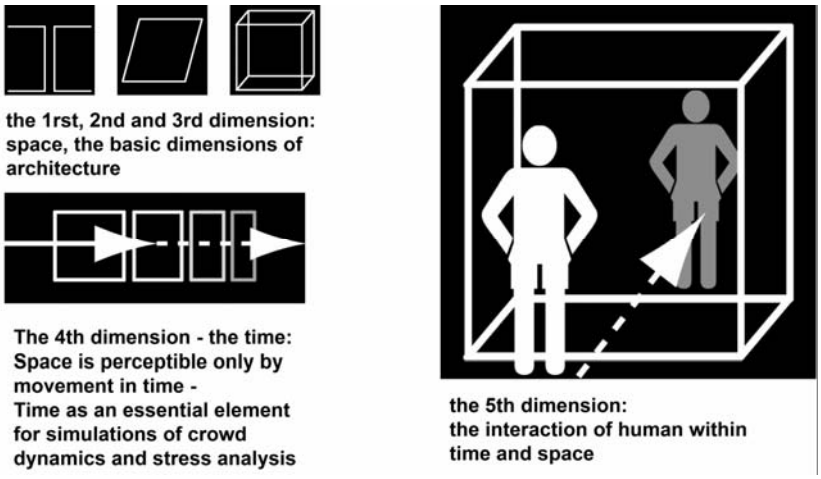


Figure 2: The five dimensions of architecture

3 Qualities vs. Quantities

Quantities in building design are easily measurable. This does, not apply to spatial qualities, which are difficult to name and complex to grasp. Quality factors from cognitive research and behavioural studies are the key to understanding user-specific aspects of building design.

As studies have shown [3], the experienced space is apparently perceived in the sequence 'floor, wall, ceiling' (see Figure 3).

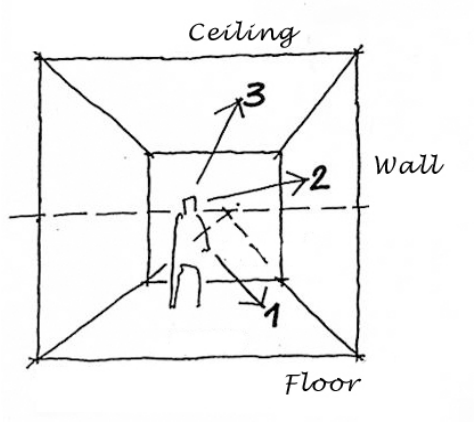
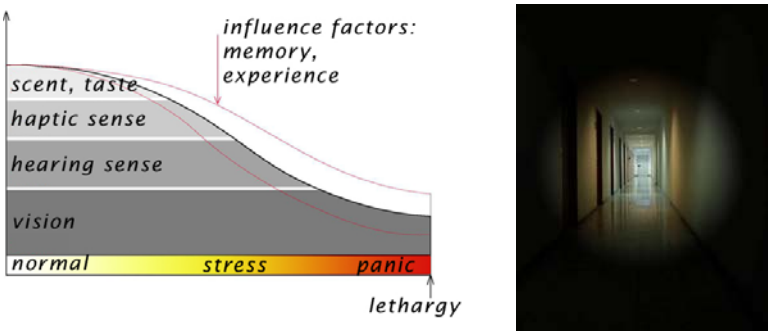


Figure 3: Space is experienced in the sequence floor, wall, ceiling.

Spatial awareness and orientation within buildings is made possible by the five senses. Under stress and panic, there is a cognitive reduction [4] that acts on the evacuee. Even though exact data on the exact course of reduction of senses is still to be researched, we see a definitive decrease in cognitive

ability as function of stress load (see Figure 4a). People under pressure gradually lose four of their five senses, eventually leading to a tunnel vision with a reduced field of view (Figure 4b). It is interesting to note that even healthy and young persons react like being mentally impaired in stress situations. As a matter of fact, it is essential to make space intuitively perceivable, so that an evacuee can concentrate on simple, basic, understandable spatial structures.

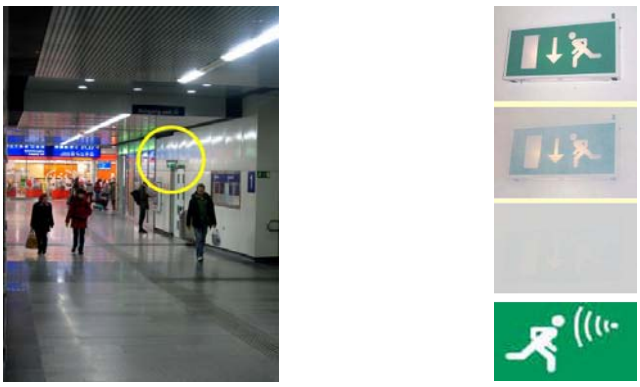


(a) (b)

Figure 4: (a) Pattern of cognitive reduction (b) Tunnel vision

4 Signage vs. Space

Deriving from the last section, we can say: If the signage is not supported by the architectural space, it will not be recognized in the case of stress or panic (see Figure 5a). The space itself with all its dimensions tell the user how to flee and not the "little green man", a small label mounted on the ceiling (see Figure 5b). It can be assumed that especially in the case of panic humans are acting on instinct: the directionality of the space is clearly more compelling than the direction of the arrow. Furthermore, in the case of fire, smoke may seriously impair the visibility of such escape signage.



(a) (b)

Figure 5: (a) Spatial reality vs. escape signage. (b) "Little Green Man"

5 Towards Architectural Solutions that Support Egress

Every architectural measure concerning egress must be based on a clear and logical structuring of spaces as well as a intuitive sense of orientation originating in the building under consideration.

Figure 6 shows the example of such a solution: Taking into account the three dimensions, the staircase is clear and straight. To plan for the fourth dimension (crowd movement), the staircase is of reasonable width and has handles on either side. Finally, the fifth dimension is met by targeted lighting, aiding evacuees in path finding (crowd interaction under effects of tunnel vision). Consequently, the escape route becomes a bright sub-space within its parent space.

Figure 6: Escape lighting for staircases

It is, however, not enough to be safe - you must feel secure! Building codes, ordinances, and regulations prescribe design measures to ensure the safety of occupants entering and exiting buildings - again, however, only in terms of measurable dimensions such as escape route distances and width of door sizes. But the far more important are the qualitative design criteria regarding elements of architectural composition, which are rarely formulated. These qualities are what establish a sense - or feeling - of security as perceived by human beings by supporting a cognitive awareness of the correct escape route in emergency situations.

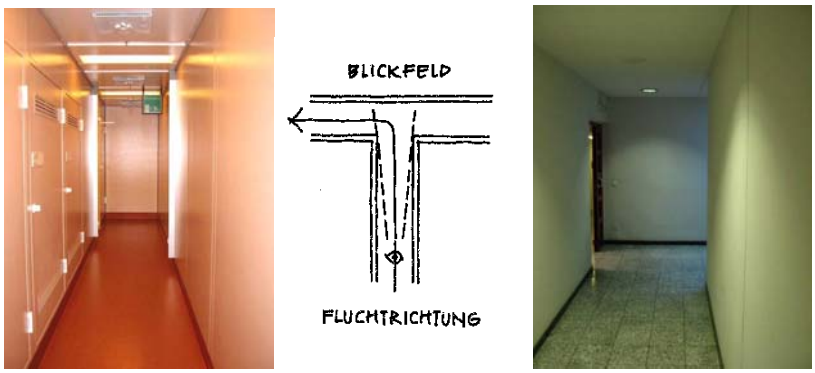


Figure 7: Visual field of escape route

5.1 Avoiding Delays in Egress

Analysis shows that the perceived distance depends on number of intersections along the path [5]. Crossings delay orientation and exit ways with any number of intersections appear longer than equal-distant routes without any such intersections. This is due to the fact that exit routes with intersections contain more information, and therefore requires more time and effort to process. This of course means also a higher cognitive load for the user.

Furthermore, it was shown [6] that the human brain gets confused by frequent changes in direction or turnarounds. In consequence, orientation is delayed. Additionally, the uncertainty of an escape route that appears to run straight into a wall is stressful [7], as is shown in Figure 7.

5.2 Avoiding Dualities

Duality means a perceptual ambiguity in terms of architectural elements. In the context of egress, dualities induced by multiple equivalent exits produce uncertainty in recognizing the escape route. It is usual that the exit sign shows into one direction while the space offers several possibilities - the signage is not supported by the space.

Another problem that can originate in exit dualities is the possibility to take the wrong exit. This is typically the case in smoke-filled rooms when in *herd instinct* [8] governs crowd behaviour. The sketch in Figure 8 (left) elaborates this situation: Width and number of the two exit doors is calculated according to regulations. Through herd instinct, evacuees will gather before one exit only. As a consequence, the envisioned egress rate cannot be achieved, or even worse, the taken exit is disadvantageous for the overall evacuation.

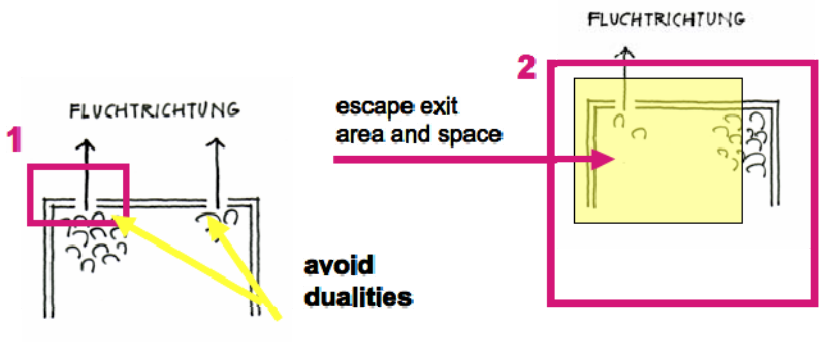


Figure 8: Dualities: (left) phenomenon of the herd instinct (right) exits as *escape space*

We thus argue for the need to plan for only one exit instead of more at different places (see Figure 8, right) if regulations allow. We are convinced that this can reduce uncertainty and stress. Additionally, architects should not consider the exit as ‘an opening in a wall’ but as a whole area or an *escape space* where egress happens. Planning has to take the whole area into account, not only the doors.

Another type of exit duality is given by the human disposition towards light during stress situations, directly related to the tunnel vision phenomenon (see Figure 9a): On the escape route, the view through a large, bright window communicates a safe and rapid way out of the building, and is generally more tempting than a superficially added exit sign pointing to the darker interior. Of course, the design of exits should avoid such visual dualities along the escape route, as people who have jumped through safety-glass were seriously injured or even killed [9].

(a) (b)

Figure 9: (a) Emergency exits vs. openings to the exterior (b) Light from openings attracts more attention than dark, occluded exit at the back.

We must therefore consider all openings as *exits of choice* (see Figure 9b). Since many emergency exit doors have resemblance to openings of a safe, they might be less attractive when comparing them with other exit choices. This applies even more when they are shut.

5.3 Architectural Elements for Managing Egress

Emergency exits require the architectural design of the entire surrounding, the so called *"escape space"* (see Figure 8, right). Analysis has shown that an obstacle before the exit – such as a column – can control the speed of the flow [10]. From the architectonical point of view,. however, a column which stands in front of an exit is a clear nonsense. The fact that obstacles can control the speed of flow does not unbind the architect of coming up with a clever design for them. Such flow dividers, which we see not simply as 'obstacle' but rather as 3-dimensional architectural elements that can also be used for managing crowd flow, must have other functional meanings for the normal case of building use which is present in 99% of the time.

An depictive elaboration of architectonical elements as obstacles is given in Figure 10: A room without obstacles induces slower flow rate because of the formation of a bulk before the exit area (Figure 10a). Adding a corridor-shaped obstacle produces raises the exit flow rate and can mitigate bulk formation (Figure 10b) [11]. However, these examples are purely artificial. An architect might rather consider to build a column-shaped info-point before the exit area which is brightly lit and can be used by visitors to check mails

(refer to Figure 10c). Furthermore, two showcases near the opening could act as a corporate showroom for new products and be a corridor at the same time.

(a)

(b)

(c)

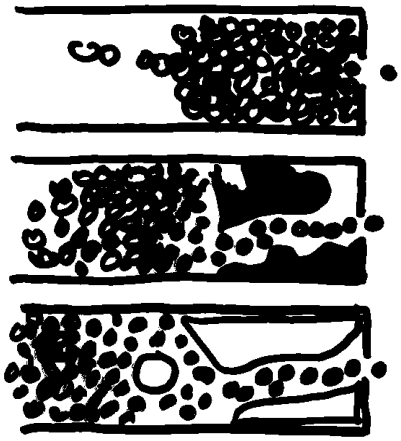


Figure 10: Space (a) without obstacles, (b) with obstacles that server only egress purposes (c) architectural elements used as obstacles.

6 Conclusions

Panic and stress originate in spaces and spaces are the action field for architects. The valuable results of research to date must finally find its application in building design practice. Poorly designed spatial structures or figurations are not improved by superficial addition of signage, or as the Dutch information-designer Paul Mijksenaar commented: „Even the best signs cannot cure sick buildings“[12]. Spatial reality clearly overrides escape signage (see Figure 11).

Figure 11: Architectural space vs. escape signage

Egress planning needs to be based on all dimensions of architecture, starting from three-dimensional space, going over temporality and ending in interaction between evacuees. We thus argue for the need of three-

dimensional tools and thinking for the design of egress routes, rather than the now-common map-based approaches.

As our future contribution, we plan to develop design recommendations based on the results of pedestrian trans-disciplinary research as an instrument for planners and architects. Furthermore, we plan to develop tools based on our research that can support architects in the process of designing emergency spaces so that not only building safety is considered, but also the feeling of security of each individual user of the building can be raised. We are convinced that this is essential to lessen the impacts of stress and panic in egress situations.

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