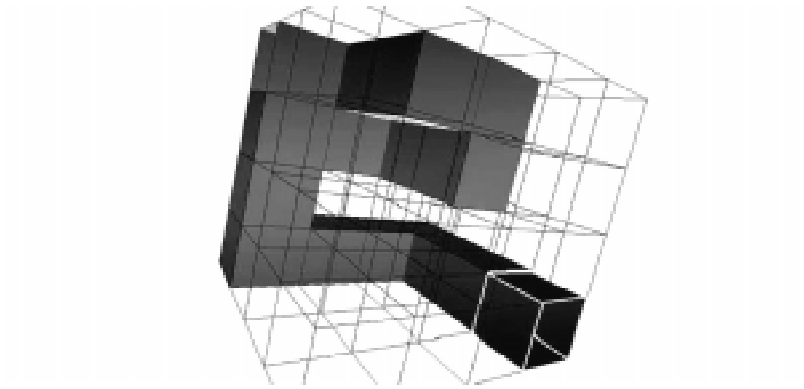
3D MAZE: GETTING LOST IN VIRTUAL REALITY



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Abstract
Virtual Environments (VE) influence design processes increasingly. We investigate the outcome of creation, interpretation and communication of architectural design, by using a three-dimensional (3D) maze together with text-based communication in a series of collaborative design experiments. The goal of our study was to identify how designers use and communicate design ideas by using VEs versa conventional methods of two-dimensional representations such as paper and pen. We developed a 3D-maze tool and set-up a series of experiments, including navigation- and perception-challenges, transcription of design, remote communication between design partners and controlled observations. We discuss how architects collaborate with partners and communicate their proposals in VE compared to actions in paper environments.

Introduction

Virtual Environments (VE) play an increasing role in architectural design (Bertol, 1997). Equipment and software become easy available and especially affordable. However, not sufficient attention has been paid to the results and possibilities of architectural design within VE (Stuart, 1996).

The design and exploration of mazes is a fascinating topic throughout history of architectural design (Berer, 1981). On one hand a maze is a very basic task with clear and simple rules. On the other hand it is a considerable high challenge for both designers and users. A maze represents a fundamental architectural problem, which allows an objective analysis of process and results. Traditionally however, mazes are two-dimensional (2D) stretching out in length and depth with 'walls' defining or separating the paths. An architect always deals with complex three-dimensional (3D) structures. Therefore a real 3D maze, which also expands into different levels, is more appropriate for our research.

By using VE to envision ideas the architect is challenged to deal with perception of solid and void, navigation and function, without translations to and from a 2D media (Campbell, 1996). In this moment, we may expect different qualities of maze-designs. We studied the results of creation, interpretation and communication of architectural design, by using this core-task together with text-based communication in a series of collaborative design experiments.

The goal of our study was to identify how designers use and communicate design ideas by using VEs versa conventional methods of 2D representations such as paper and pen. We focused on the creation and communication of a real 3D maze as a mean of transportation of ideas and spatial expression. We explored which factors influence designers during the process of design and which role colour plays for the orientation of designers within a 3D environment (Mahnke, 1996). Assuming colour is an important factor we anticipated that designers might create richer structures with the help of colour as a spatial cue. Finally we investigated design intentions, their translation/realization, textual descriptions and collaborations within VE or a 2D realm.

Getting Lost

We set-up a series of experiments including navigation- and perception challenges, transcription of design, remote communication between design partners and controlled observations (Kvan, 2000) and examined the outcomes of two major conditions:

- which differences make 2D- versus 3D environments on the results and
- does colour assist designers in their design process.

Eighteen pairs of randomly selected architectural students were asked to

design 3D mazes within a 4 * 4 * 4 grid framework (Illustration 1) in remote collaborative design sessions. Predefined were entrance and exit on opposite corners of the maze-structure, a time limit of thirteen minutes as well as the medium. The team-partners could only communicate via a text-window, so that a description of the design process was recorded, which was analysed later. Previous studies showed that in chat-lines, participants maintain the same amount of high-level design exchanges while the design is not different from the condition of higher bandwidths communications (Kvan, 2000). Additionally both partners had their own independent view of their common maze structure as well as were able to observe the other's design action and movement on screen.

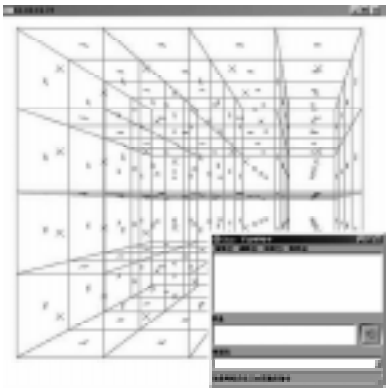

Fig 1. Screenshot of 3D Maze with a 4 * 4 * 4 grid

2D Maze

In the 2D design environment participants could only draw on a paper/pen equivalent medium by using 'Whiteboard'. They were offered a grid template, which represented the four levels of the maze structure (Illustration 2). However, students were free to sketch in their own style, even three dimensionally.

Fig 2. Screenshot of the 2D design environment with 'Whiteboard' template.

3D Maze

We developed a tool, which allows users to 'fly' though a 3D VE and create a maze by placing walls in all directions of a grid framework (Illustration 3). Our networked application allows interaction, viewing and manipulation of the structure independently of the other participant. The user can in real time move freely in every direction, zoom, place and delete walls as well as see a representation of the team-partner, his movements and actions on the screen.

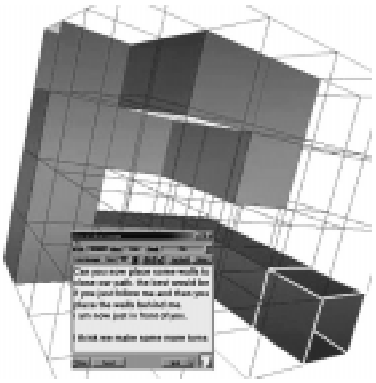

Fig 3. A 3D-maze in its design environment with chat line.

Monochrome versus Polychrome

Colour is a significant factor in an architectural environment that can influence the behaviour of its users (Mahnke, 1996). To investigate whether colour would assist designers in a 3D environment, two conditions were set up. One set of tests was carried out in polychrome, in which the maze and its walls of each dimensional plane had a distinct colour. The other series were to be resolved in monochrome, in which the maze, its structure and all elements were in shades of grey only.

Results

In the majority of resulting cases it was impossible to determine a path of solution. Many mazes were 'open' to different sides and too many grid-fields have been left blank. This made it difficult, to trace an explicit path with turns, alternative routes or dead-ends. To investigate the richness and complexity of the solutions we subdivided the grid-structure into its individual cells. We analysed the numbers and directions in space of each wall at this nucleus (Illustration 4). With this method we were able to interpreted the mazes and formulate differences in the design behaviours.

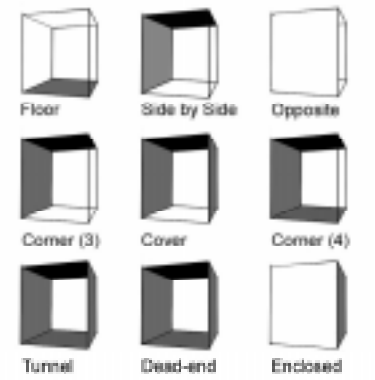

Fig 4. Maze-cells analysed by its wall count.

Most importantly, the resultant designs surprised in their new interpretation of traditional 2D mazes. Volumes, paths and enclosures are differently perceived and expressed in real 3D mazes. It appears that mazes created in 3D VEs permitted students to express and explore their ideas and intentions less ridged, more fluid and therefore more three-dimensional. In total contrast of that, students using the 2D medium designed mazes, which are stacks of 2D mazes making no extent use of the three dimensionality. Secondly, colour did not assist designers in a significant level when the complexity

of the design is considered. Moreover, monochrome results were constructed with a higher level of detail by placing more walls and creating more 'tunnels' rather than open spaces.

More interesting are the results from analysing communications between designers. The analysis of the chat communications showed that teams did engage in collaborative work. Students using the 2D medium discussed issues of design significantly more and longer, compared to the 3D medium. Surprisingly the teams using the monochrome environment engaged in fewer discussions about navigation, orientation or interface than the polychrome teams. Similar to the 2D medium, students designing a monochrome maze talked about design issues significantly more often and longer.

Discussion

We looked at several frameworks for investigation how architects communicate their proposals in VE compared to actions in paper environments and how they collaborate with partners to solve 3D tasks. We transferred our acquired experiences to an architectural virtual design studio that took the above-mentioned issues to a less abstract but real architectural design scenario (Schnabel et all, 2001). In both exercises our findings are similar. In early design stages it is important for architects to use a tool, which reflects the three-dimensionality of their design such as VE. Using a 2D medium to translate spatial ideas reduces the exploration and communication of volume and space. Visual enhancing features such as colour distract the designer more than it assists. Technology issues such as usability, interface and navigation and have to be further developed to reach the same ease to use and familiarity as any 2D media.

Conclusion

The interactivity of VE in the design process, the direct feedback of cause and effect and the enhanced collaboration offers architects a new way to explore, design and communicate spatial constructions. However, similar to complex CAAD software, simplicity and low bandwidth information is essential for users to focus on the design.

The above experiment will be further developed. For example, we will ask participants to solve a pre-designed maze collaboratively or rebuild a given maze in different media. This may give glues on the cognitive design understanding and behaviour of architects within VE.

Acknowledgements

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