The Integration of Virtual Reality (VR) into the Architectural Workflow

Experiences with an interprofessional project at DaimlerChrysler.

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Abstract: DaimlerChrysler as a worldwide operating company is continuously maintaining and developing their brand architecture for the points of sale. It is one of the strategic decisions to have a 'Brand Architecture Center' at the company headquarters in Stuttgart to develop the brand architecture and engage local architects to adopt it to the local context.

As a major step, a new generation of autohauses is currently developed. Many aspects have to be taken care of in this process, therefore a great number of specialists have to be involved. They are supported by Virtual Reality (VR) and Augmented Reality (AR). To integrate VR/AR into the architectural process, necessary architectural interactions have been integrated into the software.

Keywords: Virtual Reality, Augmented Reality, Architectural workflow, Visualization, Simulation.

Introduction

To successfully sell products, maintaining and developing a brand has become more and more important over the last years. In order to support the core business of DaimlerChrysler, a new generation of autohauses is currently developed by the "DaimlerChrysler Architecture Center". These points of sale shall strengthen the brand by communicating the brand values.

As one main emphasis of an internal collaboration strategy, Virtual Reality (VR) and Augmented Reality (AR) shall support this approach by providing a representation of the autohauses that allows all participants in a project to judge the implications of the architecture and contribute to the design process.

While VR and AR is already integrated into the work process of other disciplines like crash simulation, flow simulation or car design, in architecture there's still a wide gap between the possibilities and the state of the art.

Tasks and teams

Due to the size and complexity of the projects, many specialists of various disciplines have to participate in the design process. Some are e.g. architects, brand managers, sales specialists, event designers, marketing specialists, artists, simulation experts (e.g. airflow, temperature) and even potential customers. The term "interprofessional" best describes the mixed team and their meetings.

Phases

Phase 1: Prototype building

In the first phase of this "brand project" prototype architecture for the DaimlerChrysler points of sale was developed and presented in VR. The focus of these presentations was on the one hand on representing the visual appearance of the building on the other hand on explaining the concept of the architecture by showing the invisible ideas using VR animations.

Figure 1: a) "red thread" showing retail formats b) prototype building appearing in model scale and c) helicopter flight over building scaled 1:1.

Phase 2: First "real" building

Now the second phase of the brand project is to support the design of car selling centers in large European cities with VR and AR. The images below show the process of the planning for the sales center Milan. Since the early beginning, from the first conceptual sketches through the current stage to a completely developed project, VR assists all professionals involved to communicate with each other and gain security in their decision process.

Whereas in phase 1 the focus was on the communication of the overall idea, in phase 2 the interprofessional team concentrates on specific topics. Depending on the participants of the meetings several software tools had to be prepared to allow appropriate interactions to discuss the design topics.

Figure 2. a) Team discussion in the CAVE. b) Sketching on the projected model on the powerwall.

Interaction methods

Different and similar interaction methods are used in 1:1 scale and in model scale. It mainly depends on the human range. Some samples interactions are:

Virtual model scale 1:1
Color-picker:
changing the color of walls / floors / ceiling interactively.
Texture-picker :
changing texture on the fly to judge the right material.
Exhibition-designer :
creating, placing and modifying exhibitions interactively.
Move/scale tool:
modify parts of the architecture interactively.
Interactive elements.
Switching through variations.
Interactive creation of animated walkthroughs and flythroughs.
Model scale

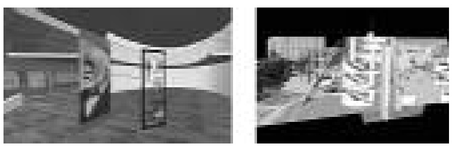

Figure 3. Samples of interaction methods at 1:1 a) Exhibition designer b) sliced model c) Color-picker.

Scale less interaction like multiple clipping planes for use in 1:1 or a smaller model.
Move/scale tool:
modify parts of the architecture interactively.

Interactive elements.
Switching through variations.
Interactive creation of animated walkthroughs and flythroughs.

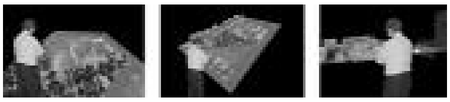

Figure 4. Interaction in architecture model scale.

AR / VR interaction

The design process is improved by integrating traditional techniques like architecture models with the new VR-technology in 1:1 scale. As an additional and intuitive input tool, a model with AR markers is tracked with a camera and its position and movement transferred to the CAVE. This allows e.g. composing exhibitions in model scale and reviewing them immediately in 1:1 scale.

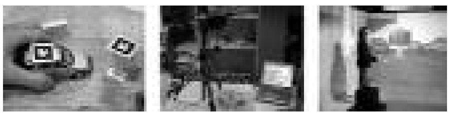

Figure 5. a) Moving the marked exhibition elements is b) tracked by a camera and c) transferred to the CAVE to move the virtual model.

Simulation

To handle climate aspects, the thermal simulation was coupled with the VR system to communicate the impacts of the architecture.

Figure 6. a) Simulation of airflow. b) Simulation of temperature distribution.

Collaboration

The VR-system supports distant collaboration by linking two or more virtual or augmented environments. A generic event synchronization allows using interactive VRML scenes in a collaborative session without any modification. In test setups the collaboration worked well, for future scenarios it is planned to equip the local sites with temporary, mobile VR systems to improve VR communication with the headquarter.

Hard- and software

The DaimlerChrysler Virtual Reality Center (VRC) in Sindelfingen provides the necessary infrastructure with 2 CAVEs (4 and 5-sided) and several different powerwalls driven by SGI Onyx workstations or PC clusters.

A large powerwall (7,5 x 2,5m) fits best for larger group sessions, whereas the 5-sided CAVE provides higher immersion for small groups of up to 8 participants.

Even though the rendering performance could be increased dramatically by using PC clusters instead of SGI workstations, it is still necessary to optimize the models to achieve interactive frame rates. Different methods like level of detail (LOD), distance and viewpoint clipping and automatic strip generation have to be used.

During the evaluation phase different VR software packages have been evaluated. Due to its extensive VRML support, its tight integration with 3D Studio MAX, and its flexible plug in system, the software COVISE fits this scenario best.

Data import

The data im- and export like with all digital collaborations is still a bottleneck. As a common base, VRML 97 with specific extensions for VR and AR support is used, that allows describing typical spatial interactions. Furthermore a 3D Studio MAX export plug in as well as COVISE import plug ins have been created to simplify the data exchange.

Observation

The moderated interprofessional meetings are supported by the new technology. By immersing the users into the "as if real" scene in a CAVE the discussions are very concentrated and determined. Even though the users are from many different professions, they reach a high degree of planning safety as well as consent.

Conclusion and outlook

VR and AR, together with an innovative approach of integrating different teams have been proven to be efficient tools to develop architecture. They help specialists to understand each other's work and find better solutions in shorter, interprofessional meetings. Coupling virtual environments, long distance work relationships can be initiated and teams spread around the world.

VR can and should be used from the very beginning of a project, the conceptual phase, to the final planning stage, even for marketing or event planning. Though meanwhile a certain state in VR has been reached, there is still a lot of work to be done like developing software integration, interaction methods or communication tools.

The main benefits which were to be quantified in a research project were: reduction of planning time, more security in the planning decisions, finding and eliminating of problems already in the planning phase, better interprofessional cooperation and better prepared presentations for the decision makers; and thus better decisions. Though these benefits can be named, still a number of questions like data exchange, user expectations and others have to be dealt with.

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