

Interactive stage and dynamic costume design for the opera "Marlowe: The Jew of Malta"

In 1996 André Werner was commissioned by the Munich Biennale Festival, a festival for modern music theatre, to compose a contemporary opera. The opera premiered in 2002. It's based on the play "The Famous tragedy of the rich Jew of Malta", written by Christopher Marlowe in 1596. The Jew of Malta unfolds as a story of expropriation, revenge and death of the Jewish merchant Barabas set in a power struggle between representatives of three world religions.



Very early a team was formed taking care of the direction, the stage design, the media concept and the programming. The task was to create an interactive stage and dynamic costume design in close co-operation with André Werner during the process of composing. It was clear from the outset, that the aim was not to create a high-tech spectacular on stage but to extend the options of the traditional stage and costume design.

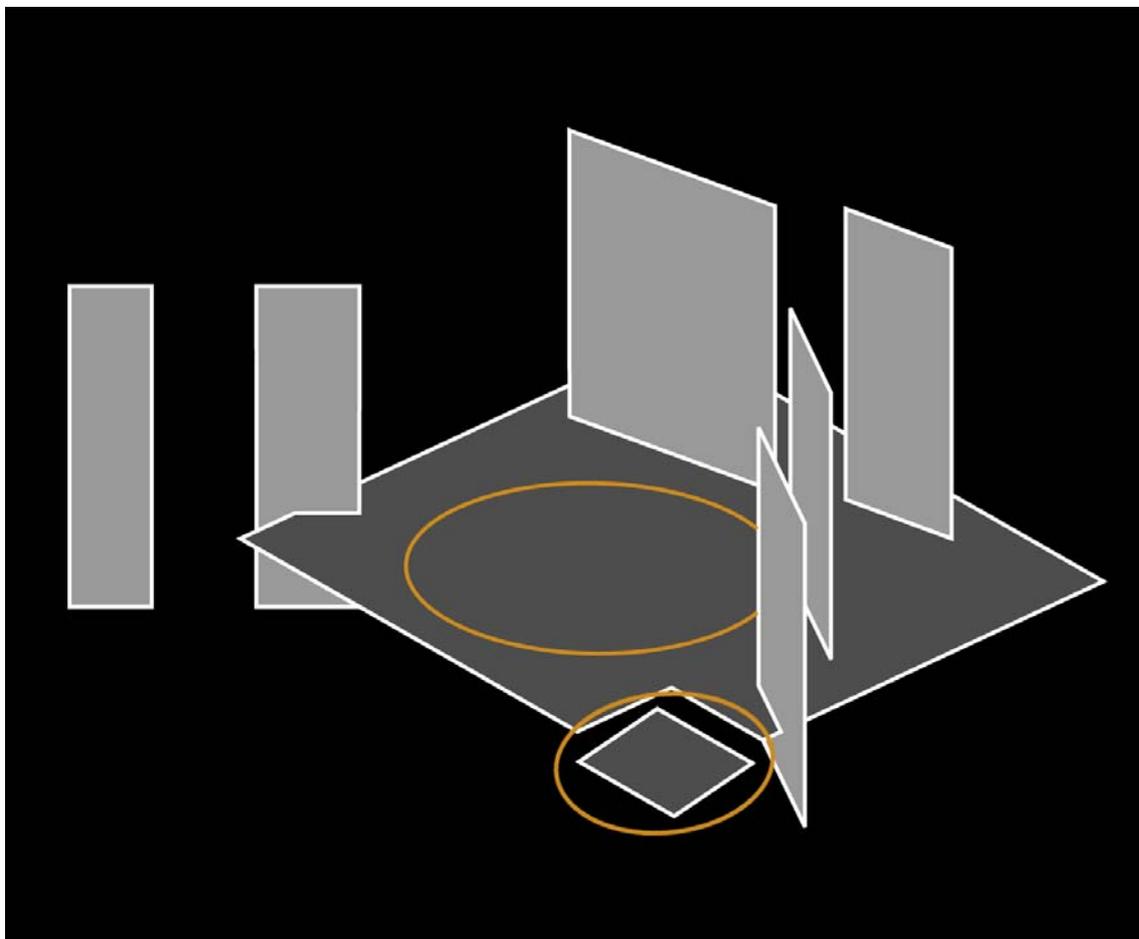
The composer rewrote the drama for the libretto. He broke the chronological storyline and used only fragments of the original text. Although in Marlowe's play Machiavel only appears in the prologue, André Werner made him the central figure of his opera.

Machiavel considers himself a creator of worlds. In the opera he sets up experiments like improvised plays-within-a play. He directs his experiments, which mainly deal with the acquisition of power. Machiavel controls the scenery. He interferes with or stops his experiments, to initiate a new setting, like starting a new program. His power is also expressed by distributing the 15 roles among the other four actors on stage - though technically this process is pre-defined. In the course of the opera he ultimately loses control and fails in his own game.

Stage configuration

As mentioned in the beginning our task was to provide an interactive, controllable stage design. The aim was to support the narrative statement and to emphasize the presence of the main character Machiavel. We used a virtual environment with an interaction concept for the main character, in order to make the stage his world.

The stage was divided in a three levels: the theatre stage, the virtual stage architecture and the neutral stage. The virtual stage architecture was projected onto rear-projection screens, staggered across the stage. Their position and dimension provided different views and perspectives of the virtual architecture. The neutral stage is a fragment of the theatre stage, a separate landing from where Machiavel initiates his experiments. According to a certain choreography he steers the process of the generative architecture.

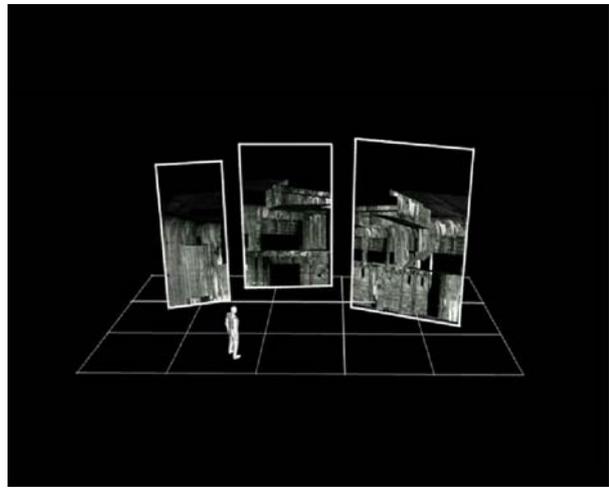
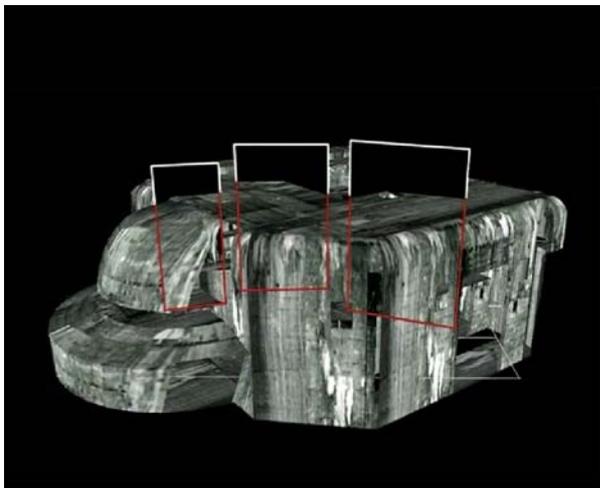


Virtual architecture

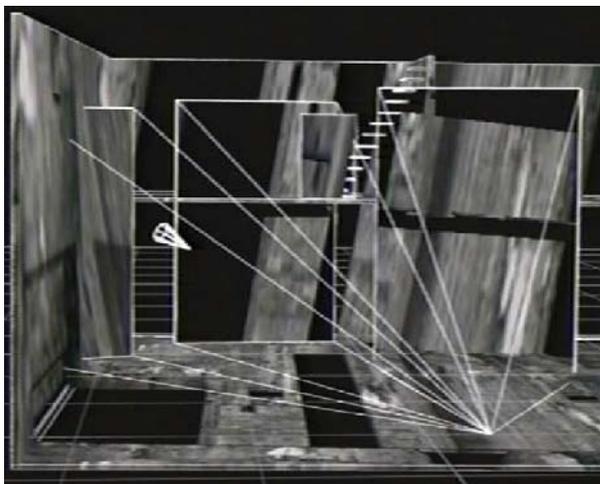
In Werner's adaptation the opera is mainly set in a Christian monastery. We decided not to use the real image of a monastery but the images of a ruined war bunkers. Both bunker and monastery are shelter and prison at the same time.

Six large rear-projection screens were staggered across the stage. Since it is not possible to project a computer generated volume onto a stage, only the intersections through the virtual bunker were projected, defined by the position and dimensions of the screens.

The projection screens on stage were congruent with clipping planes through the virtual architecture. Thus only the intersections of the clipping planes were projected onto the screens on stage. Depending on the position and dimension of the screens - respectively the clipping planes - we achieved a three dimensional impression of the virtual space.



Only parts of the architecture were pre-modeled, most of it was generated in real-time. Moreover the virtual scenery was generated according to a plant-growing algorithm within certain preset parameters. The software generated polygon-models with the ability to grow, duplicate or divide to become new independent pieces. We allowed architectural forms to be generated within defined boundaries and dimensions. The textures used for the mappings were also predefined. The aim was to design a process not to create the unalterable form, but to achieve a similar result for each performance.



Interaction

To make the virtual architecture perceptible as reproduction of Machiavel's world, the body movement and gestures of the performer were connected with the virtual scenery.

As indicator for the linking the pivot point of the virtual architecture was placed in the body center of the performer. This results in an analogy of the movements between the performance of Machiavel and the virtual space.

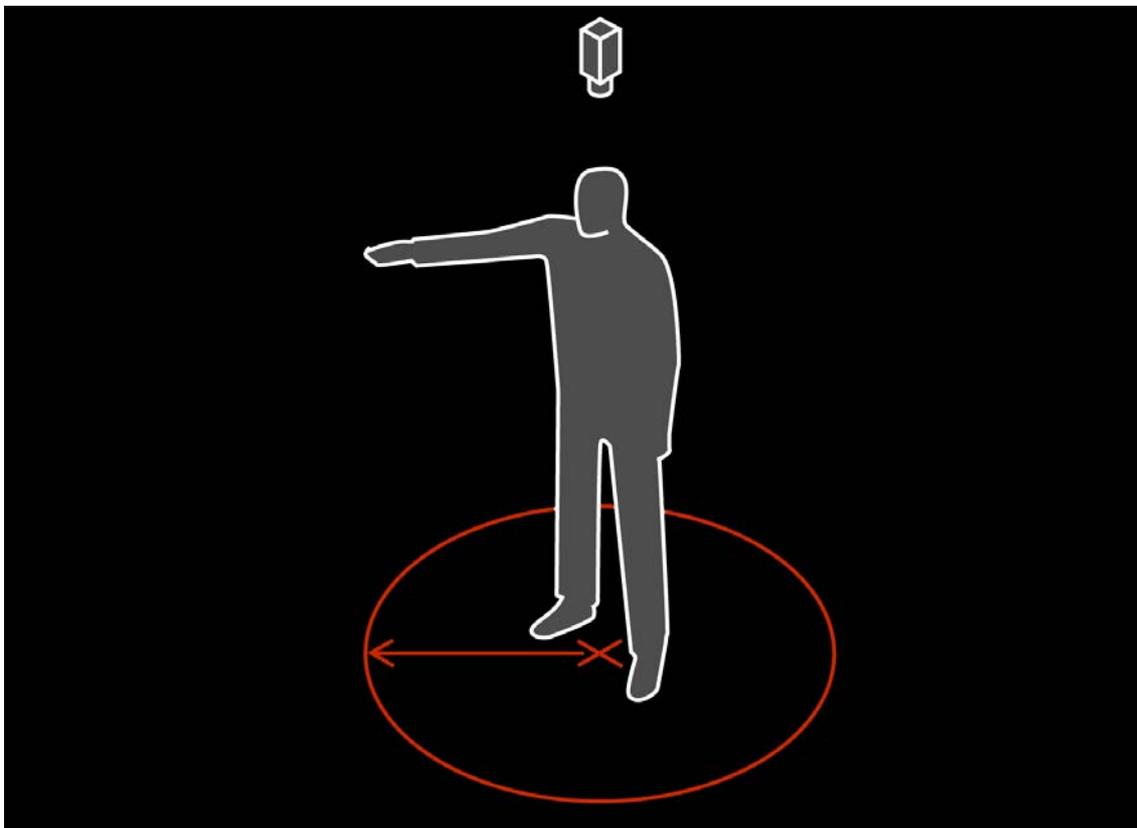
The performer applies different interaction principles to control the virtual architecture. When he moves forward or backward, the architecture follows him; if he turns around the architecture turns in the same way. Furthermore he has the ability to choose a setting and to trigger the generating of the virtual architecture. Likewise he is able to "reset" the virtual reality simulation to start a new setup, initiating a new experiment as improvised play-within-a play.

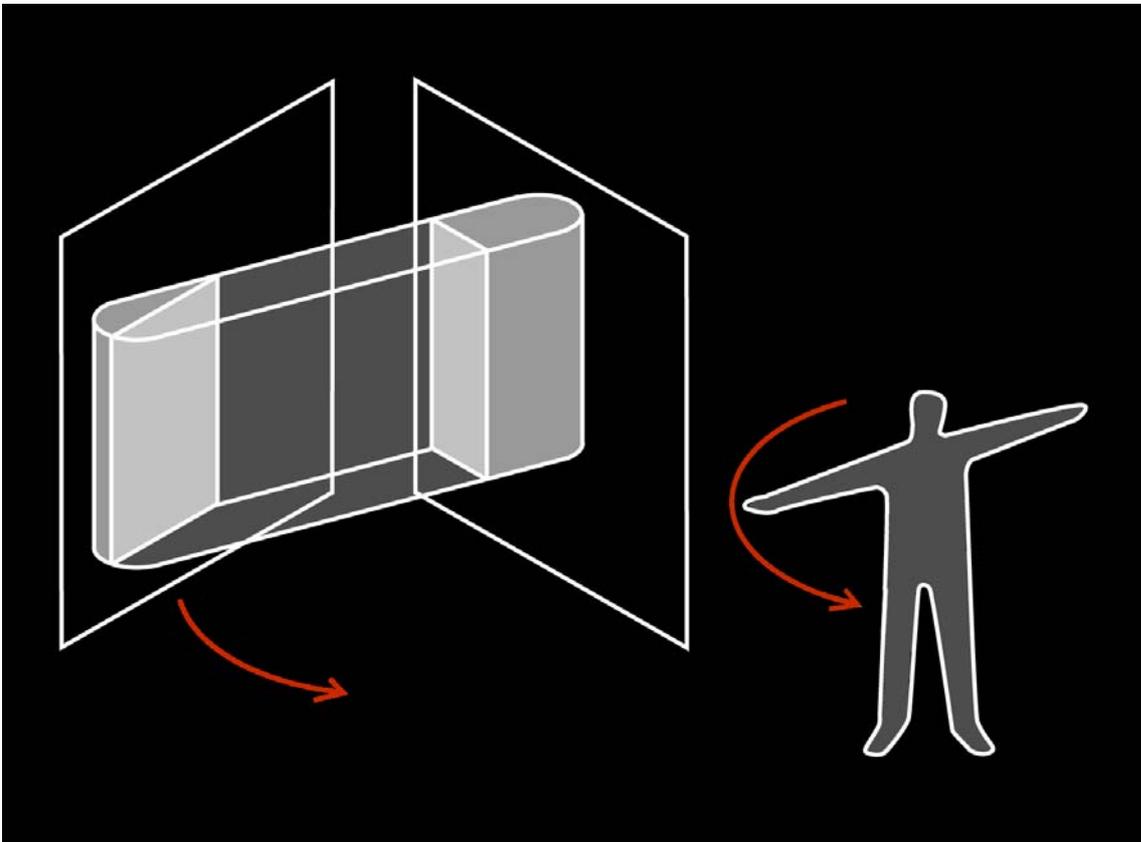
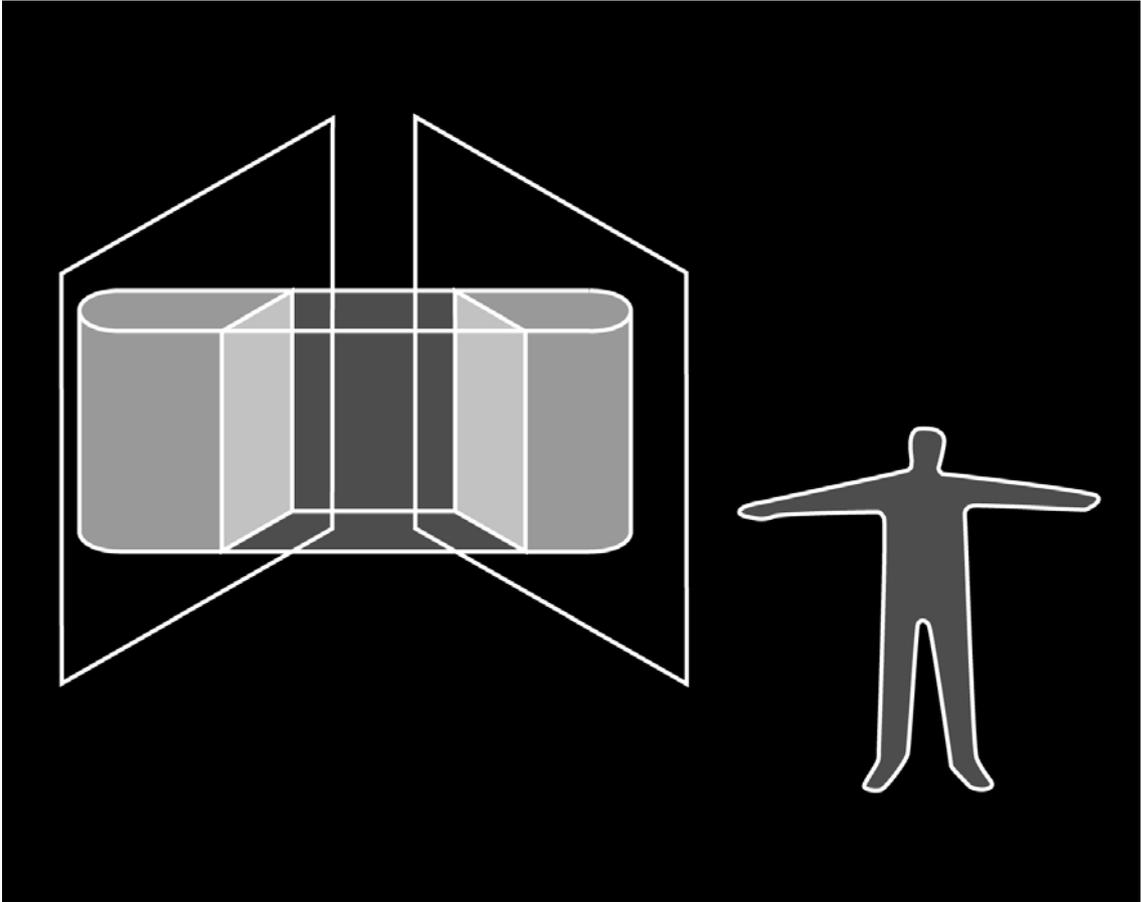
Motion tracking

Machiavel uses his body as instrument, an interface to navigate the virtual architecture.

Therefore a customized motion tracking system has been developed.

An infrared camera with a bitmap-tracker captures the performer from above to detect his position and body center and also his center of gravity. Additionally by computing a vector between the body center and the most distant point of his body (e.g. his arm) it was possible to interpret his gestures. The coordinates of his movements were passed to a real-time renderer together with the 3D data of the architecture. Combined with mappings and lights the corresponding scene was calculated to match the virtual architecture with the performance of Machiavel.





Costume design

In order to achieve a consistency between projected virtual stage design and the costumes, a process was developed to project textures or rather the costumes onto the actor. The performers are free to move as they please. The projection follows all movements and changes of position of the actors.

The options of such a system had of course an impact on the composition and the writing of the libretto. The dynamic costume projection made it possible to project the inner condition of the characters onto their outer skin and allowed quick changes of the costumes.

Apart from Machiavel the other roles within the opera are not assigned to specific performers. Machiavel pretends to set the projection of the virtual costumes, in order to distribute the roles for the experiments, he sets up. It appears as though he decides which of the disguises for the fifteen characters goes to one of the four performers.

The silhouettes of the performers are tracked via infrared and evaluated so that the disguises with their diverse textures can be projected onto them. An algorithm makes it possible to identify the performers, separates them when they overlap and calculates their virtual costumes to perfectly fit in real time.





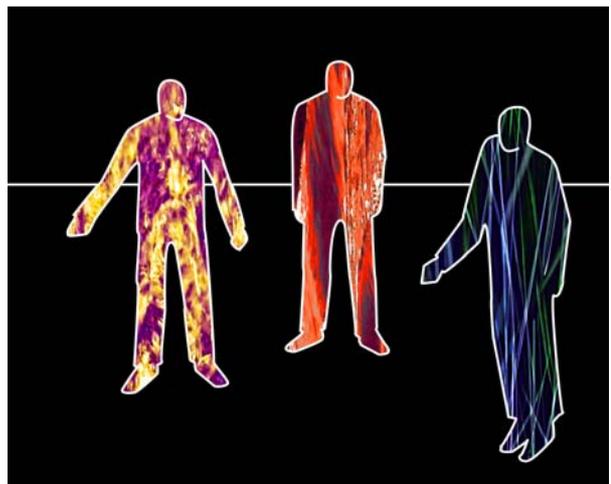
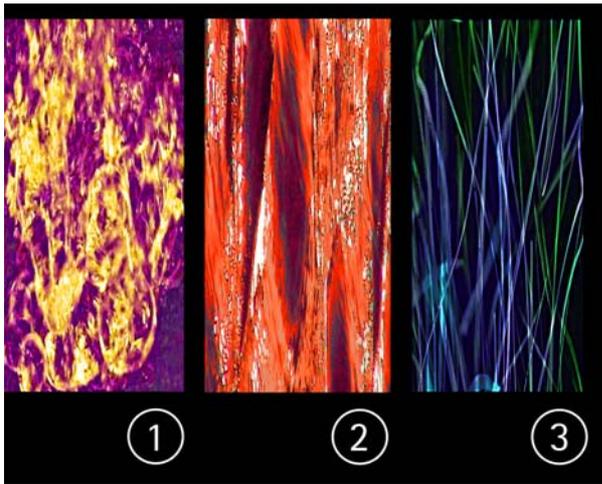
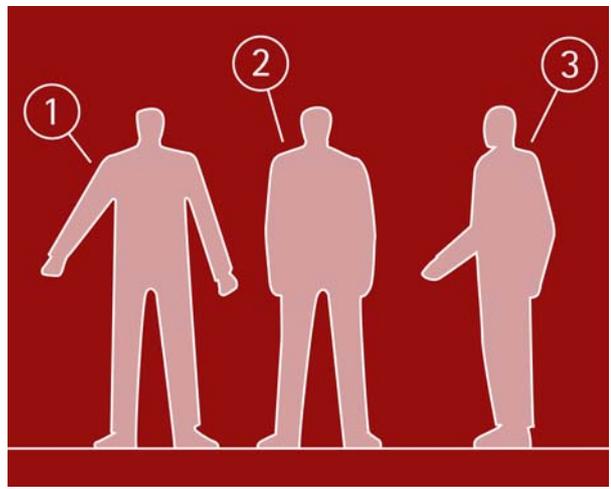
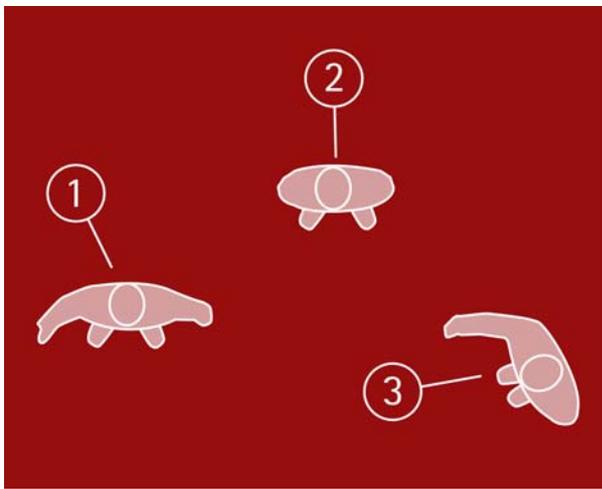
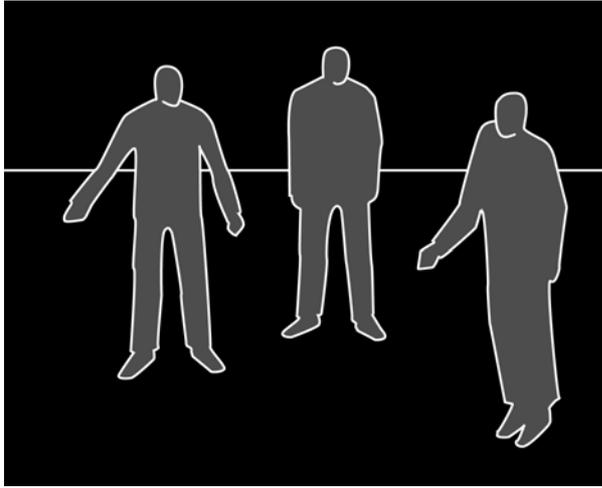
All performers wore infrared reflective costumes and were illuminated by infrared light. Infrared cameras were pointed at the whole stage and produced 25 high contrast images per second to detect the position of each actor on the stage.

An algorithm was creating masks in which the textures were applied. The final image was projected onto the actor from the same standpoint as position of the infrared cameras. We used this system from two sides allowing the projection to wrap around the body of the actors.

As there were up to 4 actors on stage, with projected costumes, a rather complex system was developed to identify each of the performers, when their silhouettes overlapped. In order to apply the corresponding texture to each of the performer, it was necessary to detect where the silhouette of one actor ends and the outline of the other actor begins to calculate the projection masks.

Four cameras were pointed at the stage: two from the side, one from above, one from the front. Out of the four camera images a 3-d model was created in real-time for each individual performer. This allowed to detect the location of each actor and the calculation of the overlapping.

This system was only used when the actors overlapped and the outlines for the projection mask could not be exactly separated from one another.



Loss of Interaction – finale

In the last third of the opera Machiavel fails and is disempowered visualized by the loss of interactivity with the virtual stage architecture. The scenery does no longer respond to his controlling movements. His loss of power is also symbolized through his loss of control over the other characters, hence the costume projection.

When the performers take off their white infrared reflective costumes, they reveal black ones, which cannot be detected by the infrared cameras. Therefore no costume texture can be projected onto them. They withstand Machiavel's influence and no longer serve as projection screens.

Machiavel is humiliated and ridiculed by the other characters and in the end he is alone. The virtual stage architecture takes its own control and starts playing its solo.

At the finale the orchestra triggers the software of the virtual architecture: via certain microphone pick-ups of the brass section, specific sound features serve as parameter to trigger the software. The cues of the trumpets and the French horns control the scenery.

Machiavel's experiments have failed, and he is left alone in his struggle dominated by the virtual scenery.



Staging

We needed five to six weeks to set up the production. As we had only ten to fourteen days for the rehearsals in the original theatre, we rebuilt the actual Munich stage in a venue in Berlin. This gave us enough time and the possibility to test the motion tracking systems and the projections in a genuine environment. All parties involved had to deal with the virtual scenery to become aware of possibilities and limitations such a system implies. It was also important to give the actors enough time to deal with the virtual architecture and costumes, when developing their choreography. The virtual architecture itself was like an additional actor to rehearse.

Since then we further developed the graphic user interface to handle the software of the dynamic costume projection. As the calibration of the beamer and cameras on stage was a time consuming process, we designed a special object to ease this procedure.

Credits

Premiere April, 27th 2002, further performances April, 28th, 30th and May 1st
Muffathalle, Munich

Realization interactive stage and dynamic costume design, project management:
büro+staubach gmbh

concept, design and development:

Nils Krüger

Bernd Lintermann

André Bernhardt

Jan A. Schroeder

Joachim Sauter

Andreas Kratky

André Werner

music and libretto: André Werner

director: Stefan Herheim

conductor: Rüdiger Bohn

orchestra: Bundesjugendorchester

production: Munich Biennale, in co-operation with büro+staubach, Berlin and Art+Com AG

buero+staubach gmbh
Dieffenbachstraße 37
10967 Berlin
finger@buero-staubach.de
www.buero-staubach.de