

# Virtual studio technology

## The 1996 Eurovision Song Contest

D. Hughes (Video Graphics BV)

*The Eurovision Song Contest in 1996 broke new ground in the arena of live television – one hour of the programme, performed in front of an audience of 6,000 people, was made in a “virtual studio”.*

*In this article, the Author reports on many of the aspects that had to be considered, leading up to and during transmission of the programme.*

### 1. Introduction

The words *virtual studio* and *virtual set* have come into our vocabulary over the last two to three years. They refer to slightly different versions of the same basic idea, namely the production of a television studio, or set, inside a computer rather than by using traditional techniques.

The first real-time virtual studio was shown at the National Association of Broadcasters (NAB) conference in Las Vegas during March 1994. It took the form of a “technology presentation” by Ultimatte Corporation of the USA and IMP GmbH from Hamburg, Germany.

During the summer of 1995, the NRK in Oslo started to think about the possibility of using a virtual studio for the Eurovision Song Contest in

1996. What follows is a review of some of the considerations and techniques that went into the final production, which was transmitted live on the evening of 18 May 1996.

### 2. Initial considerations

It was during IBC-95 that Pål Veiglum and Terje Klevsand of NRK visited the Author and asked if he considered that a virtual studio could be used in the 1996 Eurovision Song Contest. The considerations were as follows.

A virtual studio requires the use of a blue studio so that the actors can be placed in the virtual environment using well known “blue screen” techniques. While it is possible to get anybody accustomed to working in a totally blue environment with virtual objects around them, the task of getting 23 different singing acts to work on a blue stage – with no more than one hour of rehearsal time each – was a task as close to the impossible as could be imagined.

The scoring at the end of the Eurovision Song Contest has become a tradition that builds to a crescendo of excitement and, in the Author’s opinion, would be a perfect use of virtual studio techniques. The reasons were:

- *Virtual studio* is a computer-based technique that lends itself perfectly to scoring with instan-

Original language: English  
Manuscript received 21/6/96.



taneous updates and ranking charts. Knowing the work that NRK had done for the Winter Olympics in Lillehammer two years previously, the Author knew that the special scoring software that would have to be developed was well within the capabilities of NRK's own staff.

- The person hosting the show would be an NRK employee, as opposed to being a visiting singer, who could be coached in advance to feel comfortable in a blue environment with virtual objects.
- The need to be able to display a lot of information, in an uncluttered way, was a perfect use of virtual studio techniques. Examples of the images to be displayed included the score boards, a "ranking" board, the in-vision voting, and the "Green Room" where the singers sit during the voting.

director could choose which elements of the studio he wanted to display, just as he would in a normal studio through the use of camera positions. Generally, DVE devices constrain the director to use fixed camera positions and limit the freedom to switch at will between camera positions. In virtual studios, there are no such constraints. In short, here was an application looking for a virtual studio.

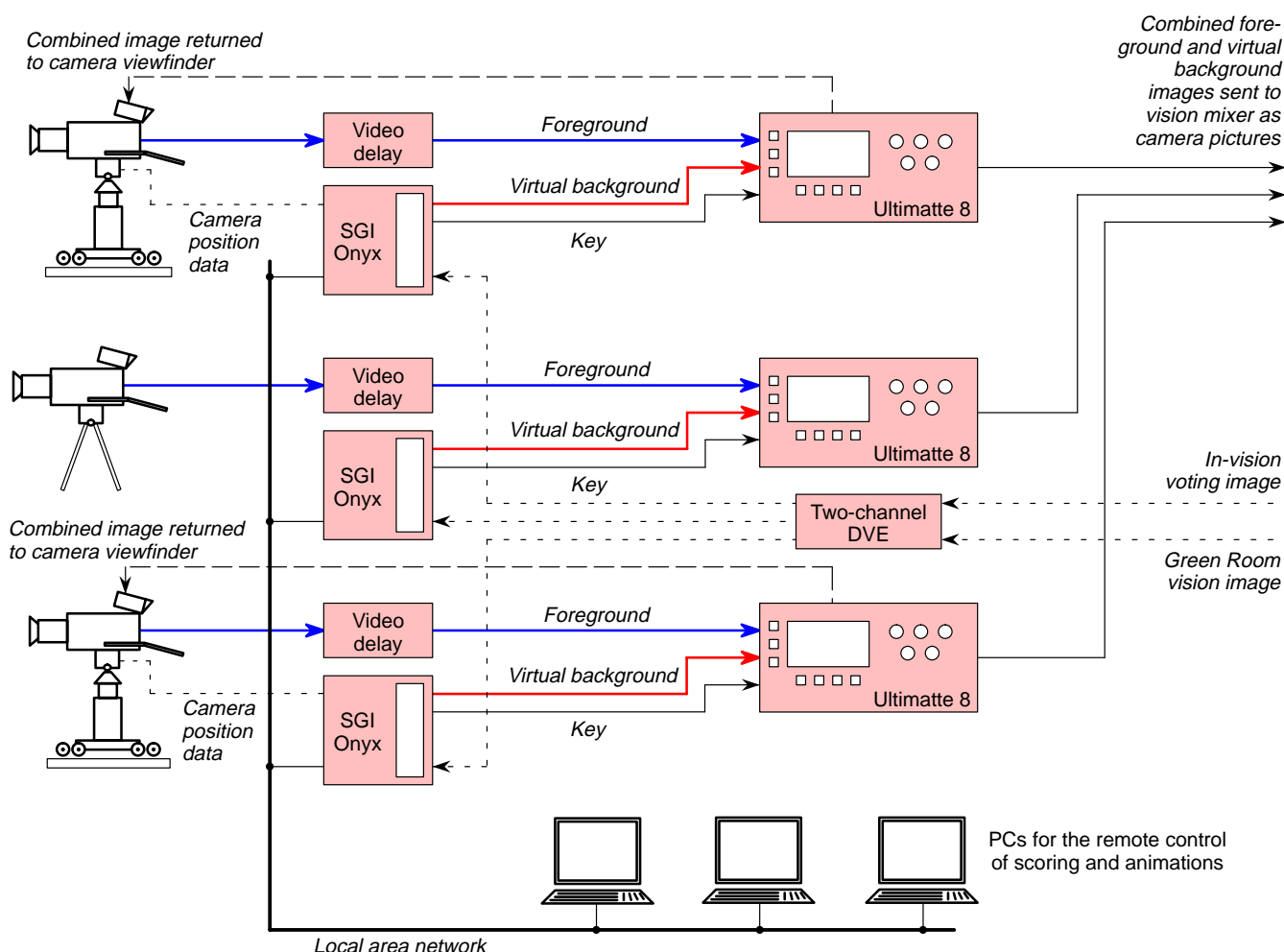
Over the next few months there were many discussions about the feasibility of undertaking such a challenging production, not least of which was the cost of the high technology involved. It was not until Silicon Graphics offered to sponsor the virtual studio event that the project really seemed certain to happen. For the event, Silicon Graphics supplied three Onyx deskside computers – one for each camera position. Each Onyx was equipped with a *Reality Engine Two* graphics engine.

Figure 1  
Basic equipment configuration used at the 1996 Eurovision Song Contest.

All these could be made to be part of the virtual studio in a light open way that would be difficult to achieve with conventional character generators and digital video effects (DVE) devices. The

### 3. The preparations

In the subsequent months, there were many discussions and meetings until the pilot programme was





made, over a period of four days, at Virtual Studio Hamburg (IMP GmbH) in March 1996.

It is important to know that every branch of conventional television was involved.

The team of programmers from IMP, coordinated by Henrik Sondergaard, worked closely with NRK's Production Designer, Bjarta Ulfstein, and its Graphic Designer, Sigrun Gill. The Norwegians wanted to have a sense of fun with the virtual studio, combined with attractive graphics that were surreal but not ridiculous. A great deal of work went into understanding the limits involved in rendering a real-time environment so that the best visual graphical presentation could be made without exceeding the limits of real-time rendering. This was a very challenging task since we are currently only on the first generation of computers that have sufficient power to render 3-D graphics images in real time.

The European television system transmits 25 frames per second but, due to interlacing, it is necessary to generate 50 fully-rendered fields per second. Thus, real-time rendering in a computer means that a new image must be created fifty times each second.

Many people have the impression that lighting is not important in the virtual set. Nothing could be further from the truth. Lighting Designer, Tom Sundli, played an important role in the design of the virtual set, advising on the lighting, and played a crucial role in lighting the blue stage.

During the pilot production, the rehearsals and the final production, the Author had the responsibility for ensuring that the integration of the virtual and the real was as perfect as possible. This meant working particularly closely with the lighting and set designers.

As shown in *Fig. 1*, the virtual studio used three real cameras and three SGI Onyx deskside computers. For each real camera, one of the Onyx computers provided a dedicated virtual camera output. Two of the real cameras were on rails at the side of the blue stage and one was mounted on a fixed tripod several metres back from the blue stage, towards the audience. The fixed camera was positioned to give a wide-angle image of the complete blue stage and was the camera that was used during the switch between the blue stage and the virtual image at the beginning of the production.

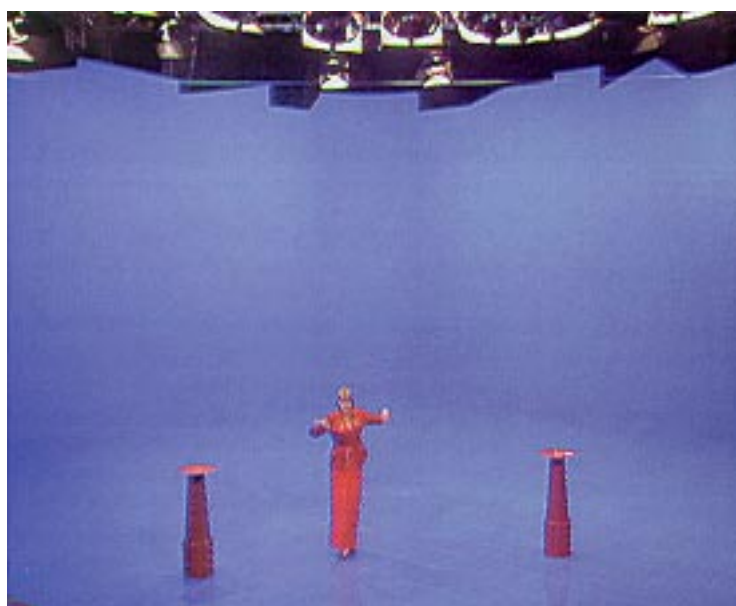
In *Figs. 2 and 3* it can be seen clearly that, at the switch from the blue stage to the virtual studio, the

lighting grid, tables and reflections had to be removed in order to get a correct image. This was done in the Ultimatte 8. After the hammer dropped a few seconds later, the tables and reflections were returned to the image (see *Fig. 4*).

In fact Pål Veiglum, the Director, didn't even have a direct feed of the three "blue screen" cameras on the vision mixer; he took only the combination of real and virtual images coming out of the Ultimatte 8s. The switch from the blue set to the virtual set at the beginning was made from the controls of an Ultimatte 8.

Figure 2 (upper)  
Transmission output immediately before switching to the virtual studio.

Figure 3 (lower)  
Transmission output immediately after switching to the virtual studio.



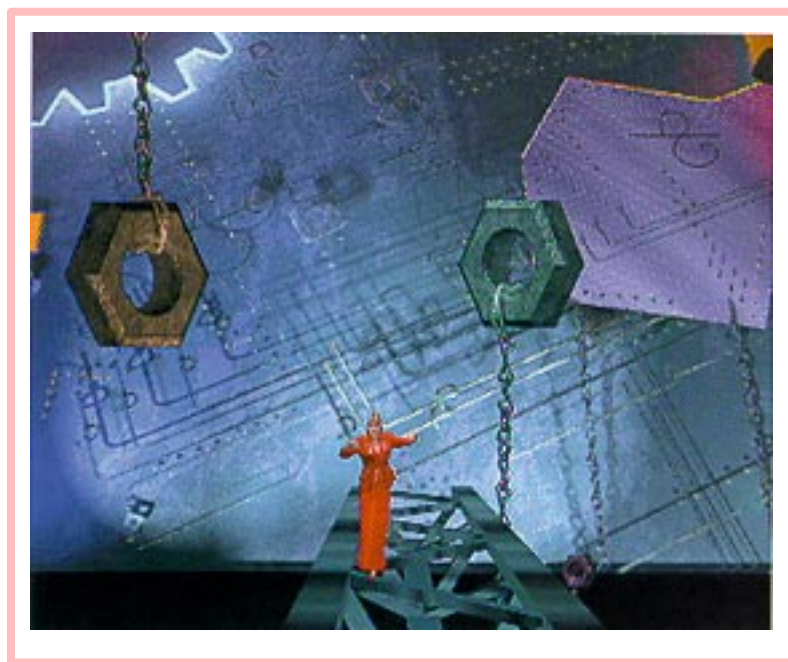


Figure 4  
Transmission as seen  
after the “hammer”  
had fallen: note how  
much more space  
there appears to be  
than in the original  
blue set.

There are many ways in which virtual sets can be made using less powerful combinations of equipment. However, when making a three-camera, 1-hour-long, live transmission to an estimated 300 million people, it is not conceivable to have no pre-view or even limited preview facilities. The use of a less powerful combination of equipment was never considered as a real alternative.

The software used was Discreet Logic’s *Vapour*, developed by IMP GmbH. Camera calibration was performed by means of Discreet Logic’s *Glass*, developed by Hybrid Vision in Paris.

#### 4. The blue stage

Some of the first blue stages used in a virtual studio had the shape of the letter “U”, i.e. they had three sides and a blue floor. However it had become clear to the Author that this was not the best shape to use; on his recommendation, NRK chose to use an “L” shape. Why “L” rather than “U”?

Although the first reaction is that a “U” shape would give the widest virtual panorama this rarely outweighs the disadvantages, namely,

- restricted access for the actors (with a U-shaped blue screen, access is only possible from the front);
- restricted positioning of cameras (again, the cameras can only be placed at the mouth of a “U” shape);

- excessive blue light spilling onto the subjects, making good matting much more difficult.

In order to provide the best access for the actors and the best visibility for the theatre audience, it was decided to angle the “L” shape so that it had its apex at the back. The blue stage could not be too big, otherwise it would occupy too much of the hall and would tend to dominate the show. In fact, the blue stage was in darkness up until just a few minutes before it was used. A size of 7 metres by 7 metres was chosen.

There are basically two ways to ensure that the real objects really integrate into the virtual background; the first is the use of real *shadows* and the second is the use of real *reflections*. Most presentations of virtual studios so far have chosen shadows.

If shadows fall *backwards* away from the subject they will fall on the back wall unless the back wall is placed many metres away. Backward-falling shadows thus require a large blue set so that the subject is always more than a shadow’s length from the back wall.

If the shadows fall *forward*, this requires a spot light or several lights at the back of the blue stage. This lighting configuration is tricky to work with as it tends to increase the white light on the floor and makes a substantial difference between the blue level on the floor and the blue level on the back walls. It is possible to add more light to the walls to compensate for this but, in practice, it is difficult to get it right. It can also make the subject look dark. Although the colour corrector in the Ultimatte 8 can usually fix this, it is still difficult to get everything correct.

As can be seen from *Figs. 5* and *8*, reflections fall forward, towards the camera. While making the pilot programme, we tried to use very large sheets of Plexiglas (also known as perspex) but the edges could not be made completely invisible without using “clean-up” on the Ultimatte 8; the objective was to avoid using “clean-up” if at all possible. So, it was decided to make a feature of the joins by cutting the perspex into 50 centimetre squares to look like tiles. The reality was embellished by using visible screws at the corner of each tile. It would have been possible to just lay the tiles on the blue floor and place small strips of blue wood at the very ends to stop them sliding, but everyone liked the “look” which the screws gave.

The junctions between the floor and the walls, and between adjacent walls, were made as a one metre radius curve. This was to avoid dark edges being produced in the corners.





Back lighting and key lighting from several different directions was used, avoiding the frequent criticism that subjects in virtual studios often look very dark and badly lit. Tom Sundli needs to take credit for getting an excellent balance between the needs of the Ultimatte 8 and the need to have creative lighting.

A gobo<sup>1</sup> was used to project the Eurovision Song Contest logo onto the floor. This was done partly in response to the request of the Director, Pål Veiglum, to make the floor in front of the score boards a little more interesting and also to add an “uncertainty element” to what was real and what was virtual. We guessed that most television people would expect the rotating logo to be a computer graphic, not a gobo projected onto the blue floor.

## 5. Scoring

The scoring was done with a program written by Terje Klevsand, running on a PC using Windows NT and connected to the Onyx computers through a LAN. The Vapour software has a script language that allows data to be sent to any object in the virtual studio.

The user interface for the program written and operated by Terje had controls that forced the correct order of the scoring. Had any of the juries not followed the correct order, then the EBU adjudicator would have stepped in to ensure that the votes were cast in the correct order.

Terje also provided control of Delta character generators to ensure a backup scoring system, should there have been a failure with the virtual studio. He also provided separate displays for Ingvid which showed who was voting and what the scores were. There was yet another feed to all the commentators, showing the ranking information and scoring.

## 6. Animations

Using a different PC on the LAN, Henrik Sondergaard of IMP activated the animations, again using Vapour’s script language.

There were more than 15 different animations used during the broadcast; e.g., the hammer falling at the

beginning, the scoreboards rising and falling, and the rotation of the in-vision voting screen.

In order to make control easy, two keyboards were used. One keyboard was a special development from IMP just to turn the external key on and off; the other was a regular PC keyboard with dedicated buttons to activate the animations. The key signal was used when the impression of Ingvid walking behind a virtual scoreboard was needed (see Fig. 5). This switchable key signal was generated by the Vapour software and delivered to the matte input of the Ultimatte 8 from the Sirius board of the Silicon Graphics Onyx.

## 7. Colour balance

The cameras were adjusted to get the best quality keying and then the extensive colour correction controls in the Ultimatte 8 were used to obtain a gamma match and colour level match between the foreground, background and the other studio cameras.

## 8. Keying quality

Many people in the TV industry will think that the glass of water was added to show the quality of keying (see Fig. 6). It wasn’t! It was a genuine last-minute request by Ingvid who wanted to have a glass of water during the voting. It was too late to check if this would look good; the lights would not be on the blue stage again before going on-air. There was no possibility to adjust the Ultimatte 8s, before 300 million people saw the glass. Since no

Figure 5  
Ingvid Bryn, the  
presenter, walking  
behind a virtual and  
transparent score-  
board: note how the  
reflections fall  
towards the  
camera.



1. A gobo (“go-between”) is an adjustable mask used in a studio to shield the camera from direct light rays, or to produce special lighting effects.



Figure 6  
The quality of the keying can be seen in the hair and in the glass of water.

clipping or clean-up had been used at all in the Ultimatte 8 set-up, the decision was made to go ahead. When we went on-air, the glass looked perfect.

This one event truly vindicated all the effort that had been made to ensure that the best possible image was being received by the Ultimatte 8s instead of relying on electronic clean-up.

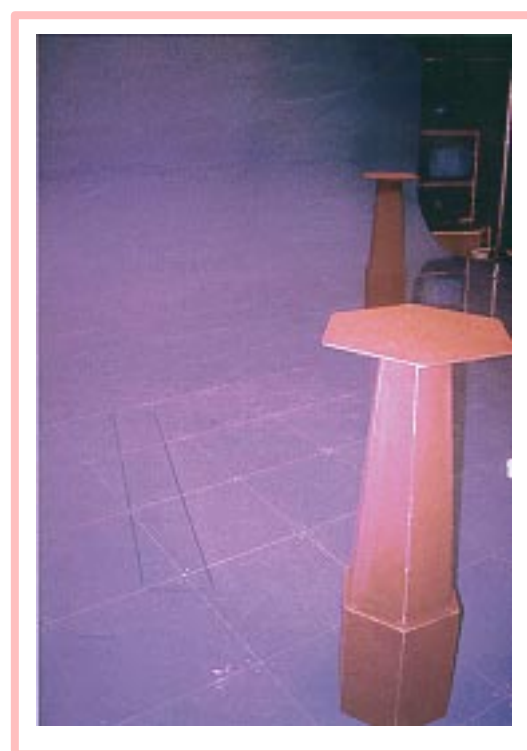


Figure 7  
The blue tape was clearly visible to Ingild but not to the cameras or the Ultimatte, because it was placed underneath the perspex.

## 9. Acting in a visual set

Acting in a virtual set can be difficult, but there are some techniques that can make this easier.

The use of real objects in the blue set make it much easier for the actor to maintain correct orientation. At the rehearsals in Hamburg during March, there were no tables. The use of real objects in the set requires that the "lens calibration" be very accurate. Simply put, this calibration is the creation of a virtual camera in software that exactly replicates the real camera. If this is perfect then there is no visual movement between co-sited virtual and real objects when the camera moves. The calibration achieved by the Glass software provided extremely accurate results and so the decision was taken to use real tables during the production.

The use of cue marks on the floor – to show the position of the virtual objects in the blue set – is very important but the problem faced here was that no electronic clean-up was being used in the Ultimatte 8s. Blue adhesive tape which contained more green than the Ultimatte blue paint used on the floor was used to mark the position of the virtual objects on the blue floor. The dilemma faced was that, if the blue tape was exactly the same blue as the floor then not only would the Ultimatte not see it but then neither would Ingild, the presenter. This slightly-green blue tape was visible to Ingild but unfortunately was also visible on the final image.

The solution was to lift the perspex tiles and place the blue tape underneath. The blue light reflected off the back wall onto the perspex floor was sufficient to stop the cameras and the Ultimatte seeing it but, because Ingild was looking directly downwards on the tape, this reflected blue light had no effect on how she saw its colour (see Fig. 7).

There were three sets of three monitors used to guide Ingild through the programme. Each set of monitors showed the same information:

- the transmission output, mirrored left to right with a DVE;
- a character generator display, showing the current scoring;
- a character generator display, showing the current ranking.

These monitors allowed Ingild to see herself as though she was looking in a mirror and it also allowed her to see the scoring and ranking at all times.



The positions of the monitors were:

- three monitors directly in front of Ingvild, placed side by side;
- three monitors on the right-hand side of the stage, positioned where they would make it look as though Ingvild was actually talking to the in-vision voter;
- three identical monitors on the left-hand side of the stage.

All the moves and walking that Ingvild made were carefully scripted and, during over an hour of live on-air voting with 23 different countries, not one mistake was made by Ingvild.

## 10. The virtual studio and a live audience

At the first meetings in September 1995, one of the major concerns raised was about using a blue stage with a live audience of 6,000 people. NRK decided to have two large-screen projectors throughout the complete three-hour production. During the final hour, in the virtual studio, a third supplementary projection screen was lowered into the middle of the main stage.. This worked very well. The audience reacted very well to the final transmission images, removing any doubts about using virtual studios with live audiences.

## 11. Conclusions

The use of a virtual studio for the voting at the Eurovision Song Contest in 1996 was a complete success. Its ability to combine visually many pieces of information (see Fig. 8) was not only a visual success but also a technological success. This live transmission proved beyond any doubt that the use of virtual studios for live transmissions



and with live audiences is a tool of today, not just of the future. As computers get more powerful and so can create more complex graphics, then the virtual studio will certainly be used more and more in broadcast television.

### Acknowledgements

The Author would like to pay tribute to NRK for their tremendous professionalism and determination to achieve the highest quality possible in the production of this event; but most of all for having the courage to go ahead with such a challenging project.

Further tribute should go to Silicon Graphics for sponsoring this project and to Discreet Logic, Virtual Studio Hamburg (IMP) and Ultimatte for the work done in producing this outstanding result.

Figure 8  
The virtual studio allows many visual elements to be combined without the movement constraints usually associated with DVEs.

**Mr. David Hughes** graduated from the University of Bradford, England, in 1969 with an Honours Degree in Electronics. He joined Tektronix shortly afterwards and soon became responsible for marketing the company's television products in the UK.

In 1974, Mr. Hughes left Tektronix and worked for two other companies over the next two years before re-joining Tektronix, this time as European Product Manager for Grass Valley Products. He subsequently moved to Holland when Tektronix decided to consolidate its international operations in Amsterdam.

David Hughes joined a small Dutch distribution company in 1979 where he had responsibility for the establishment of European operations for System Concepts (later known as Quanta), Ultimatte and Hedco. In 1982 he established Quanta International and, when the company was later purchased by Dynatech, he rose to become Vice-President of their Video Division.

Since 1993, Mr. Hughes has been running his own company in Holland – Video Graphics BV – which, among other activities in the television field, specializes in the development of virtual studios.

