

Television studios use advanced technology for sports broadcast

Innovative technology has revolutionised sports on television with networks merging virtual environments with the real world to create an immersive experience.

By Chris Hollier

Virtual production is now commonplace in sports presentations and many broadcasters such as ITV, BBC, Sky & TNT Sports regularly make use of virtual studio elements for their flagship shows.

As these spaces have become more complex and as the technology available to us has advanced, my role has also evolved. They now require an even greater collaborative approach between departments and as Director of Photography I work closely with production and their creative teams, from the initial concept stage, to deliver that vision onscreen, with the Camera, Lighting, Engineering and Graphics teams.

Working with new, innovative technology, to not only enhance the look of the production, but for a specific purpose, is the challenge I most enjoy and the part that scratches the creative itch for me.

Eurosport certainly did this and at scale, when they tasked myself and Andy Cottey with 20 presentation areas for their various markets at the Pyeongchang Olympics in 2018. Each territory was given a 'technology tool kit' and we specified the lighting and cameras according to each style.

One specific piece of technology used for the first time was the Eurosport "Cube"; a three-walled LED volume with an LED floor. We did a significant amount of testing with Andy Hook and the team at White Light,

the innovators behind this SmartStage concept, to deliver the first extended reality (XR) broadcast.

To explain XR in a bit more detail - it's the catch-all term for Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) but specifically in broadcast it relates to the workflow where LED screens, camera tracking and graphics engines combine to enable cameras to move around a virtual environment, interacting and seamlessly merging with the real world.

The benefits of the XR stage are the relationship the onstage talent has with the content & the immersive nature of the environment. They can see it in real time and therefore interact with it much more naturally. As the LED tiles effectively become a light source, the talent has realistic light bounce on them from the content and real reflections in items such as jewellery and glasses; in contrast to a green screen where it can be more challenging to achieve.

A great example of innovating & evolving this technology to solve a specific issue came whilst working with ITV during the World Cup in Moscow where the FIFA studio complex built-in Red Square came with very specific challenges. The studio allocations meant that the position & dimensions would prevent us from seeing the iconic domes of St Basil's Cathedral in the window behind our presenters from the jib shot at the back of the studio.

The solution we came up with was to create a section of the physical set (an ornate header piece) housing 3 x Hitachi DK-H200 cameras facing out of the window with an unobstructed view to the domes. These cameras were then put into a Deltatre/Vizrt graphics system and fed into a virtual window above the header. To give the illusion that the virtual window





ITV's platform studio for the Rugby World Cup Quarter Finals in Marseille.

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was an extension of the real window below, we fitted the studio cameras with a Stype RedSpy tracking system so the content could be perspective-tracked. As the jib shot moved so did the content in the virtual window above, perfectly capturing the sky & domes of St Basil's.

From a lighting perspective, we weren't only dealing with the exposure challenges of controlling the real window (using neutral-density acrylic sheets) and matching the changing ambient light levels outside but we were also working with the graphics team to give an accurate representation of the virtual dome at various times of day.

The virtual window was augmented on top of the clean camera feed so it masked out our lighting grid and many believed we were in a full virtual studio in London or onsite without any physical constraints.

Then came Covid...this was a huge jump forward for the evolution and acceptance of virtual studios. With travel restricted and the uncertainty of further lockdowns, production teams looked for ways to adapt to the ever-changing landscape and Euro 2020 proved how this type of the technology could be used to not only overcome physical limitations but also logistical challenges.

The tournament was originally billed to be held in 2020, across 12 cities, however, the host cities were still in flux 2 months before the start date in June 2021. ITV had therefore decided to base themselves in London (where the final would be held) and use Maidstone studios to house a huge XR



Comedian Dane Baptiste on the set of Bamous. SmartStage was fed with green content to be used as a green screen backdrop so the backgrounds could be added in post.



The original Eurosport Cube in use at the Pyeongchang Olympics in South Korea 2018.



stage; a 20m Curved LED wall as a backdrop on a physical set surrounded by an augmented virtual set extension rendered in Disguise. Virtual models of the final host cities & stadiums could then be created and adapted if things changed further.

The LED canvas was fed with a vista overlooking the Thames at Tower Bridge; content that we commissioned and were captured at different times of the day. Shot by Rob Whitworth using 3 x Canon R5 cameras stitched together, to create a huge 11K image that was oversized for the physical window aperture. This enabled the studio cameras which were once again perspective tracked to have a parallax effect, so as the cameras moved, the audience felt as though they were looking out through the “LED window”.

Outside of the physical set footprint, AR set extensions were added to give a 360-degree virtual studio environment. These AR masks hid the studio workings off stage and our jib operator, Dave Emery was often shooting at markers on the studio floor and walls into the darkness,

towards other cameras & even back down the jib arm towards himself. Using a MoSys system allowed the jib to be tracked in the virtual space and able to explore the virtual 360-degree studio environment and beyond. The jib controls could then even be used to control a virtual camera in fly-throughs of the host cities.

It's worth noting the common misconception that because virtual environments can give the illusion of cavernous spaces, which in reality are housed in very small studios, space no longer needs to be a major consideration. However, as production teams become more comfortable with these environments, they want to explore and do more adventurous shots, such as walks between different virtual areas and virtual fly-throughs that transition seamlessly to crane-wide shots. These can be very effective but need to be preplanned and cued very accurately so the speeds match. Ultimately you will then be constrained by the length of the arm you can swing in the physical space and the corresponding physical

distance between camera and subject i.e how much room you have to choreograph moving cameras and talent around together.

Other genres of broadcast were also looking at this technology to adapt to the program-making restrictions of COVID-19 without audiences and we started working on White Light's larger XR stage housed in the Science Museum in London. I was brought in by Spirit Studios to help develop a comedy sketch show called Bamous; initially planned as a pilot it aired on BBC 1 and was the first use of XR broadcast on terrestrial television. We used the XR stage in its traditional form (with a virtual world and set extensions) and then fed the stage with a green background so the editors could chroma key content in the edit.

Teleportation

Before lockdown, I'd been lighting the cube for the US & French Open tennis tournaments and it now featured “teleportation” of players into the cube by interviewing them on a green screen, post-match, court-side. With the Tokyo

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Olympics also postponed until 2021 Alex Dinnin and his team at Discovery Eurosport further evolved the Cube to enable multiple teleports from multiple countries all on the same stage, for instance, a presenter in London in the Cube and teleported guests from Munich and Madrid could all interact with each other very naturally.

We'd learnt that more control of the green screen capture on location meant a more manageable "teleportation" so when the Winter Olympics came around again in 2022 and with a need to keep the crew on site to a minimum; I designed a small LED moving head lighting rig which was installed in Beijing and focused and lit remotely from Stockley Park.

We could then adjust the position and intensity of the lighting fixtures and improve the chromakey when athletes wore white shirts or trainers to more easily immerse them in the a virtual environment that we were teleporting them into.

In London, we'd also evolved the lighting set-up from the original cube and were now using a system called Black Trax. We'd found that washing the stage with light to give the presenters free range of movement to interact with the content made it difficult to calibrate the colours between the LED walls, floor and virtual set extension, whilst also limiting the range of camera movements as it enhanced the moiré effect.

The pitch of the LED tile, the angle of the camera to the tile and the distance between subject and tile are all contributing factors to the amount of moiré that you will have to deal with and as a general rule the higher the resolution the LED wall and the greater the distance you can achieve between the subject and the wall, the more chance you have to reduce the moiré effect.

With Black Trax, we could place a small beacon on each person onstage and use an array of cameras to capture the LED InfraRed signals meaning we could track the person around the stage and assign a group of lighting fixtures to follow them, therefore containing the lighting spill onto the LED canvas.

As Covid restrictions eased and confidence in sports tournament dates grew; ITV planned to present the FIFA World Cup on-site in Qatar. As a DR (disaster recovery) plan it was proposed that a virtual studio in London could offer a viable backup if crew travel was once again restricted.

I was commissioned by Paul McNamara, ITV's Senior Director and Executive producer on major events as part of the team to develop the concept. The "ITV Sports Hub" was to be a virtual home base that could be used to house ITV's presentation of major tournaments along with programming for



ITV's virtual studio platform at dusk for the Rugby World Cup France 2023 at EBC.



ITV's virtual studio platform at night for the Rugby World Cup France 2023 at EBC.



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Multi view of the ITV Rugby World Cup studio at Timelines TV's Ealing Broadcast Centre (EBC).

other sports in ITV's portfolio including Six Nations, Horse Racing, La Liga, the Women's World Cup and most recently the Rugby World Cup.

The main benefits of this multifunctional, virtual space, designed by Toby Kalitowski and Jim Mann was that it could be reskinned quickly and cost-effectively between sports/shows and would therefore offer a greener approach to production by reducing the amount of equipment & crew travelling to various locations and with minimal physical set elements to be built, moved and stored.

The camera specification and lighting design therefore had to be flexible too. To give the various production teams' budget options I designed a generic plot and then created "packages of lighting" with the lighting provider B360. I made camera plans & marked positions in different parts of the studio that could be scaled depending upon the number of guests and the type of elements needed within each show.

The France 2023 Rugby World Cup is the latest and most ambitious ITV Sport show to use this set-up and come out of Timeline TV's Ealing Broadcast Centre (EBC). The green screen studio was used for the main presentation area throughout the group stages, moving to a full onsite presentation in France during the knockout stages.

The camera specification at EBC consisted of 4 Sony HDC 4300's with Fuji UA24 and Canon C112 lenses. 3 of the cameras were

mounted on Osprey peds and given that the majority of the movement would come from the jib we opted for a 9ft jib arm on a tracking pedestal to give full coverage around the 185 sqm studio.

All cameras were fitted with Mosys StarTrackers which use a small camera-mounted, upward-facing LED sensor to shine light on reflective "stars" in the studio ceiling. This creates a map which can then report the camera position and orientation to the graphics render engine and place the camera in the virtual world.

There were a number of revisions made to the virtual world, mainly an external balcony area looking out towards a virtual Paris streetscape and internally a demo area used to recreate events seen on the field of play or illustrate a particular technique used within a game, with up to 10 rugby players onstage at once.

Both of these new areas highlighted how versatile the technology is and how quickly it can evolve. On the platform, MOOV (who was tasked with technically implementing and managing the journey of the virtual studio and augmented AR content) through some clever compositing in the graphics engine delivered real-time reflections of the physical set elements and talent in the virtual glass floor below; a great achievement and something that we'll look to make use of going forward. The demo area proved how far the keying systems (in this case using an Ultimatte) have come on

meaning we could have multiple players rolling around on the floor with a white ball without too many issues from shadows and green bounce affecting the key.

The "balcony" set was used pre and post-match with the team standing behind podiums and repositioning to the "internal" seated set for half-time analysis. To enable this transition to happen quickly and in contrast to the high-tech systems in play all around us, we found the most effective way was to simply cover the seated rostra area with green cloth which made it invisible to the camera when not in use.

Lighting and immersion

When you're attempting to immerse the talent in a virtual environment to this level it's vitally important that communication between all departments is constant and clear as small changes can have a knock-on effect down the line and throw the illusion at any point.

In this hybrid role as DOP, you are effectively another set of eyes for the Director, observing the technical and creative relationship between the real and the virtual worlds, monitoring the keying, light levels, masks and translating any limitations to the camera ops over talkback before they are cut to air.

The camera operators also have a composite feed of their specific output in their returns, so they can see the relationship between the viewfinder image

(with the subject against green), the virtual world behind and the augmented elements in front of the talent.

Preparation is therefore key and testing everything from the reflectiveness of certain textures in the set materials to wardrobe have to be factored into our schedule. Backup outfits and dulling spray are always on standby in case someone turns up with a green shirt or very shiny item of clothing that causes issues for the keying...it happens more than you would imagine!

To achieve a believable lighting balance within the scenes, I often work with the set designers and visual artists to add a lighting motivation into each scene, whether that be the sunlight direction at a specific time of day, a twinkle in the skyline or a light source that we can replicate in the physical world. This often means adding in imperfections that in a standard, physical studio, as LDs, we've all spent years avoiding or trying to hide. For example, hard shadows or more extreme contrast changes across a walk where the presenter travels under a virtual light source, subtle use of flares, accent colours or even colour temperature changes to replicate the different times of day, all make the scene seem more believable

and blur the lines between the real and the virtual.

Working closely with the graphics teams we are now even able to change the virtual depth of field so we can recreate the field of view and associated DOF for the shot we're creating and the time of day that we're shooting. For instance for an MCU at sunset, you'd expect to have a shallower depth of field and more bokeh so I'd soften the virtual world background and warm up the lighting, conversely, a wider shot in the daytime I'd expect to have a sharper background at a cooler colour temperature.

The application of new features such as ghost frame in LED volumes where multiple backgrounds for different markets can be recorded behind a subject at the same time or prompter in the shot but only visible to the presenter onstage will enhance the appeal and use of these systems.

There will inevitably be a natural cycle where productions crave to be back on location and a balance to be found between the use of real and virtual presentation, so I'm really looking forward to the next leap in the evolution of this technology.

As the world embraces more immersive experiences such as the recently launched

Sphere in Las Vegas, it's an exciting space to be collaborating within and a cross-over that will certainly continue to evolve between Television, Film and Live events.

This article was written by Chris Hollier, Director of Photography.

Chris Hollier

Chris has worked in the industry for the last 25 years; starting as a runner at Central Television in Birmingham to Ravensbourne before becoming a staff cameraman at 021 Television. Although the majority of his work involves lighting as a DOP or LD he still loves to operate & recent highlights include scripted ped work at the RSC & operating a remote camera inside the Abbey for the Coronation of King Charles.

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