

Mixing realities

Continuing our round table series where we discuss the latest buzz with industry specialists, this month we explore how virtual production is transforming the craft of filmmaking

INTERVIEW. Chelsea Fearnley

Part 1



What gets you most excited about virtual production?

MARK PILBOROUGH-SKINNER: The most exciting thing is the creative possibility it enables, allowing productions to go to locations that are either non-accessible, dangerous to film at, or simply don't exist. VP also encourages early collaboration between departments that, in a traditional production process, would normally work in silos. Having your DOP, art director and VFX artists engaged in ongoing conversations prior to shooting means interesting solutions, more creativity, and collaboration can occur before even getting on-set.

JONNY HUNT: We've been putting LED screens in front cameras for 15+ years, so now having the opportunity to use that experience to solve brand-new challenges every day is incredibly exciting! It has also taken us from being a primarily technical department, to being right in the middle of the creative process, while working with some of the world's leading DOPs and VFX supervisors – and gaining a real understanding of their vision. We feel very lucky to have been there right from the beginning.

“Latency is now being brought down to one frame. At the moment, nobody is able to drop below that figure”

CHRISTIAN KAESTNER: The answer for me is actually a non-technical one. While it's extremely exciting to witness the advancements in technology, real-time rendering and low-latency synchronisation, it's really the creative aspect of virtual production that excites me the most. Virtual production enables us to become an even bigger artistic partner, and it dramatically expands our involvement very early on in the filmmaking process. In-camera visual effects (ICVFX) require close collaboration between filmmaker, DOP, production designer and the visual effects department – as the shoot is being planned, scripts are being written and stories are being told. Becoming part of this process is super exciting, and requires a refreshing way of thinking about what we do.

JEREMY HOCHMAN: Our team has been working with LEDs on-camera for close to 20 years, so to see this become mainstream is incredibly exciting. In the past, we've relied on fragile systems with custom software and hand-crafted LED fixture arrays to do these things. To now have an entire industry embracing this type of workflow will benefit moviemakers and VFX companies, ultimately leading to more (and better) content for consumers.

DAVID LEVY: The ability to have such a detailed level of control over your environment, without losing creative freedom. In fact, the types of shots you can achieve in-camera are amazing, and would certainly be otherwise impossible on location.

MARINA PRAK: It's the way it has shaken up film and (in its wake) the industry for commercials and broadcast. With virtual production, there is no limitation to creativity – anything you think of can be put on screen. Furthermore, travelling the earth to go to locations that fit the scenario is no longer needed. You can project everything here and now, and go from sunrise in Japan to sunset in Norway in a second.

DAN HAMILL: The seemingly endless creative possibilities it affords filmmakers. They are free from the normal limitations of shooting on location – such as time of day, weather, etc. There is no need to wait for the rain to stop, or until it's dark to shoot a night scene; these natural restrictions can be 'fixed' extremely quickly. Another big plus is sustainability – sending large cast and crew units around the world on planes, emitting huge amounts of CO2, can be kept to a minimum, as long as more studios offering VP as a service keep being developed globally.

What advances are being made to speed up the process, and provide greater synchronicity between camera tracking, rendering and LED playback?

PILBOROUGH-SKINNER: One of the main driving forces of virtual production adoption is the use of real-time game engines as our render medium. Using video plates and other techniques works well depending on the shot, but Unreal Engine – which is free to learn and run – has accelerated VP and democratised the process. This means it can be deployed across a range of productions, including



MARK PILBOROUGH-SKINNER
VP supervisor, Garden Studios

After graduating with a computer programming degree from SAE Institute London, Pilborough-Skinner was lead Unreal developer at Satore Tech for three years, before joining Garden Studios, which boasts a 4800 sq ft virtual production stage.



JONNY HUNT
Technical director, VSS

Hunt studied computer science, before applying his practical mind to the video market. He is now responsible for the management and delivery of every technical aspect of VSS's project work in the UK, Europe and Middle East.



CHRISTIAN KAESTNER
VFX supervisor, Framestore

Kaestner is currently working as overall VFX supervisor on 1899 for Netflix – the newest project from the creators of *Dark* – which is the first show to make use of Dark Bay, the largest LED volume facility in Europe.

short-form content and adverts – it’s no longer just for high-budget TV and film.

HUNT: It’s great that Epic (and others) have seen the value of focusing on training and developing features geared solely towards virtual production. Having their team available to guide you through the process and help solve any problems is invaluable.

KAESTNER: Getting images rendered in real time displayed within a camera frustum, that’s also being tracked in real time, is quite a technical challenge, and latency will always exist. If you combine that with the difficulty of capturing these images with a physical camera, you have plenty of areas that are constantly improving. Camera tracking systems are always getting more accurate, able to provide tracking data to the game engine faster. The game engine will benefit from more powerful render nodes with better GPUs and data handling. LED walls and their firmware are regularly upgraded to allow for new protocols, or to accommodate new camera software. This means refresh rates can continue to increase and keep camera shutter and display phase in sync across render nodes, on a display several meters tall and maybe more than 50 meters wide. Any tweak or technical advancements to these components in this delicate chain of command – at 24Hz or more – demands constant feedback loops and optimisation. In the world of VP, all components evolve all the time – exponentially.

HOCHMAN: Wow, this is quite a short question with a lot of answers! We’ve



synchronised LEDs forever, because that’s a requirement for making a display with thousands of tiles operate as a single entity. But, camera tracking and rendering have always been separate systems, operated by different departments and involving entirely alternate workflows. Now that all of these technologies are being brought together, we’re seeing an enormously fast-paced advancement, with all the interconnected equipment becoming an ecosystem. We’re at the infancy of this, and Epic Games/Unreal is pushing to be a big part of it, from the software/render side of things. Megapixel is working diligently, to make Helios the core central infrastructure needed for all

of that rendered content to get distributed and displayed.

LEVY: We have observed that all technology partners involved in defining workflows and providing hardware/software solutions (including Arri) are engaged in a very open dialogue with each other. This has allowed the industry to move much faster than before, and lets us develop in a more collaborative and efficient way.

PRAK: Using LED volumes, latency is now being brought down to one frame. At the moment, nobody is able to drop below that figure.



JEREMY HOCHMAN
CEO, Megapixel VR

Hochman is an entrepreneur and designer, who made tech history in 2002 when co-founding Element Labs, the company that gave birth to the creative LED industry.



DAVID LEVY
Director of business development, global solutions, Arri Rental

Levy comes from a creative background, and was lead camera and lighting specialist at Al Jazeera for 11 years, before joining Arri Rental in 2017.



MARINA PRAK
Marketing manager, Roe Visual

With over 30 years in the entertainment industry, 20 of which were in marketing, Prak is currently responsible for growing Roe Visual’s brand in Europe and the Middle East.



DAN HAMILL
Co-founder and commercial director, 80six

Hamill co-founded 80six, with a passion for providing spectacular visual events, utilising over 15 years of professional experience in production.

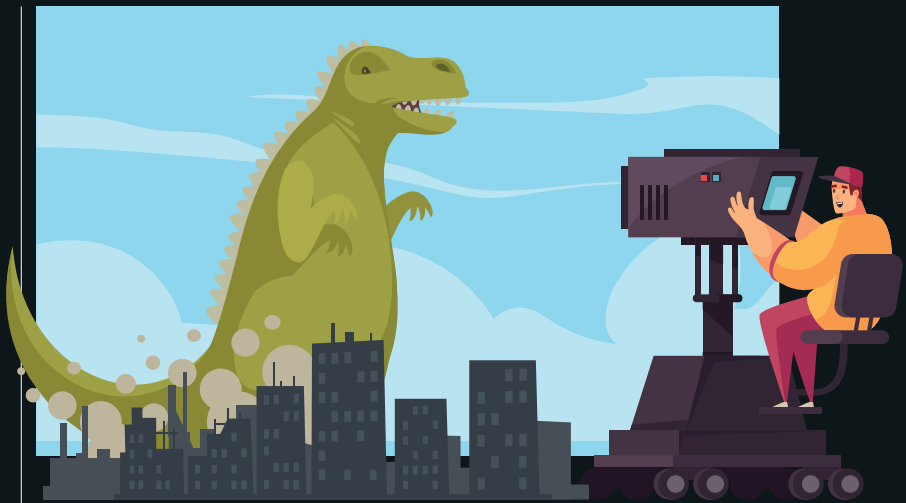
HAMILL: The current developments in Unreal Engine are helping to produce more authentic photorealistic environments, and will be increasingly intrinsic to the characteristics of camera sensors and lenses.

How important is an LED panel's pixel pitch to the camera's optics?

PILBOROUGH-SKINNER: Choosing the correct pixel pitch for your LED volume is essential to negate visual artefacting and the moiré effect. Depending on the size of your volume and the required viewing distance, the tightness of the pixel pitch can vary.

HUNT: There are so many variables to consider. The choice of pixel pitch depends on the shots you're looking to achieve, depth-of-field and countless other factors. The sweet spot of mid-2mm pixel pitch works for a lot of scenarios, but there are plenty of times when having a finer, sub-2mm pitch gives advantages. Such as shooting subjects closer to the screen, which can also reduce screen size and therefore cost. We own large quantities of 1.5mm, 2.3mm, 2.8mm and 3.4mm, which all get good use for in-camera pixels – it really depends on the project's requirements.

KAESTNER: I would say that every virtual production project currently in development is a prototype of some form. The technology is evolving rapidly and fulfilling ever-higher visual demands. Each project is unique, and there is no 'standard' per se for a virtual production methodology. Therefore, every project will have to look very carefully at the combination of LED panels, camera chips, lenses and colour pipeline. The pixel pitch of an LED panel is one aspect that has a massive influence on the visibility of moiré or pixel patterns, when seen at certain distances, through specific lenses and camera chips. For the Netflix series *1899*, DOP Nik Summerer had special anamorphic lenses crafted by Arri, to not only create a unique visual for the show, but also complement the virtual production. Using the Alexa Mini LF in the Dark Bay volume in Babelsberg, limited the amount of moiré and pixel patterns for the distances we needed to shoot our scenes.



HOCHMAN: This is quite critical, and the pitch depends heavily on the type of stage that is set up, along with the DP's choice of shooting. A large volume with a 30m diameter is fine with a 2mm, since the camera distance is quite far to the LEDs – and depth-of-field works in your favour. But, on the other hand, we are seeing certain VFX supervisors prefer as high resolution as 0.9mm, so the LED screen can be extremely close to the camera without moiré. And it's not just pixel pitch, but also the quality of the pixel itself – that's why we actually created our own LED chemistry to make Rec. 2020 colour with exceptional viewing angles and black levels. You'll see more of this next year.

LEVY: It is a crucial topic, and the choices are determined by the size of the LED walls relative to the talent performance area, camera position, sensor size and lens choice.

PRAK: It's important in relation to the type of content you're shooting and the kind of result you require. Anything close-up requires a finer pixel pitch, whereas wide shots work perfectly with a larger one. At the moment, most LED volumes work with anything between 2.3 and 2.8mm. For closer in, a finer pixel pitch might be preferable – like a 1.5mm. It's good to keep in mind that this choice has two sides: the camera optics – which might be easier to change – and the LED panel used in the wall or

volume – which is harder to change. It's a matter of taste, budget, etc. But it is most important to test your products of choice together intensively, and synchronise your camera and LED panels to get the best results.

HAMILL: The pixel pitch of LED panels is critical in creating a high-resolution, realistic virtual background that is suitable for in-camera VFX. Aside from the camera optics (focal length, sensor size, resolution), there are a series of other elements (size of LED volume and distance from camera to LED screen) which all need to be considered to mitigate issues like pixelation and moiré. In theory, the finer the pixel pitch, the higher the definition. For reference, the pixel pitch of the Roe Visual Diamond panels that form the LED volume at our studios is 2.6mm. Whereas, on *The Mandalorian*, they used 2.8mm – but in both cases, excellent cinematic visual outputs were delivered.

Does the choice you make in volume size and form (single LED wall versus volume) impact the interactive/emitted light? If so, how do you decide?

PILBOROUGH-SKINNER: Most LED volumes will provide about 80% of fill light, but we always recommend physical fixtures for key lights – and some fill, depending on the scenario. For example, sunlight is almost impossible to replicate with just an LED; you can't get the hard, direct shadows. So, the size and form of your stage should be informed by budget, the space in which you're building the wall, and what rigging options there are for additional lighting.

HUNT: An enclosed volume will certainly give a more realistic lighting environment, but that's not to say you

“The pixel pitch of an LED panel is one aspect that has a massive influence on the visibility of moiré or pixel patterns, when seen at certain distances”

can't achieve similar results with smaller screens and some creative rigging. We design and supply to both permanent fixed volumes and also many 'pop-up', one-off set-ups – and there really is no specific rule. The choice of screen layout is dependent on budget, length of shoot, size of set, etc. It's often difficult for productions that are new to using LED to get their heads around – there is no one-size-fits-all solution.

KAESTNER: This question is very project-specific, and can only really be answered by the requirements of the show. The demands for a passing background, as seen from the inside of a driving train, are different from someone standing in a dusk or dawn environment. The choice is determined by the creative and visual needs, combined with the technological factors of camera body, lenses, LED panels and display server technology. If you carefully examine all aspects of the project, you will quickly narrow down the choice to a few possibilities. This highlights one of the most important aspects of virtual production: plan carefully and stick to it, otherwise you risk being utterly disappointed.

HOCHMAN: Yes, for sure. The larger the volume, the more light you have to work with. However, this is also highly dependent on what a production requires. A single LED wall is relatively easy to move around and put where needed, which is highly cost-effective. Additionally, assets can be made for the camera frustum if shots are planned well. Or simple plate shots will work. A volume is the ultimate in all-things-for-everyone, but also requires much more upfront modelling and content work. The choice really depends on what a DP needs to get out of the shot. Volumes are the buzz right now, yet I suspect we will start to see

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thousands of single walls deployed as well. Heck, we did single walls over 15 years ago!

LEVY: Absolutely, it has a huge impact on the overall base illumination within the volume, and the achievable resolution of reflections on objects. The choice comes down to application and the type of action you plan to capture. Large scenes with highly reflective objects (cars, for example) require an LED volume which can provide 360° coverage. For smaller scenes covering dialogue with few or small reflective objects, LED volume is less of a priority.

PRAK: First of all, it's good to consider what your production wants, depending on the type of shoots, camera standpoints and set design. Small sets will fit easily within the camera angle – and large sets require a bigger LED volume to make them fit the background. A single LED wall will generate light from one side only (mostly from behind) – this might work for a lot of shoots or production types. Also, if you use XR, you don't need a large LED volume, since it will be extended by the XR environment. A curved or 270-360° volume will emit light from more angles, which might result in a more natural look and feel. The light will be ambient, catching the actor/scene from different angles. There are also many in-between solutions, like using an LED ceiling or side fills. The light emitted from the virtual background gives the scene a very real look. LED panels are capable of

emitting light at a high brightness, which is favourable in any studio environment.

HAMILL: Yes, absolutely. In an ideal world, the use case for LED would be matched in advance to the needs of the production. Ultimately, everything comes down to budget, and that's where we work with clients ahead of arriving on-set, to ensure they aren't wasting money on unnecessary equipment. We have deployed a range of installations, from small, straight rear walls, to fully enclosed internal cubes (flown, and therefore able to drop in around the subject); from straight rear walls with 90° returns, to horseshoe-shaped volumes, all in varying heights and linear lengths. Wraparound 270–360° screens are great for lighting larger sets which need full coverage from virtual backgrounds, allowing cinematographers to get panning shots that aren't achievable with small set-ups.

If light is the focus and the LED is not being used in-camera, a lower-resolution panel like the Roe Carbon 5 is a sensible choice – both for budget and the amount of light they emit (CB5 are high-brightness, capable of up to 6000 nits).

Introducing additional movable sections of LED on dollies in lower-resolution products can also help to target specific areas, with levels of brightness unachievable by finer-pitch products in the 1mm/2mm range. If reflections are key (such as for car scenes), consider resolution versus brightness. In smaller volumes, where we have created ceilings that can be lowered in front of the rear wall, we have chosen the Roe Diamond 2.6mm or Roe Carbon 3.7mm. In larger volumes, with a fixed ceiling nine metres off the ground, the Roe Carbon 5.7mm has been more cost-effective at such a scale – and rigged far enough away that pixelation is not an issue. ●

Don't miss our February issue, where Part 2 continues this interview, and we discuss how machine learning and AI techniques can evolve virtual production technology. We'll explore how colourimetry between camera and display can be mastered to avoid metamerism. And our experts will conclude by telling us what's next for this groundbreaking tech – particularly its evolution, democratisation and industry acceptance.





POWERFUL PROCESSING

How Megapixel VR's HELIOS has become the de facto processing platform for the most complex in-camera VFX

MEGAPIXEL VR IS an innovative technology partner with numerous patents. It has won accolades from Live Design, the Emmys and the Academy Awards. Launched in 2019, its state-of-the-art HELIOS® LED Processing Platform provides the most advanced in-camera visual effects tools for virtual production, with a full 8K video pipeline, support for HDR formats and customisable, upgradeable inputs.

By leveraging AV-over-IP infrastructure, systems are highly resilient with HELIOS' Seamless Failover mode, resulting in visually lossless failover in the event of a data interruption or frame drop. For robust operation, their patented NanoSync technology provides the most accurate video sync control available, down to the nanosecond, even over 10km fibre links.

HELIOS also features superior end-to-end, cinema-grade colour workflow, where metadata is always honoured to ensure colour gamut, greyscale and tone mapping. It is the most accurate in-camera workflow, reducing the time required to colour correct content footage prior to filming – and is quickly becoming the LED processor of choice for in-camera VFX productions.

1899

Netflix's highly anticipated drama *1899*, set on a migrant steamship on the high seas, recently wrapped at DARK BAY's new virtual

production stage at Studio Babelsberg in Germany. Designed by ARRI Solutions Group for Netflix, the studio is the largest permanently installed volume in Europe, with its 7x55m LED wall – and Megapixel's HELIOS was hand-picked to power it.

"The HELIOS processors are great to work with. The many calibration features allow us to achieve the best image fidelity that our LED panels can," says Jesse Kretschmer, technical director at DARK BAY. "The HELIOS API is also easy to work with, and with it we have been able to develop custom tools with the exact controls and information we need to keep productions running smoothly."

Megapixel supported industry partners ARRI, Faber AV, Framstore and ROE Visual (LED panels) in the development of the studio, which will offer future customers a proven set-up for virtual production.

ARRI'S MIXED REALITY STUDIO

In Uxbridge, London, the HELIOS processor continues to drive large volumes. Built by ARRI in partnership with Creative Technology, the stage comprises 343 square metres of LED walls and is one of the biggest permanent mixed-reality spaces in the world. It can be programmed to display 360° imagery that, even when not in-frame, casts dynamic, fully integrated lighting effects onto actors. For this reason,



COLOUR PERFORMANCE What is shown on your grading monitor is what appears on the LED display – this allows HELIOS to offer the best end-to-end workflow in the industry

HELIOS was once again selected; it can deliver a cinema-grade colour workflow and industry-leading image quality.

"In virtual production, a clean pipeline and accurate colour reproduction are essential to a great-looking result," says Tom Burford, head of technical services at Creative Technology – which partnered with ARRI to provide the volume's playback system. "HELIOS provides this with a very precise representation of our content. It's exciting to see this in the ARRI stage."

Always innovating, Megapixel has developed the newest virtual production technology, GhostFrame. It allows for simultaneous capture of multiple video feeds hidden to the naked eye, a chroma key matte and even hidden tracking markers. It can be used via the HELIOS Processing Platform to make the impossible possible for all your virtual production, XR and broadcast needs. ●

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