WHITE PAPER

Virtual Production Workflows with LED Displays

The use of LED displays in video production is on the rise, with benefits that include a smoother production process, lower costs and better-looking visuals.

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VIRTUAL PRODUCTION WORKFLOWS WITH LED DISPLAYS

The use of LED displays in film and television production is arguably one of the most significant changes to happen to the entertainment industry in decades. Already in use in productions such as the Disney+ series "The Mandalorian" and the Netflix film "The Midnight Sky," directed by George Clooney, LED displays positioned behind the action are being used to create backgrounds in real time, replacing the traditional "green screen" where content is added once live shooting is finished.

"...while LED displays in virtual productions are changing the way films and television shows are created, the process is more than just a question of erecting an LED wall on a soundstage."

As described in the Macroblock white paper "LED Displays in Movie & TV Production," an LED backdrop offers several advantages compared with a green screen, including better lighting, quicker scene changes and a reduction in the costs related to adding effects. They also make it easier for actors to immerse themselves into the scene by eliminating the need to guess where set elements will be filled in.

But while LED displays in virtual productions are changing the way films and television shows are created, the process is more than just a question of erecting an LED wall on a soundstage. In this whitepaper, we'll lay out how the workflow is simplified when using LED displays in virtual production and how to overcome some of the challenges involved in shooting an LED backdrop.

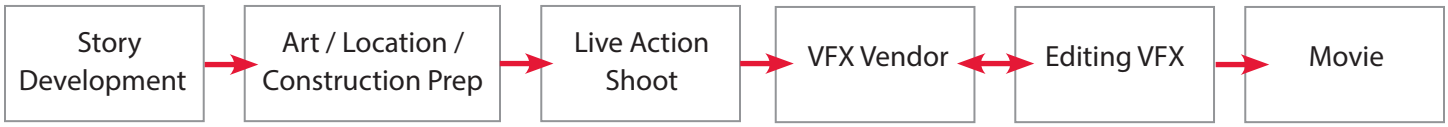
A non-linear process

Virtual production has been described in several different ways. New Zealand visual effects company Weta Digital defines virtual production as "where the physical and digital worlds meet." Method Studios' Creative Director and Senior VFX Supervisor Kevin Baillie told software company Epic Games that virtual production "removes the barriers between live production and visual effects, so that they can occur simultaneously instead of inline." APG Media, a company that specializes in LED video walls for the TV and film production industry, calls virtual production "an area of digital cinema workflow that allows for the creation of real-time, reactive backgrounds that perfectly syncs with the camera for a seamless and fully immersive filming experience."

Ultimately, virtual production incorporating LED video walls allows for a simplified, more collaborative workflow.

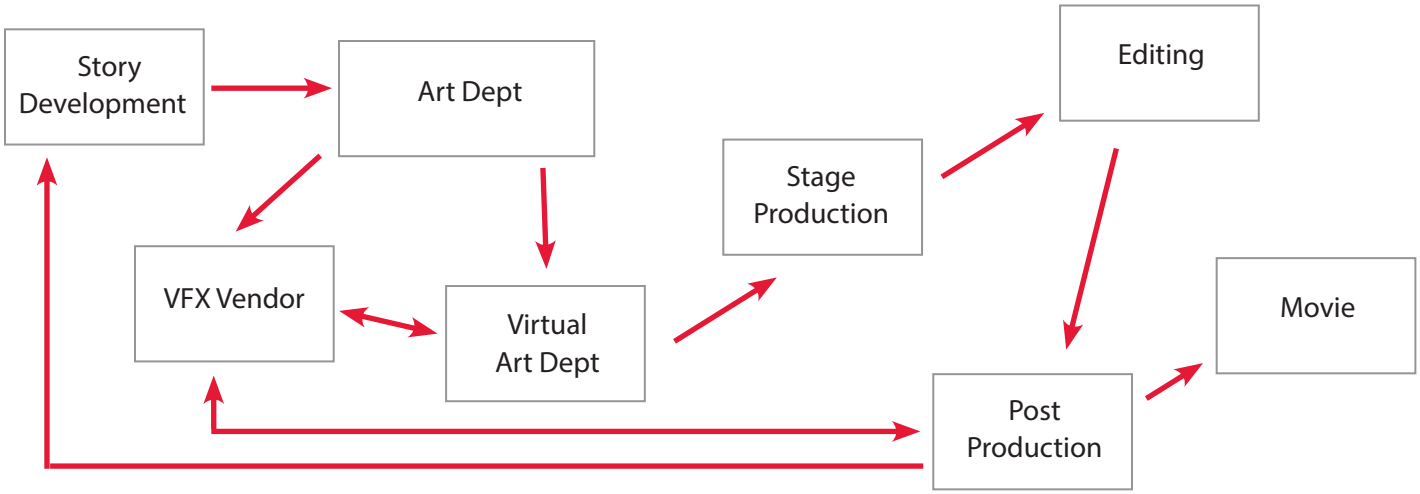
Traditional production has typically involved a linear workflow that begins with story development and the construction of sets, leading to live shooting in front of a green screen or on location, and then the incorporation of digital effects once shooting is complete. If at the end of the process it becomes apparent that reshoots are needed, crews must be called back, often at great expense.

Traditional Production Process



Virtual production, on the other hand, offers filmmakers the ability to collaborate on visual details in real time, allowing for creative decisions to be made much earlier in the process. Rather than requiring the costly and time-consuming construction and dismantling of sets for different scenes, backgrounds can be displayed on an LED wall behind the action and can be changed at a moment's notice. Images displayed on the wall can incorporate a motion tracker that senses where the camera is and how it is moving, adjusting those images for maximum realism.

Virtual Production Process



Special effects can be prepared in advance of shooting and adjusted on the fly, eliminating the need for reshoots that can come up long after production has wrapped when working with green screens. Directors can immediately see how shots look through the camera lens and make changes as needed. Because the background can be filmed along with the main action, the costs of adding those effects in later can be mostly eliminated.

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Consider, for example, the challenges in the filming of an episode of the 1990's television series Star Trek: Voyager. In "The 37's," the first episode of the second season, last-minute changes to the script prevented the completion of several special-effects shots, much to the dismay of production staff. In addition, unhappiness with the appearance of some aspects of the starship at the center of the story forced the post-production crew to obscure them with landscape scenes. And because the location where some scenes were filmed was out of proportion with the size of the starship, the production crew incorporated a combination of on-location shots and a matte painting backdrop.

In contrast, with the video-wall backdrop used in "The Mandalorian," more decisions about shot composition were made in advance of shooting, saving valuable time. Digital backgrounds could be edited during the shoot. According to a post on the trade news site FXGuide.com, "environments were lit and rendered from the perspective of the camera to provide parallax in real-time, with accurate interactive light from the LED screens lighting on the actors and practical sets inside the stage."

More than half of the first season of the show was filmed on the set, which consisted of a curved, 20'-high-by-180' LED video wall comprised of 1,326 individual LED screens of a 2.84mm pixel pitch. The wall created a 270-degree semicircular background with a 75'-diameter performance space. Topping that was an LED video ceiling, set directly onto the LED wall. Behind the cameras were two 18'-high-by-20'-wide flat panels of 132 more LED screens.

Thanks to the versatility of the LED wall, the need for location shoots was eliminated entirely.

"The new virtual production stage and workflow allows filmmakers to capture a significant amount of complex visual effects shots in-camera using real-time

game engine technology and surrounding LED screens," according to FXGuide.com. "This approach allows dynamic photo-real digital landscapes and sets to be live while filming, which dramatically reduces the need for greenscreen and produces the closest thing we have seen to a working 'Holo-deck' style of technology."

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Addressing the challenges

Although the use of LED technology promises to remake the entertainment industry, it's not without its challenges. Several issues need to be addressed before shooting to ensure LED displays deliver on their promise.

Here are the most significant ones:

Bright and dark line issues

Although LED displays may look fine with the naked eye, failing to take into account camera shutter speed and display refresh rate may result in black scan lines and bright and dark line issues when shot through still and video cameras. Solving the issue requires a bit of understanding of camera exposure time and their relationship to how LED display drivers operate.

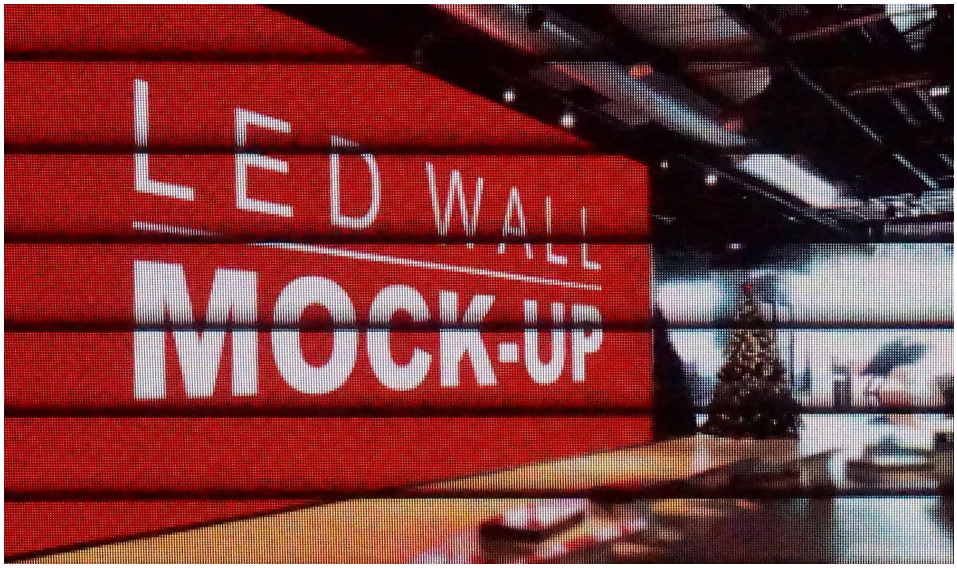
LED displays consist of rows upon rows of LED "pixels," with each pixel made up of red, green and blue LEDs. Those colors combine to create the images we see on the screen.

To help conserve energy, those pixels don't remain continuously lit. Instead, the display scans through each line of pixels, lighting one line after another with the entire sequence continually repeating itself. Our eyes don't perceive the scanning thanks to a phenomenon called "persistence of vision," which also allows us to perceive the frames in a film as continuous motion.

Consider the shooting of an LED display showing a 60-frames-per-second image, with 1/60th of a second for each image. Displays with driver ICs incorporating Scrambled-Pulse Width Modulation (S-PWM) technology break that image into 64 sub-images, or "scrambles," each 1/64th as bright as the

original image. Every second, then, 60 images are split into 64 scrambles, or a total of 3,840 scrambles. That LED is referred to as having a visual refresh rate of 3,840 Hz.

In an LED video wall backdrop, if the exposure time of a camera is shorter than one group of 64 scrambles, the shutter closes before the scan is complete and doesn't capture the entire scan, resulting in black scan lines appearing on the recorded image.



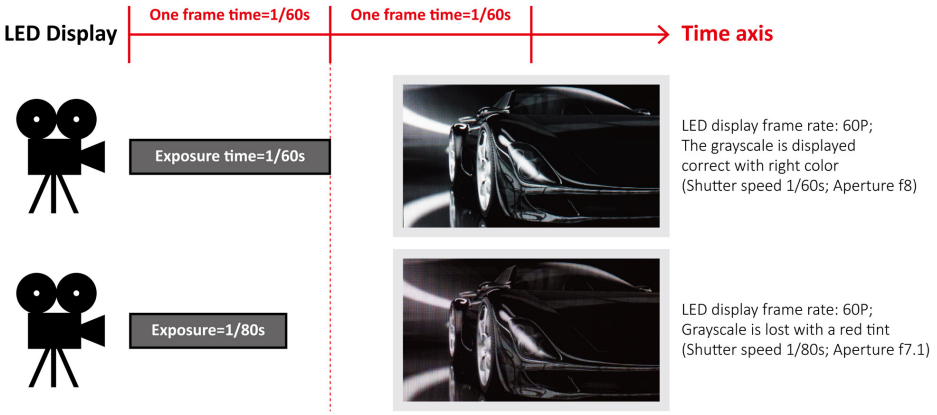
On the other hand, if the camera exposure time is longer than one group of scrambles, but not an exact multiple of the scramble, the recorded image will show alternating bright and dark lines.

There are several ways to address the issue. Increasing the camera exposure time will help eliminate black lines, while making exposure time an exact multiple of the scramble will help eliminate bright and dark lines. Also, choosing an LED display with a high refresh rate can help reduce the brightness gap.

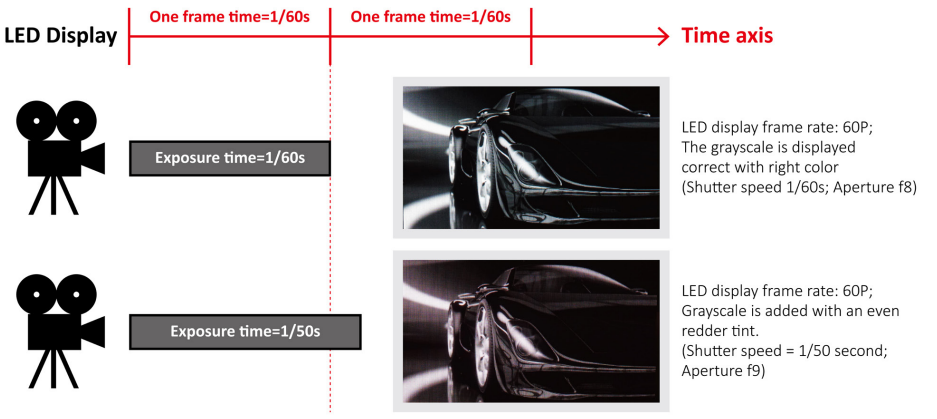
Color issues

Shooting a 60 FPS LED display with 1/60th exposure time captures all 64 scrambles, resulting in an image that has the desired brightness and color.

An exposure time shorter than 1/60th of a second, though, results in the loss of some scrambles and an image that looks "off" thanks to a loss of grayscale.



On the other hand, if the exposure time is longer than 1/60th of a second the camera captures some scrambles of the next frame, creating an extra grayscale issue.

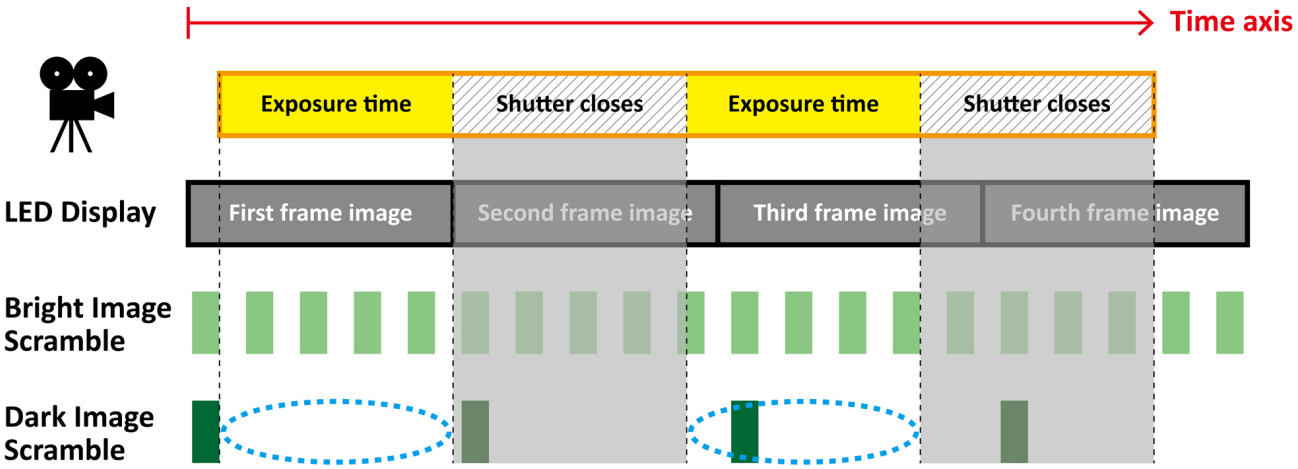


The best way to deal with the grayscale loss or extra grayscale is to match exposure time to frame rate.

Flicker at low brightness

One common problem that can occur when shooting LED displays is that darker areas can flicker. To understand why that can occur, let's take another look at LED displays that use driver ICs incorporating the aforementioned S-PWM technology.

The IC can easily break up the bright part of the image to 64 scrambles, but because darker areas don't have enough grayscale, there may only be one scramble. If the camera's exposure time is slightly less than the LED display frame rate, sometimes it will capture the darker scramble and other times it won't, creating a flicker effect.



Again, the best way to address the issue is to match exposure time to frame rate or to boost the refresh rate at low brightness.

Achieving the desired performance

Taiwan-based technology company Macroblock has created a line of driver ICs that solves issues related to black scan lines, bright and dark lines and flickering at low brightness. Macroblock provides LED driver ICs for commercial LED display applications including indoor, outdoor, VMS and message signs as well as virtual production.

For the best results when using LED displays in virtual production, Macroblock recommends ICs with grayscale boost and PWM enhancements supporting grayscale boost, 16-bit, 120 FPS and 7,680 Hz. visual refresh rate. For displays with 1-4mm pixel pitch, the company recommends its MBI5264 driver IC, while for displays with a pixel pitch of 1.5-6mm, it recommends its MBI5854 driver IC.

As more and more filmmakers and content creators realize the performance benefits and cost savings resulting from the use of LED displays in virtual production, their use is sure to spread. Choosing displays with the right driver IC can help deliver the best in performance.

Common shooting issues with LED displays

- Black scan lines - Results from exposure time less than one scramble time.
- Bright and dark lines - Results from exposure time not being multiples of scramble and not long enough.
- Grayscale loss or extra grayscale - Results from mismatched exposure time and frame rate.
- Flicker in darker areas - Results from too few grayscale levels in darker areas that cannot be scrambled.

Source: Macroblock

ABOUT THE SPONSOR:

Macroblock is a leading supplier of LED Driver ICs and LED Video Display Driver ICs. The company provides LED driver ICs for all commercial LED display applications including indoor and outdoor LED displays and message signs. With its commitment to energy savings and meeting different LED display requirements, Macroblock developed innovative products to accelerate designs and applications with excellent display qualities and perfect system reliabilities. The company holds more than 60 LED-related patents.

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