Virtual Production in Film Education
Documentation of "The Wall"

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EMERGING MEDIA EXPLORATION

Virtual Production in Film Education
Documentation of "The Wall"

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Part I. Theory

What is Virtual Production?

Virtual production is a broad term referring to a spectrum of computer-aided production and visualization filmmaking methods. To begin, here are a few notable definitions about virtual production. According to the team at Weta Digital, "Virtual production is where the physical and digital worlds meet." Moving Picture Company (MPC) adds to this definition with more technical detail, "VP combines virtual and augmented reality with CGI and game-engine technologies to enable production crews to see their scenes unfold as they are composed and captured on set."
(**Noah Kadner**, The Virtual Production Field Guide)

In simple terms, imagine that you are making a feature film. You need a camera, actors and location. With virtual production, all this can be replaced with virtual counterparts, but the result can still basically follow the "rules" of creating a "real" movie.

Virtual Production is a collective term for a wide range of computer-based methods that are designed to enhance creativity and save time during the filmmaking process. The use of real-time tools can transform traditional linear production into a parallel process in which the boundaries between pre-production, production and post-production are blurred, making the entire system more flexible. Virtual workflows can be faster, more creative, and iterated over more times in less time. We can get a better idea of the final shots and scenes earlier in the production process. With pre-built virtual sets, the director and department heads can locate locations in VR, select the desired footage, and specify precise viewing angles and specific camera movements. Unlike a traditional workflow VP allows real-time scenery changes while providing more accurate, realistic lighting, and ultimately increases team productivity.

These are just a couple of examples of how filmmakers can use real-time technology to take full creative control of the storytelling. The qualitative advantage of this technology lies in the Parallax effect - a change in the apparent position of an object relative to a distant background, depending on the position of the observer. Using the physical and optical properties of this "cosmic" effect (in literal sense - this term came from astronomy, where it is used to measure the distance to far objects in parsecs) Jon Favreau and Disney + created most of the sets of the television series "The Mandalorian".

"The Mandalorian'' is the first example of use of real-time rendering and LED walls for effects on set. This technology was chosen to optimize deadlines and the budget of the whole production. The idea of using LED screens was borrowed from the past. Similar technologies have been used since the 1930s, for example, during the filming of King Kong, when backgrounds were projected onto the wall behind the characters. When working in such a way, all the elements can be immediately captured on set during the shooting, and not being composited

in postproduction. So, in this case the backgrounds are photographs of real or fantastic locations that were recreated and photo realistically arranged in Unreal Engine 4. The team developed special trackers that capture the position of the physical camera in real world and match the position of virtual background (perspective and parallax) according to its movement. Everything is performed in real time. Thanks to these technologies, the Mandalorian team very accurately recreated the real filming process on location. With only one difference: now they did not depend on the weather and unpredictable circumstances, and could spend an entire 10-hour shooting day with a scene that takes place during sunset.

Advantages of Such a Type of Content Production

- The camera tracking system allows to track the position of the camera anywhere in the coverage area, so the virtual scene, created in Epic Games' Unreal Engine, changes the angle depending on the position of the camera operator, while maintaining the natural depth and perspective of the background. Realtime rendering is carried out on high-resolution LED screens, with sufficient LED frequency and luminescence intensity sufficient to realistically illuminate the actors.

- The entire set of pre-production tools is controlled by VFX artists, who can create any virtual scene and integrate necessary AR and CGI objects directly into the software. Post-production in this case is already being made at the stage of pre-production. This way all departments can see the final image on set and react to it immediately.

- Making the necessary changes to the virtual scene can take place right in the process of shooting at the request of the DoP of the director. Objects can be moved with ease in any direction, lighting and time of the day can be also controlled without waiting. Moreover it's possible to shoot in different locations without moving the bulky equipment.

- The whole team, including actors, can see immediately the final composited image. This greatly simplifies the work with the dramatic elements of the narrative.
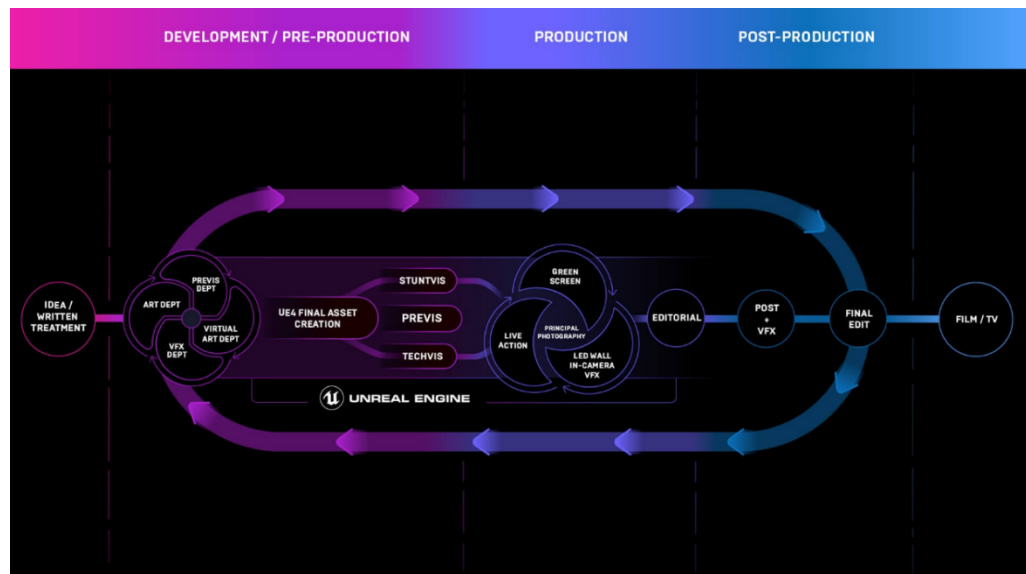
Methods of Virtual Production

Figure 1: Common VP Workflow. Unreal Engine, Virtual Production Hub

«The Virtual Production Field Guide» defines the methods of virtual production depending on the various use cases. They include visualization, performance capture, hybrid virtual production, and in-camera virtual production.

- **Visualization**
  Prototyping, Pitchvis, Previs, Virtual scouting, Pre-animation (Brekel with Azure Kinect), Cine Tracer etc.

- **Performance Capture**
  In-Engine Production: Motion capture, Facial capture, Full body

  animation etc. Virtual camera can be used.

- **Hybrid Virtual Production**
  Compositing of green screen cinematography with CG elements. Compositing in UE, Aximmetry, Zero Density, Live camera streaming etc. Virtual camera can be used.

- **Live LED Wall In-Camera Virtual Production**
  nDisplay, Virtual camera. Can be also performed using a projection screen.
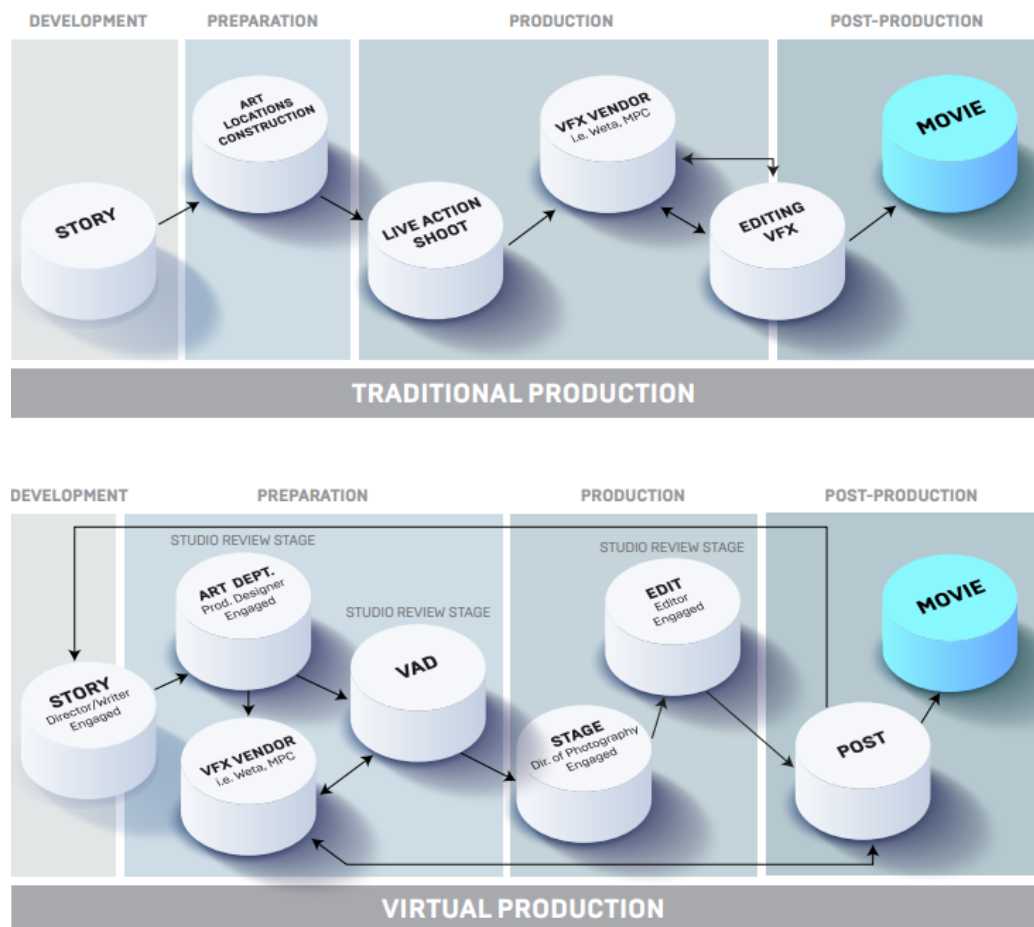
Figure 2: Traditional vs Virtual Production for Film / Visual development by Fox VFX Lab
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Part II. Creating "The wall"

Goals and Objectives

During the EMEX Workshop, we decided to use a mix of methods of Virtual Production. The main idea was to use affordable budget tools to organize the shooting process based on the Unreal Engine. We used HTC Vive trackers and DogHut open-source Virtual Camera Controller as the main tools.

The result of the work was the social video "The Wall" shot and composited in real time by the students. The main goal of this project was to demonstrate the

possibilities of preparing a virtual scene and filming it in real time, while maintaining all the traditional approaches of the classic filming process. That means, the film crew started working without any prior knowledge in 3D and game development, everything was done based on the traditional shooting processes. Of course, the Unreal Engine scenes were prepared by a specialist, but the whole point was to make the students feel natural on set.

DoP work was also close to the usual one: using the DogHut Virtual Camera, the camera operator could hold a familiar rig in the hands and work with it in the same way as with a regular camera. The only difference was that the image was created inside the game engine and the final rendering was displayed simultaneously on the viewing monitors.

Figure 4: Camera Work on Set

Tools and Workflow

To create "The Wall" video, we used the following sequence of steps, combined into a single system. First of all, a prototype of the scene was prepared in the Unreal Engine. Then the main elements of the exterior were worked out, the lighting scheme was specified, places in the scene were prepared for a real character. It should be noted that due to the availability of a huge number of ready-made assets for UE, creating an environment is more a creative process than a technical one.
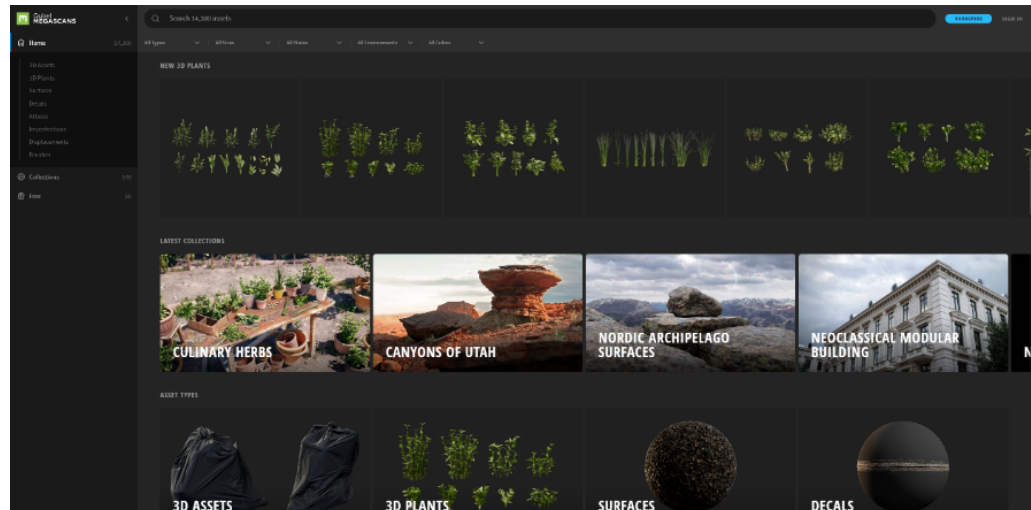
Figure 5: Quixel Megascans Library

Only from the elements of the Quixel Megascans library (free for users with an Epic Games account), you can assemble a huge number of scenes and interior and exterior elements. Together with the use of assets from the UE Marketplace, the possibilities are almost limitless and affordable.

Next, we had to prepare the mise-en-scene and choose the points in the virtual scene where the real live actor would act. It was originally planned that the main actor would be filmed against a green background, and the video would be broadcasted in real time to Unreal Engine for further processing. However, due to some Covid-19 limitations, we had to shoot green screen footage separately, before starting to work with the virtual production set. However, to maintain a real-time-process feel, the prepared green screen footage was looped in Premiere Pro and broadcasted live to Unreal Engine using the NDI protocol and the NDI Tools package. In general, it was almost the same as if the actor played live in front of the camera.

Figure 6: Preparing the Scene with the Streamed Footage

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On the other hand, due to this limitation, we were also able to try creating VFX at the pre-production stage, and not at post-production, as it is normally done in traditional production workflow. According to the script, the main character writes the word "Murderer" on the wall in large letters. Of course, she could not do this during the shooting, and the letters were supposed to be composited in post. However, having the green screen video done, we added the letters to the footage even before the main shooting began, so on the set the whole team could already see the finished effect and make creative decisions based on the final look of the image.

Figure 7: Final Result of the Text Effect

We also prepared all the elements of the underwater environment illusion and created an animation of the ship floating over the entire scene. Keying and compositing of the streamed green screen footage with the virtual scene were made in real time directly in Unreal Engine.
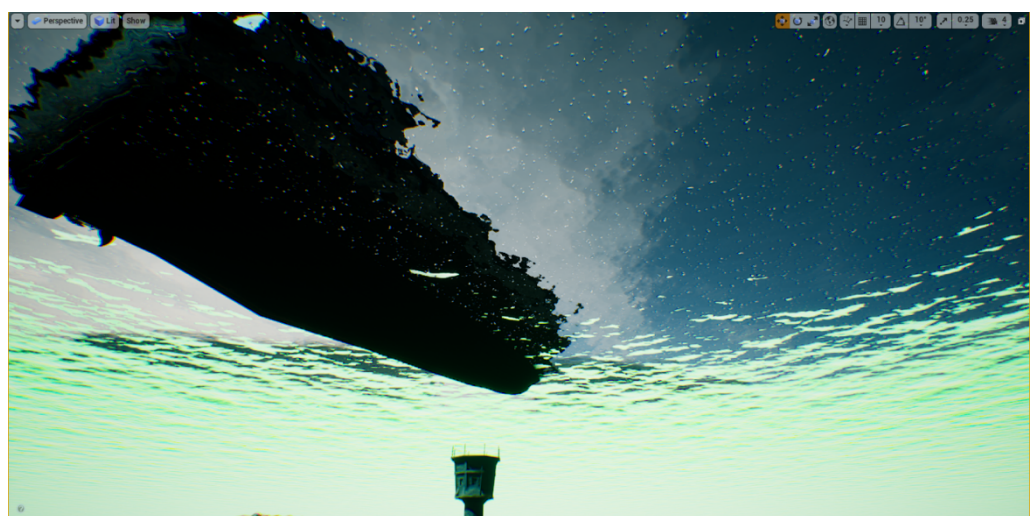

Figure 8: The Underwater Environment with the Boat Above the Scene

Now we had a ready-made 3D world with the real image of the main character and superimposed effects. All that is left is to put the camera on and start shooting.

Shooting and Capturing

Our task was to combine the movement of the virtual camera inside the game engine with the real actions made with the physical rig in the real world. To achieve this, we used the DogHut Virtual Camera system for Unreal Engine. A special Blueprint tracked the position of the physical rig using the HTC Vive tracker and precisely aligned its coordinates in real time with the camera in the virtual scene. As a result, all crew members could immediately see what the camera was filming.
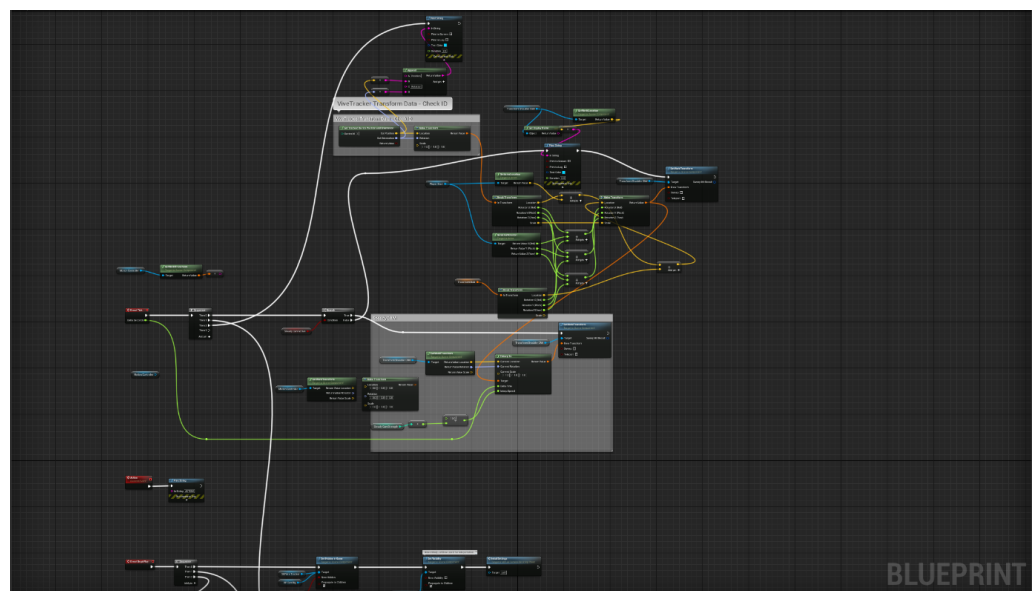

Figure 10: Virtual Camera is Synchronized with the Physical Rig

Image capture in our case was done using OBS Studio. This program was chosen only for the purpose of demonstrating live video recording and streaming possibilities out of Unreal Engine. It's obvious that for serious production more professional hardware should be used, for example, SDI or HDMI I/O cards like Blackmagic or AJA plugged into the professional image recorder.

Thus, in one shoot, we combined almost all types of virtual production methods according to the classification of The Virtual Production Field Guide: Visualization, Performance capture, Hybrid virtual production and conditionally In-Camera Virtual Production (conditionally, because we did not use LED walls).

The main steps of creating «The Wall»

1. Preparing the concept and writing the script
2. Choosing virtual production methods
3. Preparation of scene prototypes
4. Setting up the game engine and virtual camera
5. Testing trackers on set
6. Final creation of the virtual scene
7. Creation of animation of the ship
8. Shooting an actor against a green screen
9. Creating the effect of letters in the green screen footage
10. Configuring green screen footage streaming parameters using the NDI protocol
11. Keying and compositing video inside Unreal Engine
12. Test of the whole system using the DogHut Virtual Camera
13. Adding final touches to the scene at the request of the director and DoP
14. Shooting
15. Editing and finishing

Figure 11: Camera Work on Set

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Final Thoughts

It should be noted that the entire preproduction - production - postproduction process of the video took no more than two days, thanks to the real-time technologies available through VP. Of course, today there are a lot of technical and creative limitations in this kind of filming. First of all, this is the performance limit of the game engine itself and its relative unpreparedness for the transition from the game development environment to video and cinema production. However, with each new version, different modules are added to Unreal Engine that can fit perfectly into the standard video production pipeline.

Links

- Unreal Engine
- Unreal Engine Virtual Production Hub
- Unreal Engine Virtual Production Primer
- The Virtual Production Field Guide
- DogHut Virtual Camera for UE4
- Quixel Megascans
- HTC VIVE Tracker
- NDITools
- OBS Studio