**CGT 540 Advanced Topic in Animation**

# Research Paper

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# TIME AND COST ASSESSMENT FOR LOW/MEDIUM BUDGET VIRTUAL PRODUCTION

by

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## Chapter 1: Introduction

With the advent of novel real-time technologies and virtual camera systems, visual effects companies are now beginning to employ the use of virtual production workflows using cylindrical LED sets linked to the Unreal (game) Engine (Seymour 2020). These techniques bring "on-location" filming to the studio with 3D environments synchronized to camera tracking and projecting the environment in a small interior space. This allows not only employs game engine graphics but also pre-recorded 360-degree environments in the real world be projecting light and shadow in real-time onto the actors with the illusion that they are in different various locations. Sunset shots that have only a window of minutes can now be frozen in time with the pause of a button as well as virtual environments can realistically emit scene reflections onto the actors. Although some industry experts proclaim the savings of both money and time comparatively to shooting on-location or using built studio sets, the truth of that matter remains a mystery for large scale productions. What does seem to be unchallenged in opinion is that virtual production does increase production value and quality however the question has come up: can virtual production be a cost/time savings for low budget filmmakers. Currently in the development of virtual production technology, there seems to be extraordinarily little time or cost savings for small to medium virtual production budget projects despite all the "dog-and-pony" shows many lower end studios seem to tout.

## Chapter 2: ILM's Stagecraft Development

Since 2018 Industrial Light and Magic (ILM) has been using their newly developed LED volume for high profile Disney shows such as "Mandalorian" Seasons 1 and 2, "The Book of

Boba Fett", "Obi-Wan Kenobi", and "The Acolyte". Oddly named "The Stagecraft", ILM's R&D team have constructed an enormous 270-degree semicircular LED environment with ceiling for projecting real-time virtual environments via the Unreal Engine (Seymour 2020). Bold proclamations and testimonies by these developers have been presented in numerous papers as well as promotional videos from behind-the-scenes and ILM press releases. Richard Bluff, ILM's visual effect supervisor defines the technology as an "end-to-end virtual production solution." (Seymour 2020). The definition itself is not properly addressed with only a follow up presentation of a symbiotic relationship between pre-visualization (animated storyboard of what will be filmed), tech visualization (the visualization in the form of measurements of how to film the pre-visualization), and post-production visual effects (the additional effects work needed to polish off the shots filmed on the virtual set). Another declaration is that virtual production principal photography is saving on-set shooting time by 30 to 40 percent. This may sound like a savings of time, but the truth of the matter is because of the complexity of the virtual production process, time and money are needed in the previous mentioned visualization preparations (pre-vis, tech-vis) as well as completion post-processes (post-vis).

## Chapter 3: Costly/Time-Consuming Pitfall's of Virtual Production on Set

Steve Wright, award-winning visual effects industry supervisor and lead compositor has written up a non-biased investigation of ILM's Stagecraft finding numerous issues and limitations that increase both time and money to remedy (Wright, 2021).

Moire is a major issue for shooting LED screens with real cameras. This artifact is common in camera's that film patterned materials causing a wavy artifact when played back.

The reason behind this seems to come from the LED panels pixel pitch (the shortest distance between the center of one pixel to the next). On the "Mandalorian", the ideal distance of camera to LED screen was about twenty feet. Any deviation from that distance would increase the possibility of the artifact. To avoid this artifact, most of the shots of the show had the background LED severely out of focus with the cinematographer forced to use long anamorphic lenses. The use of wide anamorphic lenses (such as the typical 35mm or 40mm) were not allowed do to the limitation of the volume set itself. Although the walls and ceiling of ILM's Stagecraft set were virtual projections, the floor still needed to be set-dressed by huge dump trucks full of costly sand, soil, rocks, leaves, and not to mention plywood sets. The matching of the real set to the virtual surrounding vista had to be carefully lit and art directed to match between the virtual world and the real. Sound on the volume set was horrendous due to the acoustics from the curved shape of the LED set. All camera's had to be rigged with "chatter off" blimps and more time and money would be allocated to post-dialogue looping for the actors. Lighting was a hassle as well due to the nature of the emitted light from the LED panels always being mostly soft. Hard lighting required the setting up of production lights within the volume which had to be carefully flagged to avoid light pollution on the LED walls. Latency (1/3$^{rd}$ second delay) in the frustrum recording projected on the wall would limit shots to slow moving pans and tilts. If a whip-pan or fast-moving dolly shot were incorporated, the post-production compositing team would be required to rotoscope (trace around frame-by-frame) foreground elements and re-composite the recorded unreal engine footage.

## Chapter 3: Costly/Time Consuming Post-Production Workflows

The irony of ILM's Stagecraft is that it increased the labor costs and time for post-production. For every shot on the volume there was a large seam between the ceiling and the walls littered with crevice shadows and infrared camera sensors. All shots would require a manual rotoscoping of the different actors and elements for adjustments in color in the compositing stage. Matching the fully CG renders with the stagecraft footage was a colorspace nightmare. Without the advanced knowledge and laborious color science pipelines developed by the ILM R&D team, the Stagecraft productions would have a bottleneck look of varied dynamic range mismatches. Although Steve Wright's investigation pointed out these flaws inevitably required increase in cost, time, and crew, he unfortunately did not have access to the accounting books as to whether the process was saving money as well as time.

## Chapter 4: Costly and Timely Color Management Nightmare

In Siggraph of 2021, the Visual FX Double Negative (DNEG) took on the many problems that plague the color mismatch not only for ILM's Stagecraft but other newly developed volumes as well. The goal was to "enable filmmakers and visual effects artist to prepare virtual environments in advance of shooting, confident that their color intent will be preserved in the final footage" (James, 2021). The team goes over the basic concept of taking a picture of a picture and how contrast and color are slightly offset in the process. The color-management workflow involved taking out the color-rendering step in the pipeline and replacing it with a set of operations designed to invert all the subsequent color transforms in the chain of filming acquisition. This not only allowed continuity of output from original virtual environment creation but also the avoidance of banding and posterization (common artifacts in virtual

production footage). The process itself involved a dozen developers as well as meticulous on-set supervision to make sure proper (time-consuming) calibration was set for virtual production.

## Chapter 4: Quality, Time, and Cost of Low-Budget Virtual Production Studios

Since the advent of LED volume-based virtual productions, many other studios have tried to jump on the tech-excitement bandwagon and develop their own versions of ILM's Stagecraft with lower budgets and a variety of LED and OLED designs (Koshino, 2021). Sony PCL's system was presented at Siggraph 2021 using 8K Crystal LED panel arrays linked to their camera system "VENICE". The live audience demonstration was a notable example of what raw LED virtual production looks like with the costly and time-consuming addition and flagging of studio lights, the complete mismatch in color due to no post-production workflows.

## Chapter 4: Conclusion

Currently numerous production houses are using cheaper LED panel-arrays with obvious lack of light throw (distance/intensity of light from LED screen onto the set itself). From watching the demonstrations, one might ask: why not just film on location?

Although many of these production studios will gladly lease their virtual production stages to any production (for a price), any time saved in the principal photography will require additional allocation to such tasks as the preparation, techy-filming, and post-production glitch fixing in the compositing/colorist stage. Nobody seems to deny that virtual production yields an

incredible increase in a production value (if executed properly) but its promises to save time and money for medium and low budget films remains to be seen.

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