

Reengineering Rear Projection? A Genealogy of Virtual Production Spaces and their Aesthetic and Logistical Potential

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“[T]he foreground appears as one flat plane, and the background as another flat plane, and the two are not fully synthesized into the convincing illusion of an integrated whole.”

So writes Julie Turnock (2016, 95) on *To Catch a Thief* (Hitchcock 1955), as part of an examination of the challenges using rear projection techniques in 1950s Hollywood. Despite significant developments in screen compositing technologies, including bluescreens and greenscreens, filmmaker Stanley Kubrick still found uses for rear projection in *Eyes Wide Shut* (1999), projecting “process shots” of New York behind Tom Cruise, while the actor walked on a treadmill in London’s Pinewood Studios, the film’s shooting location. Commenting on the “utter unreality” of this set-up, Kolker and Abrams (2019, 82-83) note how “‘realism’, in its banal sense, was never as important for Kubrick as the perfect image”, with his ambiguity about cinematic realism also reflecting how conventional Hollywood “realism” is “of course, an illusion”.

Building on such practices and insights, this chapter will situate the emergent uses of virtual production spaces within film history, including through critical analysis of related historical and contemporary industry discourse on the value of these technologies. My approach draws on archival trade journal accounts focused on background plates and composite images, which are compared with contemporary accounts in trade journals. I aim to demonstrate how greater attention to the technological precursors to virtual production can offer important lessons for those using it or considering using it. Industry scepticism related to virtual production might be somewhat alleviated if there was increased contemporary awareness of precisely how and why esteemed filmmakers, including Alfred Hitchcock, Stanley Kubrick and Joseph L. Mankiewicz, deployed virtual production’s precursors to good effect. Because as is

often the case within the screen industry, the “newness” of an emergent technology can seem less radical when you contextualize it within a longer media history.

Cinema’s History of Compositing

As Entertainment Technologists Inc.’s “Demystifying Virtual Production” (2023) white paper puts it, “there’s really nothing virtual about it... “Virtual Production” is not virtual but real, physical production, on a set, with cameras, microphones, actors, and props all combined with real-time visualization workflows. The key distinction with legacy production is that virtual production is enabled by a suite of new and emerging technologies” (Entertainment Technologists Inc. 2023, 6). When framing virtual production within historic screen practices, this and other sources generally compare it to Special FX such as motion capture and green screens, but without reference to earlier “real-time” special effects, such as rear or front projection. The *Variety* report includes a brief but broader pre-history (2021, 7). Yet I would argue that rear projection and other forms of composite imaging than green screens provide a much better reference point for historicising virtual production.

Rear-screen projection is a technique which composites studio sequences with location or effects shots, by projecting images on a screen behind the live action and then simultaneously photographing them. It was developed during the late 1920s and became standardized in response to the emergence of synchronized sound in the late 1920s and early 1930s, when the cumbersome equipment prevented on-location shoots. Rear projection was most famously deployed in sequences where characters drive in cars or ride in other vehicles like boats, but it was used also used across a wide range of other shot types, becoming the primary special effects composite technology used between 1935 and 1970 (Turnock 2012, 157).

Rear projection and other forms of transparency shot were pioneered by Farciot Edouart at Paramount and earned him an exceptional ten technical and scientific Academy Awards. Edouart’s articles in *American Cinematographer* and other journals help to reveal the full scale of rear projections practices, which are often now remembered as a novelty contained largely to car scenes. As he writes, “scarcely a picture is released by any major producer which does

not include at least two or three such scenes—and some few productions have used this process to make 75 or 80 of their total footage” (1932, 15). For Edouart, the key advantages to rear projection include “the fact that greater control is possible, with less expense, less effort, and greater certainty,” (1932, 15). Indeed, as I will explore in more detail below, these are precisely the kinds of advantages presented for virtual production. But rear projection also came with challenges. Technicians often struggled to hide flaws in the projected background plates, despite boosting projector lights which could help somewhat (Turnock 2012, 159). There were also issues related to the perception of movement in the background plate relative to the on-set recording.

By the 1970s, most filmmakers moved towards the more recently developed technique of green screen compositing, where a green backdrop placed in the background of a shot to allow for digital effects to be added in post-production. It gained mainstream traction after George Lucas employed it in the original *Star Wars* (1977–1983) trilogy. Unlike virtual production and rear (and front) projection, green screens rely on post-production rather than the real-time production, and thus I consider them a less useful point of comparison.

Logistical Benefits

When it comes to logistical benefits, there are notable overlaps in the discourse on virtual production and its analogue predecessor, rear projection. In classical Hollywood, the reduced need for casts and crews to travel to shooting locations was already valued for the cost savings (even outside of travel restrictions due to WW2—discussed below). The contemporary savings due to virtual production are generally framed in terms of both economic savings and environmental ones (Deloitte 2020), with the latter in line with broader social goals for more sustainable approaches to industry.

With virtual production, attention is often paid to the potential for virtual assets to be reused across multiple screen productions, with potential for substantial cost savings. As the authors of the Demystifying Virtual Production paper note of savings to LucasFilm from reusing assets, the fact that many of their productions are in the sci-fi genre (and where the look of the futuristic

storyworlds can share commonalities) means they are “not confident that other productions should assume such similar gains” (Entertainment Technologists Inc. 2023, 25). But reusing rear projection backgrounds was common practice in classical Hollywood and did lead to cost savings. By 1932, Edouart explained that, at Paramount:

“We have, naturally, built up a sizeable library of background plates of all types. These negatives can be used repeatedly whenever a background of their particular genre is desired... and through the use of different foreground sets and treatment, we are able to alter the composition of the plate as well... I have recently, for instance, employed the same shot of a group of dancers on a ball-room for several different pictures, yet we defy anyone to recognize that the same background has served in both instances.” (1932, 39).

In an *American Cinematographer* survey of the changing costs of composite shots in one studio – likely Paramount -- the average cost per shot dropped from \$314.95 in 1930 to \$116 in 1933, a reduction partly attributed to the reuse of background plates from the studio library (Rogers 2016, 72; Blanchard 1933, 110).

Certain kinds of remote locations make capturing background plates, or virtual assets for virtual production, particularly appealing. Beyond the travel and environmental costs of shooting in extreme weather or lighting conditions, both cast and crew may work better in more comfortable studio settings. These elements come together in both the use of rear projection for *Spawn of the North* (1938), set in Alaska, and in the use of virtual production for *The Midnight Sky* (Clooney, 2020), set in a post-apocalyptic world and shot partly in Iceland.

Both productions involve the careful combination of bespoke on-set assets with virtual backgrounds from cold and remote locations. For *The Midnight Sky*, ILM’s StageCraft team collaborated with the director, production designer and cinematographer to construct a bespoke StageCraft LED installation built into the set itself. For *Spawn of the North*, in addition

to some location shooting, director Henry Hathaway describes how, “At the studio, workmen built a new steel-and-concrete tank stage, holding 375,000 gallons of water, and in this we launched three 17-ton fishing smacks and a power cruiser for close-range scenes” (Hathaway 1938).



Figure 1. A probable rear projection shot from *Spawn of the North* (1938).



Figure 2. A probable virtual production shot from *The Midnight Sky* (2020).

Both films involved extensive planning and an understanding that, to have the necessary range of pre-recorded footage to match with the subsequent filming process, it was necessary to capture large amounts of footage in different environmental conditions. Affirming the importance of pre-planning to such production practices, Hathaway describes how the actual shooting of the film was “the least of our worries. All the ‘groundwork’ had been laid carefully and with considerable pains beforehand.” A 14-week camera exhibition “for the shooting of action and background scenes” resulted in 80,000 feet of footage (Hathaway 1938). Hathaway explicitly acknowledging the established practice of studios building up a library of background plates for reuse, explaining that the unused Alaska footage will not go to waste as it has “been filed in the studio [Paramount] film library and undoubtedly will prove of value later on”. For *The Midnight Sky*, when recording footage of Iceland’s Vatnajökull glacier – which served as the backdrop for views out windows of the (studio-built) observatory and also provided naturalistic lighting for the scene itself – the crew captured the same footage at dawn, day-time, dusk and night-time, as well as during various weather conditions (Zemler 2021). Building on this comparison, I will now compare the formal properties of virtual production and rear projection filmmaking in more depth.

Lighting, Cinematography, Colour, Scale

Both contemporary virtual production recommendations and historic rear projection recommendations highlight skilled lighting and technicians as crucial to their form of composite cinematography. Edouart explains the benefits of working with the camera person who has shot the remainder of the production, to “match the lighting of the projected scenes to that of the remainder of the production perfectly,” by altering “the contrast, density and general quality of the background plate to suit the scenes into which the composite shot is to be cut” (1932, 39).

Lighting practices are a frequent point of discussion in the virtual production guidance in well, as signalled in my discussion of *The Midnight Sky*, where the team captured the same footage at four different times of day to allow a range of lighting option for matching during the subsequent virtual production process. This recalls 1950s advice on background projection in *American Cinematographer*: “Some process specialists require three prints to be made at different printer-lights thus providing a range of plates from which the best is selected for projection. [...] Thus a last-minute adjustment can be made on the set to balance the background density with the foreground lighting.” (Anderson 1952, 359).

The careful lighting of background plates is also signalled out in *My Cousin Rachel* (1952) by the aptly named Herb Lightman (1953) who notes how 20th Century Fox cinematographer Joseph LaShelle expertly “demonstrates the technique of matching the lighting of indoor ‘exterior’ sets with that background plate (of sea and surf) used to backdrop the scene”. For the period film, where a second-unit crew had shot some shots on the rugged Cornwall coast, LaShelle also recreated the strong wind in that footage in the studio using wind machines, leading to what Lightman calls “a perfect match between the real thing and the studio product” (1953, 59).

Entertainment Technologists Inc warn those beginning to experiment with virtual production, “Don’t be tempted to cut the lighting budget”, explaining that “Even though LED volumes can provide plenty of fill light and natural reflections, you’ll still want on set lighting to add extra

and targeted illumination” (2023, 32). Unlike with rear projection, dimness of the projected background shots is not an issue with LED walls through which lighting changes are achieved quickly and easily with a few taps on a smart tablet. There remain other lighting challenges, however: the light can cast its colour on practice set objects and performers, leading to unwanted colour changes, while the screen’s surface also reflects other practical lights being used in the studio.

Another shared dimension of virtual production and rear projection is the crucial role played by camera angles and framing to create an effective sense of on-screen perspective. This is the focus of a 1962 *American Cinematographer* article on the photography of background plates, which includes advice and various illustrative images to show how elements of the real studio set are designed in tandem with the shooting of the background plates to create a conventional vanishing point. As Frederick Foster (1962, 116) explains: “Of great importance in filming plates with a mobile camera is that the camera be at the correct heights. ...The plate camera should be tilted *slightly* downward –just a trifle below horizontal. The vanishing point of a straight-on shot would be just above dead center of the screen.”

In the virtual production discourse, attention to cinematographic factors such as focus, perspective and mise-en-scene influences the kinds of shots that are recommended for achieving in virtual production, as well as the precise kind of rendering (2D, 2.5D, 3D) to be created for the LED wall. Entertainment Technologists Inc. (2023) recommends shots that involve “travel in cars, boats, planes, trains” as well as shots of indoor spaces where the (virtual) environment is visible through windows and doors, as suited for virtual production. This recalls trends in classical Hollywood shots/set-ups for which rear projection tended to be used. Ariel Rogers (2016) examines this in relation to films such as *King Kong* (1933), *Gone with the Wind* (1939) and *Notorious* (Hitchcock, 1946), which all experimented with stacked image planes by combine rear projection backgrounds (or related techniques, such as stacked glass-mounted matter paintings) with layered image planes on set, such as those of window frames (Rogers 2016, 75-7).

Related issues of creating coherent depth and focus when combining images planes recur in the contemporary discourse. The Demystifying Virtual Production white paper notes that “3D volume using LED walls is typically out of focus to the camera because the narrow depth of field is focused on the key characters – and a skilled VAD can take advantage of that, much like any other movie magic ‘sleight of hand’” (Entertainment Technologists Inc. 2023, 14). Again, awareness of rear projection practices amongst classical Hollywood filmmakers can offer insight, with Hitchcock and producer David O. Selznick “sometimes attempted to bridge the gap between the foreground and background planes by positioning objects in the middle ground” (Rogers 2016, 77).

For anyone versed in the fraught and complex histories of film colour technologies, it is perhaps unsurprising to learn that colour presented a major challenge for rear projection spaces. Turnock (2016, 92-95) classifies colour rear projection techniques it as the primary crisis for special effects in post-war Hollywood – and colour remains a challenge for contemporary virtual production. In an extension of the lighting issues that LED generations can present, current LEDs cannot display a full colour spectrum (Giardina 2022; Entertainment Technologists Inc. 2023, 33). Reflecting on *The Mandalorian* season 1’s issues with on set colour matching, Rob Bredow of Industrial Light & Magic explains how the LED wall lightened the colour of the real sand on the ground: “Because we have orange lighting orange, it doubles up the colour, so now we have to adjust until we get exactly that seamless transition we were looking for.” (Variety 2021, 9). Director-producer Jay Holben similarly explains the need for time to be spent adjusting the colour balance to blend the on-set and virtual elements of a given shot, correcting a common misperception with virtual production that people “can just turn on the camera and shoot” (Giardina 2022).

Optionality of scale for virtual backdrops or sets was an important issue for rear projection techniques and it remains an important factor in contemporary virtual production. One of Edouart’s major advances in 1939 was the improvement of the triple-headed background projector which allowed for three separate background positives to be superimposed on a single screen “to form a single registered image of greater size and brightness than would

otherwise be possible” (Edouart 1939, 171). As Rogers puts it, this development “enabled the use of larger rear-projection screens” which both facilitated and required an increased depth of focus for the composite camera, since larger rear projection screens “meant a concomitant ability to increase the distance between actor and screen” (Rogers 2016, 75).

In the contemporary landscape, virtual production stages come in a wide range of shapes and sizes, ranging from a small roll in monitors for use as an exterior of an interior shot, to immersive curved LED walls with ceiling panels. And yet, as the *Demystifying Virtual Production* authors explains, bigger is not always better. Huge LED walls “may not match the intimacy of the scene, or the production may benefit from more efficient use of multiple smaller stages” (Entertainment Technologists Inc. 2023, 32). Overall, then, while virtual production sets can benefit from a broad range of size options, issues of scale had already largely been overcome by the end of classical Hollywood’s rear projection period.

Global Challenges Encourage Technological Adoption

Virtual production and earlier compositing technologies share a trajectory in terms of their expanded use being tied to major global events that made traditional production challenging. While the COVID-19 pandemic created a sudden demand for virtual production, in the late 1930s it was World War 2 (1939-1945) that created more demand for rear projection processes. This was the case with Alfred Hitchcock’s *Rebecca* (1940), with *International Photographer* (1939, 12) detailing the unusual location trip made by a crew to Monterey, California for background plates and atmosphere shots which could “match shots made in Europe on a location trip that had been stopped before completion by the outbreak of hostilities”. They include photos of both the shots taken, and the dangerous setups needed to get the correct angles to match those from Europe, given “the unique camera setups that were necessary to accomplish the desired matching with material already in hand” (1939, 12). Features such as this, while not downplaying the technical challenges, demonstrated how the existent use of rear projection background plates could be combined with careful planning to allow for film productions to be finished—even when international travel for desired location shoots could not be completed due to sudden and disruptive global events.

As during the height of the COVID-19 pandemic, the ability for these newer compositing practices to allow for production to be continued or completed despite significant global disruptions was no doubt a welcome development on earlier disruptions to the U.S. film industry, including those related to the earlier pandemic of the Spanish influenza in 1918-1919. In October 1918, the National Association of the Motion Picture Industry decided to “abandon production as far as possible” (Koszardski 2005, 469) and in 1919, *Photoplay* reported that film production in California had been cut by 60 percent due to the ongoing pandemic, while work in the eastern U.S. studios had “ceased completely” (1919, 76; 97). When the next global pandemic hit approximately a hundred years later, digital technologies – including virtual production, as well as more basic operations such as cloud data storage and video-conferencing– allowed for much film and television production to continue in modified form. In 2020, virtual production had been in use for a small number of films and shows for some years. But within months of COVID-19, dominant industries magazines were reporting on the increased embrace of virtual production, with ongoing coverage of its benefits to the pandemic period:

“Enderby Entertainment defies pandemic to start virtual production on global thriller ‘92’” (Kay 2020)

“Studios Ramp Up Virtual Production Efforts Amid Pandemic-Era Filming” (Giardina 2020)

“Training: how virtual production will become essential beyond the pandemic” (Baughan 2021)

“Why Virtual Production Benefits Filmmaking in a Pandemic” (Eriksen 2021)

“Productions Embrace LED Walls as Necessary in Pandemic Times” (Brodsky 2021)

By May 2021, *Variety* had published a twenty-page special report on virtual production. In the subsequent years, reports continued to provide evidence that there was a significant embrace of virtual production practices during the years of the pandemic, in the U.S. and more globally. By autumn 2022, Epic Games – maker of the Unreal Engine – were renting out approximately

300 stages for virtual production, an explosive expansion from the three stages that were in use pre-pandemic in 2019 (Giardina 2022).

Focusing entirely on high-tech virtual production practices can overlook some less obvious longer-term impacts of the COVID-19 on the industry, particularly when it comes to audience responses to new media conventions. Throughout the pandemic, videoconferencing backgrounds became a part of daily life, work and education for a significant portion of the Western world in work and educational contexts. Moreover, the backgrounds used often drawn from existing film and television storyworlds (O'Meara and Szita 2023, 6). Thus, as the professional media industry increasingly moved towards virtual production using high-tech LED walls, everyday users were becoming more accustomed to the logistics and aesthetics of more low-fi virtual "sets", as experienced via personal devices.

While many users simply uploaded basic background images or short videos from familiar media works to replace their "real" environment that would otherwise be captured on camera, the official websites of *Star Wars* and the Pixar animation studios, among others, provided curated high-definition images to download for this very purpose. Discourse on these basic virtual backgrounds suggests that many users embraced the fakery of this composite technology instead of aiming for "realistic" representations (O'Meara and Szita 2023, 9). Such uses implicitly acknowledge the unreal, constructed nature of film sets and demonstrate a tolerance for perceptible inconsistencies between the real-time recording of the person in the foreground and the pre-recorded environment in the background.

Personnel and Training

Aside from issues with accurately capturing colour for both rear projection and now virtual production, other challenges to the successful adoption of both innovations relate more to personnel and training. This includes resistances to change on various grounds: general distrust or anxiety around new technologies; their perceived threat to the existing film personnel and, relatedly, mismatches between available skills and training opportunities and those required to successfully utilise the new technologies.

This anxiety is perceptible in archival materials, where the likes of Farciot Edouart began his 1932 *American Cinematographer* article by directly addressing the “good deal of misinformation abroad concerning the nature, the effects and the purpose of projected background or transparency cinematography” (Edouart, 15). He explains that “the purpose of this article to attempt to correct some of these misconceptions” – including ones related to film personnel, such as art directors, set-dressers, and electricians. Similar concerns are addressed in the Demystifying Virtual Production paper, which cautions that the labour of set dressing will remain important and that “A VAD [virtual art department] isn’t a panacea – like any tool, it’s only as good as the team that wields it” (Entertainment Technologists Inc. 2023, 32; 14).

In classical Hollywood, articles by Edouart (e.g. 1932; 1939; 1943; 1983) and other effects pioneers offered a rare opportunity for the industry to gain R&D insights from a major studio like Paramount. In the absence of the film schools that developed decades later, and with studios typically secretive about their proprietary technical innovations and equipment, then articles like this were an important opportunity for the masses to learn about this, and other forms, of movie magic, with a view to applying them.

Virtual production emerged into a very different training and techno-cultural landscape, and one that can thus assist with the mainstreaming of these processes. For one thing, film and media courses are now well-established in the global education sector. Though the funding landscape, and thus access to state-of-the-art production equipment varies considerably across institutions, various educational organisations have already expanded their curricula to include virtual production training. In 2021, the UK’s National Film and Television School launched a part-time certificate in virtual production skills in partnership with WarnerMedia. University of Portsmouth introduced an undergraduate degree in Virtual Production in 2024 as part of their Centre for Creative and Immersive Extended Reality. In Australia, in 2022 Flinders University launched a Virtual Production Master’s degree, developed to include strong industry connections with international partners. Other industry-offered training options are conducted remotely, including Epic Games’ “Unreal Fellowship,” launched during the pandemic, and with the aim of helping “film, VFX, and animation professionals understand the state of the art in virtual production” (Milligan 2020). Unreal Engine also has an “academic partner” programme,

which can be awarded as endorsement of specific educational programmes that use Unreal Engine during teaching.

In terms of the logistical challenge of personnel and aspiring filmmakers being able to adapt to virtual production, there are thus hopeful signs that a sub-sector of the film and media education sector is already updating their curricula. Furthermore, unlike the often-proprietary rear projection technologies developed within Hollywood studios such as Paramount, the dominant virtual production player – Unreal Engine – offers its software freely, with modest royalties that are charged on successful commercial outputs (Machkovech 2020). For Daniel Gregoire, owner of Halon Entertainment which deploys Unreal Engine as part of their pre-vis work, Epic Games' freely available software is evidence that the company has "more than a passive interest in the Hollywood community," and instead aims to be "an active positive force towards important storytelling and change" (Milligan 2020).

Planning and Pre-visualization

An emphasis on detailed pre-production planning is another key parallel between emerging discourse on virtual production and reasons why filmmakers including Hitchcock and Kubrick made selective use of rear projection and other compositing technologies. Consider, for example, the rear projection planning process that Joseph L. Mankiewicz and cinematographer Milton Krasner deployed to set *All About Eve* (Mankiewicz 1950) in New York but shoot mostly in San Francisco. As Leigh Allen (1951) writes, collaborative pre-production planning was crucial to their successful use of background plates from New York: "once shooting preparations began, Krasner and Mankiewicz plotted the photography of "Eve" in a number of huddles that saw them make location scouting trips to San Francisco and later New York..." in order to find a New York theatre whose lobby closely resembled the Curran in San Francisco, where most of the shooting was planned to take place (Allen 1951, 10-11).

In the advice on virtual production, there are recurring mentions of both the significance of pre-visualisation processes and planning, and the increased control it can afford to filmmakers. In the Demystifying Virtual Production paper, the authors explain how it "requires careful

planning in pre-production to take advantage of the technology, and not all creatives will want, or be able, to make the transition to this much more careful planning” (Entertainment Technologists Inc. 2023, 33). Because the default reference point in this guidance is the contemporary production landscape, the workflow/scheduling discussion is framed as a radical departure from recent workflow practices that grant substantial time and energy to post-production. Yet, in certain ways, pre-vis is just an update on the kind of detailed advance planning, including storyboarding processes, for which the likes of Hitchcock and Kubrick are well-known. Hitchcock was one of the first studio directors to rely heavily on storyboards in the production of his films (see: Pallant and Price 2015). He mapped out his distinctive set pieces, using drawings that showed exactly what would be in the frame and often create them on set, shot for shot (Bailey 2012). Kubrick was similar – hiring talented artists including Saul Bass to do the storyboards for *Spartacus* (1960) and continuing to use them till his final film, *Eyes Wide Shut*. In subsequent decades, filmmakers associated with sharp camerawork, such as Martin Scorsese and Christopher Nolan, have also tended to storyboard during pre-production planning (Bailey 2012).

Kubrick and Hitchcock were both technological and stylistic pioneers in their use of special effects. Their use of compositing techniques aligns with this broader experimentation and also fits with popular perceptions of both filmmakers as very exacting when it came to executing their cinematic vision. (For the fearful-of-flying Kubrick, compositing technologies also offered a convenient alternative to international location shoots.) Extensive pre-planning through storyboarding and other methods helped to grant them increased control. Similarly, increased control for filmmakers is often mentioned as a benefit of virtual production, with Entertainment Technologists Inc going so far as to describe virtual production as offering “god-like powers” (2023, 27).

While I do not have the space here to fully Hitchcock and Kubrick’s use of process photography methods, both filmmakers found consistent use for such effects in their work. With *2001: A Space Odyssey* (1968), Kubrick built on his previous experiences of rear projection in *Lolita* (1962) and *Dr Strangelove* (1964) to develop an ambitious front projection process for the

‘Dawn of Man’ African desert sequence (see: Benson 2019, 268). As Joe R. Frinzi (2018, 76) outlines, after deciding that the more standard options – a painted backdrop, rear projection, or a blue screen to later be replaced by a photographic plate – would look overly artificial, Kubrick worked with Tom Howard, head of MGM’s effects department, to develop “a revolutionary front projection system and use it on a scale never before attempted” and which could create a more realistic-looking effect. In this case, throwing an image onto the screen from in front (rather than behind) involved building an extra-large 8 X 10” projector; a 40 X 110-foot front projection screen; heat resistant glass slides with photography taken in Namibia by the camera crew; and a large studio-built set pieces based on this photography (Frinzi 2018, 76-78).

The parallels current discourse regarding virtual production and Kubrick’s approach, and the benefits to it, seem clear. Based on Frinzi’s detailed report of the successful process, which included Kubrick’s novel lighting solutions – such as covering the ceiling of the soundstage with 1500 small and individually controlled lights that allowed the cinematographer to more precisely shape the light falling on the rocky landscapes – it is easy to imagine that Kubrick would also be a major advocate for virtual production. With the *Space Odyssey* sequence, Kubrick wanted “to shoot in the controlled environment of a studio,” avoiding both air travel and subjecting the cast and crew to the “uncomfortable climatic conditions” that a desert shoot would entail (Frinzi, 76). Virtual production technologies now allow for this kind of controlled shooting environment, and they are available to more than just the most technologically pioneering filmmakers, like Kubrick—though his comprehensive approach to planning remains important.

Conclusion: Unreal Media

As this chapter aimed to show, the challenges and opportunities offered by virtual production technologies are less radical when positioned within the much longer history of screen compositing technologies and pre-recorded sets. This is partly owing to similarities in terms of

the various analogue and digital technologies that filmmakers have used to create the illusion of coherence, even when pre-recorded background content is combined with real-time recording of the action on set.

But these parallels also depend on broader conceptions of cinematic realism, and of audiences' perception. Writing on what they term "reality media", Bolter, Enberg and MacIntyre (2021) assert that since the origins of cinema reality has been redefined by media representations of the real world, which provide viewers with new perspectives on the real (xxiv). Crucial to my comparison of rear projection and virtual production is Bolter *et al's* articulation of this as a cumulative, comparative process: "Each reality medium mediates and remediates. It offers a new representation of the world that we implicitly compare to our experience of the world in itself, but also through other media" (2021, xxiv). Applied to virtual production, I would argue that this kind of comparative approach to viewing reality media means that audiences and filmmakers are likely designing and consuming outputs that use virtual production through this historical lens, if only subliminally. Most contemporary audiences have already experienced rear (and/or front) projection through Hitchcock or Kubrick films, for example, as well as largely accepting the outputs from postproduction bluescreens and greenscreens in a wide range of blockbuster movies. So, although there remain "inherent risks and challenges" with virtual production (Entertainment Technologists Inc. 2023, 33), we should remember that -- like the aptly titled Unreal Engine, which fuels much virtual production -- the screen industries have extensive experience of using unreal methods and technologies to establish accepted conventions of realism.

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