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ZHANG TIANYI

SCHOOL OF ART, DESIGN & MEDIA

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FROM DIGITAL VISUAL EFFECTS TO EMERGING IN-CAMERA
VISUAL EFFECTS: INVESTIGATING THE CHANGE OF
WORKFLOW, OCCUPATIONAL ROLES AND COMMON
CHALLENGES IN SOUTHEAST ASIAN AND EAST ASIAN
COUNTRIES

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School of Art, Design and Media

A Thesis submitted to the Nanyang Technological University in partial
fulfilment of the requirement for the degree of
Master of Arts (Research)

Statement of Originality

I hereby certify that the work embodied in this thesis is the result of original research, is free of plagiarised materials, and has not been submitted for a higher degree to any other University or Institution.

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Supervisor Declaration Statement

I have reviewed the content and presentation style of this thesis and declare it is free of plagiarism and of sufficient grammatical clarity to be examined.

To the best of my knowledge, the research and writing are those of the candidate except as acknowledged in the Author Attribution Statement. I confirm that the investigations were conducted in accord with the ethics policies and integrity standards of Nanyang Technological University and that the research data are presented honestly and without prejudice.

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Abstract

In-camera Visual Effects (ICVFX) occupy an intermediate position between film and game production. It is an emerging filmmaking technique that combines traditional cinematography and motion tracking technologies with a real-time game engine and computer-generated imagery (CGI). This allows actors to perform against a real-time generated background displayed by an LED wall, enabling the film production crew to view the scene and deliver a close-to-final product on set. ICVFX has been widely embraced not only by Hollywood but also by the East Asian (EA) and Southeast Asian (SEA) production industries. This research aims to investigate the impact of ICVFX on workflow, occupational roles, and shared challenges occurring in EA and SEA-based production companies.

Compared to green screen VFX production, the ICVFX workflow offers an iterative and interactive process supported by real-time technology. It seamlessly integrates filmmaking, game development, and LED wall-related methodologies. The workflow begins with film pre-production methods and progresses through two phases of game engine-oriented creation, followed by two LED wall-related review and rehearsal phases before principal photography. As a result, the demand for match-move and roto departments, prevalent in green screen VFX production, is significantly reduced. Additionally, instead of replacing the green screen, ICVFX is considered a distinct method with its own workflow features. With its advantages, limitations, and applications, ICVFX production serves as an alternative tool instead of fully replacing the green screen.

Concomitantly, ICVFX transforms the departmental landscape by introducing new departments and roles responsible for the entire production. These include the Virtual Production (VP) supervisor, the virtual art department (VAD), and the "Brain Bar." This study investigates occupational changes by examining four key roles from each production technique. To adapt to ICVFX, the VFX supervisor must work closely with the VP crew led by the VP supervisor; the environment artist transforms into the VAD artist; the VFX compositor and technical director become part of the "Brain Bar." This transformation creates a demand for technical artists (TA) and requires the artists to be versatile and able to work "live" with on-set communication styles.

With an understanding of the new workflow and occupational roles, this study pays equal attention to the ICVFX industry in EA and SEA countries. Five main challenges are observed and analysed from sampled interviews, highlighting a different industry landscape compared to Hollywood. Furthermore, industry and academic-related suggestions and recommendations are provided to address these challenges.

Keywords: Virtual Production, ICVFX, East Asian Studies, Southeast Asian Studies

Abbreviations

CG	Computer Graphic
CGI	Computer-Generated Imagery.
Comp	Compositing. It is a technique of combining visual elements from separate sources into a single image
DCC Tool / DCC software	Digital Content Creation tools like Maya, 3D Max, Nuke and, Blender
DoP	Director of Photography
EA	East Asia
GPU	Graphics Processing Unit
Mocap	Motion Capture
Plate	Referring to a pre-recorded live-action element intended to be used as a compositing element
Previs	Pre-visualisation
SEA	Southeast Asia
VAD	Virtual Art Department
VFX	Visual Effects
ICVFX	In-camera Visual Effects
VR	Virtual Reality

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Chapter 1: Introduction & Background

1.1 Background of the Study: From Visual Effects to ICVFX

In-camera Visual Effects (ICVFX) occupy an intermediate position between film and game production. Its goal is to capture cinematic quality with photorealistic computer-generated imagery (CGI) on-set, using real-time technology provided by a game engine. This revolutionary approach has transformed the traditional visual effects (VFX) industry (Global Media Company Group, 2023).

The usage of special and visual effects in the film industry has not only provided audiences with the wonders and excitement of a world that seamlessly surpasses the boundaries of space and time (McClellan, 2007; Prince, 2012), but it also unleashed the creative imaginations of filmmakers, taking viewers on fantastical journeys throughout the history of cinema (Kracauer, 2004), beginning with George Méliès's groundbreaking film, *A Trip to the Moon* (1902).

Michael Fink (2021), a founding member of the Visual Effects Society and a professor of VFX at the University of Southern California's School of Cinematic Arts, outlined three scenarios that justify the use of VFX in a film: 1) when it is not feasible to shoot the scenes practically as written in the script, 2) to avoid endangering someone's life, and 3) when it is more efficient or practical in terms of cost, scene scale, and location availability. In his book, *The Filmmaker's Guide to Visual Effects: The Art and Techniques of VFX for Directors, Producers, Editors, and Cinematographers*, Eran Dinur (2017) highlights six practices for creating VFX shots: 1) fixing-it shots, 2) rig removal and period cleanup, 3) crowd simulation, 4) action elements, 5) screen inserts, and 6) set extensions. Among these practices, this research focuses specifically on set extensions, which involve compositing a live-action foreground with a synthetic background.

In the realm of live-action movie production, a set is constructed to serve as an environment for actors to perform. However, constructing an entire practical set is often impractical and can drain the budget. As a result, filmmakers often choose a cost-effective solution by building only the necessary portions of a set. Through effective project management and shot planning, set extension shots not only reduce the unnecessary time and cost associated with constructing a complete practical set but also overcome location-based challenges related to modification and destruction. The remaining environment is generated using set extension techniques. These techniques have evolved throughout the history of filmmaking, aligning with technological advancements. They have progressed from early cinema's glass matte painting to the rear projection techniques of the 1930s, ultimately leading to the widespread use of green/blue screens in today's industry.

Since 2000, the digitalisation of the VFX industry has led to a significant increase in the number of VFX shots integrated into feature films. This escalation can be observed by comparing the VFX shot count across different films. For example, *Jurassic Park* (1993) featured approximately 60 VFX shots, while *Titanic* (1997) made a substantial leap with over 510 VFX shots. This trend continued with subsequent movies like *Spider-Man 3* (2007) and *Harry Potter and the Order of the Phoenix* (2007), surpassing 900 shots each. This marked a staggering rise of nearly 1500% over a decade. More recently, the sci-fi movie *Star Wars: Episode VIII - The Last Jedi* (2017) boasted a production involving approximately 2,000 VFX shots, and the superhero movie *Spider-Man: No Way Home* (2022) raised the bar further with an estimated 2,500 VFX shots (UpcomingVFXMovies, 2022).

In 2021, the demand for VFX artists has reached unprecedented heights, with approximately 6000 VFX experts and animation specialists engaged in Montreal, Canada, a global hub for VFX and animation (QFTC, 2021). This surging demand has been spurred by streaming service platforms such as Netflix, HBO Max, Disney+ and Apple TV, which required increased VFX capabilities to produce high-end episodic content. As the workload reaches new peaks, the industry confronts the pressing challenge of delivering heightened efficiency within the constraints of limited budgets. The conventional green screen VFX production pipeline, which has been entrenched for decades, is now being questioned for its relevance, prompting the exploration of alternative workflows to address the evolving demands and expectations of contemporary film production (McGowan, 2022).

Conventionally, the green/blue screen technique involves placing a green/blue screen behind actors during the filming phase, which is later replaced by a digitally rendered environment during post-production to achieve an extended setting. An alternative approach, known as rear projection, involves projecting pre-recorded background footage onto a screen positioned behind actors during filming. However, both of these methodologies impose creative and visual limitations. Challenges include actors and film crew experiencing disorientation when working against a green screen backdrop (Bode, 2017; Dreamspace, 2014), the occurrence of undesirable green spills on reflective objects and a lack of visual parallax between actors and the background (Prince, 2012).

In contrast, ICVFX has emerged as a new filmmaking technique that combines traditional cinematography with a real-time game engine and CGI to enable the film production crew to generate cinematic output on set in real-time (Kadner, 2019). It presents filmmakers and actors with an LED wall-surrounded real-time generated virtual background, allowing them the ability to visualise and interact with the extended set with correct parallax during the shooting process. Furthermore, the integration of a massive LED wall environment can create an immersive setting with realistic content, reflections, colours, lighting and parallax, all generated by the game engine. This dynamic environment facilitates interactive engagement for the entire

film crew and actors, leading to a paradigm shift from conventional green/blue screen production workflows and effectively overcoming the associated uncertainties.

ICVFX shifts the traditional “fix-it-in-the-Post” mentality to a “fix-it-in-the-Pre” approach and embraces a “what you see is what you get” philosophy (Disguise, 2021b; Kadner, 2019), significantly changing the division of labour and the production process.

1.2 Technological Innovation and Production Process

Throughout the history of film production, technological advancements have influenced the tools used, production workflows, and the division of labour, eventually impacting the power dynamics. Examples of these observations can be found in the introduction of sound in silent films, digital editing and VFX creation.

Bordwell et al.’s seminal work (1985) depicted how the incorporation of sound in films necessitated the establishment of the subdivision department to accommodate sound synchronisation, leading to a profound shift in the film production landscape. They pointed out that “when Hollywood added a soundtrack to the silent picture, it added a labour process and divided the workers into a parallel hierarchy.” (p.478). In Walter Murch’s book *In the Blink of an Eye* (1992), he highlighted how technology transformed the division of editing. Additionally, technology has also changed the division of labour in the VFX realm. Michele Pierson, a prominent scholar in the field of VFX, argues that the impact of digital technologies on filmmaking extends beyond technical operations. It engenders a profound transformation in the cognitive and practical involvement of individuals engaged in the filmmaking process. Pierson emphasises the need for a careful examination of digitality alongside distinct filmmaking practices, characterised by unique methods of organisation, training, and credentialing of personnel responsible for executing specific tasks (Pierson, 2002). These observations serve as a testament to technology’s significant role in reshaping the structure of filmmaking and production culture.

The game engine-based ICVFX production triggers a new workflow and introduces new departments, eventually creating a significant paradigm shift. While Kadner (2019) and Bennett et al. (2021) provided relevant workflow diagrams, they omitted crucial details concerning the placement of the “Brain Bar” – a critical technical department in the ICVFX workflow. Therefore, this study considers *The Mandalorian*’s departmental structure as a reference to investigate how the VP supervisor, the virtual art department (VAD) and the “Brain Bar” contribute to a new mode of production.

1.3 East Asian (EA) and Southeast Asian (SEA) Perspective: China, Singapore, South Korea, Japan and Thailand

The VP industry is not only rapidly evolving in Hollywood but also experiencing significant growth in East Asian (EA) and Southeast Asian (SEA) countries. In fact, these regions are projected to have a higher growth rate than North America over the next four years (Grand View Research, 2021; KBV Research, 2021). EA and SEA countries are emerging as leading adopters of VP technologies not limited to the film production field. China, Singapore, Japan, South Korea and Thailand are among the key countries driving the demand for VP solutions, indicating notable development in these regions that should not be underestimated. However, little research has been conducted from these perspectives (Letcher, 2021; Nila, et al., 2023). This thesis aims to address this gap in the literature by offering insights from an EA and SEA perspective.

1.4 Research Gaps

This study faces a range of challenges, from the fundamental understanding of VP and ICVFX to investigating the ICVFX industry in EA and SEA countries. To address the following research gaps, this study proposes research questions to address those problems.

1. Lack of a clear ICVFX-specific workflow and occupational role description:

As highlighted by Renee Dunlop (2014), there are distinct differences in production workflows between the film and game industries. With ICVFX merging elements from both film production and game development, it raises a question of what type of workflow it entails. Previously proposed VP workflows (Bennett et al., 2021; Kadner, 2019; Weaver et al, 2021) offer a good overview, but they lack detail of describing all required phases prior to principle photography, such as specific pre-production steps involving the LED wall.

Additionally, previous studies (Bennett, et al., 2021; Kadner, 2019; Weaver, et al., 2021) are not comprehensive in studying the new roles (such as the VP supervisor, the VAD and the “Brain Bar”). Thus, this study suggests a more integrative analysis of these new roles.

2. Lack of first systematic comparison of workflows and occupational changes between green screen VFX production and ICVFX production:

A systematic comparison is required to understand the impact, yet there is a lack of comparison between green screen VFX production and ICVFX production from a workflow and occupational perspective. This research bridges the gap by identifying the differences in workflows and examining the responsibilities of selected occupation roles between green screen VFX production and ICVFX Production.

3. Present common challenges in the EA and SEA ICVFX industry:

The ICVFX industry is also rapidly evolving in both EA and SEA countries, yet most of the ICVFX-related literature focuses on Hollywood. There is a gap in examining the ICVFX industry from the EA and SEA perspectives. With distinct cultures compared to Hollywood, what kinds of challenges can be observed and what suggestions can be proposed to address those challenges?

1.5 Research Questions

This research aims to address the following key questions:

- 1) How does the new ICVFX paradigm reshape the VFX set-extension workflow?
- 2) How do occupational roles transition from VFX set-extension productions to the new ICVFX paradigm?
- 3) What are the common challenges encountered by the ICVFX industry in EA and SEA-based production companies?
- 4) What suggestions can be proposed to address these common challenges?

1.6 Methodology

This study is primarily qualitative and uses a mixed methodology comprising an intensive literature review, semi-structured interview and comparative analysis.

In-depth semi-structured interviews were conducted with 10 ICVFX professionals across EA and SEA countries from April 2023 to January 2024:

Table 1

Interviewed Professionals List

Name	Job title	Company Name	Country
Interviewed as corporate:			
1)Choong Chyi Kei	CEO	Aux Media Group	Singapore
2)Nicholas Tan	Head of Production	Aux Media Group	Singapore
3)Chris Yan	VP Technical Lead	Aux Media Group	Singapore
4)Higashida Takanori	VFX Producer	Hibino VFX Studio	Japan
5)Harumi Miura	VFX Technical Director	Hibino VFX Studio	Japan
6)Narita Yuki	VFX Technical Director	Hibino VFX Studio	Japan

7)Watanabe Shinnosuke	VFX Manager	Hibino VFX Studio	Japan
Interviewed as an individual:			
8)Sirasit Sawetprom	VP Supervisor and Founder	RealBangkok Digital Media	Thailand
9)Piao Teckwon	VP Supervisor	(Hidden as requested)	South Korea
10)Evelyn Wu	(Hidden as requested)	(Hidden as requested)	Shenzhen, China

The above interviewees were chosen based on their affiliation with local VP companies that have been at the forefront of embracing LED volume, or due to their significant positions as head of VP departments. Each semi-structured interview lasted between 30 minutes to 1.5 hours, with most being one-to-one meetings, except for one group interview conducted with Hibino VFX Studio.

During the in-depth interviews, participants not only shared their firsthand insights into their work but also expressed their concerns and discussed the challenges they face. Their responses were documented, analysed in context, and included in Appendix A.

The insights provided by the interview participants are categorised into two main areas, corresponding to the proposed research questions: 1) ICVFX workflow and occupational roles-related information. This information aligns with existing Hollywood-centric literature and is integrated into relevant chapters and sections. 2) Concerns and challenges, which emerged as unexpected findings, are listed in a separate chapter (Chapter 5) inspired by Michael Porter's *Five Forces Model* (1979). This model offers an overview perspective and analyses the ICVFX industry in terms of Competitive Rivalry, Supplier Power, Buyer Power, Threat of Substitution, and Threat of New Entry.

Other information was extracted and analysed from recent industry sources such as SIGGRAPH and Real-Time Conference presentations, industry reports, podcasts interviews, and historical literature. These supplementary resources aided in identifying and comprehending how real-time technology has brought shifts in the division of workload.

To answer the first and second research questions, a comparative analysis of workflows and selected roles between green screen VFX production and ICVFX production was conducted based on personal interviews and an intensive literature review.

To address the third question, the concerns and challenges gathered from personal interviews are listed in Chapter 5.

1.7 Thesis Structure

This thesis consists of seven chapters that follow a structured sequence, exploring the concept of ICVFX, workflow, occupational changes, and common challenges from EA and SEA-based production companies along with corresponding suggestions.

Chapter 1 provides an introduction, offering a background overview of ICVFX and identifying the research gaps.

Chapter 2 focuses on the literature review, presenting a chronological exploration of the VP concept, set extension techniques and the evolution of ICVFX alongside technological advancements throughout film history. A theoretical framework is introduced in this chapter, deconstructing the concept of set extension through three fundamental elements.

Chapter 3 compares the working phases of typical green screen VFX production and ICVFX production, revealing an ICVFX workflow and discussing the advantages and disadvantages of each approach.

Chapter 4 examines the transformation of selected occupational roles and responsibilities from typical green screen VFX production to ICVFX production, exploring how these roles change in response to the implementation of ICVFX.

With an understanding of ICVFX workflows and occupational roles, Chapter 5 focuses on ICVFX industry in EA and SEA countries, investigating the common challenges faced from the perspective of production companies based in these regions.

Chapter 6 synthesises the findings, address the research questions and uncovers new communication modalities and suggestions necessitated by the transition to ICVFX, offering valuable insights.

The concluding chapter, Chapter 7 presents future-oriented perspectives, including themes such as education and the implications of artificial intelligence (AI).

Appendix A contains the complete recorded interview transcript, while Appendix B provides a list of ICVFX-related terminologies and concepts.

Chapter 2: Literature Review

To date, with technological advancements, the term ICVFX is rapidly growing and can be understood as an on-set real-time set extension technique. To comprehend ICVFX, it is essential to retrace and understand the prerequisite concepts: Virtual Production (VP) and set extension.

2.1 Virtual Production: From 2010s to 2020s

2.1.1 Virtual Production in 2010s – The Rise of Virtual Production

Around the 2010s, the VFX industry manifested that VFX technologies are capable of blurring three distinct film production phases:

Visual effects technologies blur the line between pre-production, production and post, almost the exact opposite as it was in the 1930s. This new reality leads to a far more active and collaborative role for VFX supervisors and artists across every phase of production, long before other collaborators have joined and long after they've moved on. (Dunlop et al, 2008, p. 5)

Looking back, Peter Jackson and Weta Digital developed and used VR goggles and a virtual camera in *The Lord of the Rings: The Fellowship of the Ring* (2001) (Weta Digital, 2024) and *King Kong* (2005). James Cameron combined performance capture, virtual camera, on-set pre-visualisation and rendering technology during the production phase of *Avatar* (2009) (Autodesk, 2011; Thacker, 2012). The traditional soundstage was transformed into an area for real-time motion capture known as the Volume. Within the Volume, actors wear in motion capture suits and facial capture head cameras to bring their virtual characters to life. Furthermore, the physical camera became a motion-captured camera named Simulcam. Simulcam is a realtime motion-tracked screen that represents the virtual camera in a 3D virtual space. The DoP can use this screen as a viewfinder to control the virtual camera, navigate the shot composition and intuitively view the final output of the 3D scene. This output is also shared with the director's monitor, allowing them to observe the live-action scene with superimposed CG characters and the virtual environment (Sawicki & Moody, 2020). This real-time technology not only allowed Cameron to focus on creative decision-making with the virtual characters and the CG set, but it also revolutionised the production into an interactive and nonlinear process (Newton, 2012). The film consists of 60% photorealistic CGI using VP and 40% of live action (Billington, 2008). The success of *Avatar* inspired other large-scale productions such as *The Adventures of Tintin* (2011) and *Ready Player One* (2018) to use a similar technical setup (Failes, 2018b; Robertson, 2012). With the well-known success of *Avatar*, the term VP captured the attention of both industry filmmakers and academic

scholars. In 2010, the VFX industry defined this term:

Virtual production is an interactive, iterative and integrative process that starts from pre-production and continues till the final frame is printed to film (or packaged electronically) for distribution (Patel, 2010, p. 4).

In 2014, Gray Roberts (2014) discussed the distinguishing feature of VP in Dunlop Renee's *Production Pipeline Fundamentals for Film and Games*:

Virtual Production is a live interactive process for everyone on set and in production. Shooting in the virtual world (or partially, when it comes to live-action integration) is generally done in real-time which allows creative storytellers, filmmakers, and the entire technical team behind the production to make quick iterative changes to the physical worlds on set to compose a shot or define a character's performance. (p. 287)

The frequently mentioned buzzwords among these definitions were real-time interactive, iterative and integrative process. However, how these features affect the practitioner's working paradigm was not articulated in detail. The study of VP-related production culture study was overshadowed as scholars focused on examining the emergence of Machinima (Fosk, 2011; Lowood, 2011; Nideffer, 2011); devising tools for virtual cinematography in 3D environments (Balakrishnan & Diefenbach, 2013; Götz, 2015; Lino, Christie, Lamarche, Guy, & Olivier, 2010; Lino, Christie, Ranon, & Bares, 2011; Nitsche & Kirschner, 2013), motion capture-related research (Bennett & Kruse, 2015; Carter, Opdenbosch, & Bennett, 2013) and transmedia debates (Brooker, 2009; Galloway, 2006; Kallay, 2013).

2.1.2 Virtual Production in 2020s – The Democratisation of Virtual Production

Building upon nearly a decade of continuous research and innovation, *The Mandalorian* Season 1 (2019) was a remarkable achievement. Following the phenomenal success of this TV drama and the promising trajectory it has set, the term VP has garnered considerable attention as a buzzword encapsulating the latest technological advancements: seamlessly integrating high-quality CGI, LED walls and real-time game engine technology with live actors. Subsequently, definitions have proliferated within the community, and VP-related definitions can be generally categorised into the following types:

Firstly, VP is where physical and digital worlds meet in real-time. In *The VES Handbook of Visual Effect* (Okun & Zwerman, 2021), Addison Bath deems VP as "the technique that uses technology to join the digital world with the physical world in real-time". Others have expounded VP as a technique where physical and digital converge through digitalisation and game-engine technology such as photorealistic environments, visualisation and immersive technology (Bennett, et al. 2021; Rank,

2021; Vicon, 2020; WetaFX, 2023). Two main keywords highlighted from such definitions are “physical and digital world” and “real-time”. The former term remains generic as it fails to critically identify the medium specification of VP from a practitioner’s perspective: *How* do these worlds intersect each other?

Undoubtedly, real-time technology is a critical element underlying VP. Various definitions of VP are used in the Hollywood film industry: 1) pre-vis/visualisation, 2) performance capture/motion capture, 3) real-time keying/hybrid production and 4) in-camera virtual production (Deloitte, 2020; Kadner, 2019). However, this is a problematic approach as it leads the term becoming vague, covering a wide range of production techniques that utilise real-time technology. It becomes challenging to differentiate between each specific technique. For instance, despite both pre-vis and real-time keying being driven by real-time technology, they should be considered as two different means. The former predominantly uses low-polygon 3D animations to create proxy shots aimed at serving as guiding references for on-set shooting (Keil & Whissel, 2016; Okun & Zwerman, 2021; Venkatasawmy, 2013), while the latter can be further expanded into on-set pre-vis and Virtual Studio. On-set pre-visualisation could allow the director to get the visual idea and focus on the composition of synthetic shots. Virtual Studio finds application in TV productions, particularly for news reports and weather forecasts, delivering information instead of cinematic languages (Gibbs, et al., 1998; Mark & Juniko, 2020; Rotthaler, 1996).

Secondly, VP encompasses the incorporation of background and camera tracking methods. The China Research Institute of Film and Science and Technology categorises VP into two types: 1) real-time keying as pre-vis and 2) LED wall-based VP (China Research Institute of Film Science & Technology, 2023). Japan PRONews defines it in four categories: 1) ICVFX LED, camera tracking, real-time rendering, 2) LED, preproduced background, 3) greenscreen, camera track, real-time rendering and, 4) greenscreen, match-move (PRONews, 2023b). These categories mainly emphasise the importance of the camera and set correlated with real-time technology.

Furthermore, LED stage-related manufacturers and relevant service providers define VP as a technique using the LED stage to maximise their marketing strategy (Disguise, 2021; ROE, 2021; Sony, 2022).

Alternatively, besides highlighting real-time technology and apparatus, the production type is also included. VFX journalist Ian Failes (2018) categorises three production types that can be leveraged using VP: 1) live-action films, 2) TV production and 3) pre-visualisation. While Kadner (2019) suggests VP can be used to produce 1) full CG animation and 2) live-action films. These reflect VP can be used in most, if not all, kinds of media production.

Academics and researchers have been investigating VP from various angles, but most of them focus on the advantages of VP (Dong, 2022; Priadko & Sirenko, 2021),

particularly LED wall VP (Pires, Silva, & Raposo, 2022). Among the frequently cited benefits are 1) an iterative process, 2) reduced on-set location shooting, 3) natural reflection provided by LED screens and 4) time and cost reduction. These benefits essentially align with the findings from a 10-year-old project, the EU project Dreamspace (2014), where the research team highlighted several key advantages associated with VP: 1) created elements are reused and refined throughout the entire process, 2) VP transcends the restrictions of physical space, elements, time, size and technology, 3) increased real-time production and decreased post-production enable creative personnel to make better decisions, 4) communication between team members become more precise, replacing assumptions with detail and facts, and 5) quality dimensions are linked to resources and performance.

With these repeating findings, it is necessary for us to adopt an alternative viewpoint towards VP, one that differs from that of producers perspective and marketing hype. The true state of production is a multifaceted and relatively unexplored. As a result, this thesis investigates VP from a practitioner's standpoint.

2.2 Integrative Theoretical Framework: Set, Actor and Camera

Clearly, VP is an emerging field of research with an increasing number of published articles and materials, causing VP to become an umbrella term and making further VP study challenging. News and reports (Blake, 2021; StudioBinder, 2023; Vox, 2020) have created the misconception that the entire production of *The Mandalorian* Season 1 was solely achieved through the LED wall approach, eliminating the need for the traditional VFX production. This portrayal has led to an illusion of the "End of Green Screen".

However, as stated by Rob Bredow, the Chief Creative Officer of ILM and Senior Vice President of Creative Innovation at Lucasfilm, ICVFX was used for only half of *The Mandalorian* Season 1 (Bredow, 2022; Image Engine, 2020; PIXOMONDO, 2020). Together with other blockbuster movies such as *Avatar* (2009), and *The Lion King* (2019), these three film and TV titles were all produced involving VP technology, but the current definitions cannot clearly distinguish and locate them on a VP spectrum. Each technique has its own history, workflow and impact. Failing to dissect and comprehend them will overshadow their characteristics and make future studies challenging. Rather than categorising all physical-to-realtime transformations under VP and making the term ambiguous as real-time technology advances, it is crucial to introduce an integrative conceptual framework to encompass and distinguish existing set extension techniques, eventually demystifying and reducing confusion.

As illustrated in the following Table 2, this framework outlines the existing shot practices based on three foundational components of filmmaking: Set, Actor and Camera.

The set can take various forms, including physical, post-produced, pre-produced backgrounds, real-time generated virtual backgrounds and game engine-generated virtual backgrounds. Actors can be categorised into physical, animated and motion-captured. The camera can be divided into four types: physical, virtual, simulcam and real-time camera tracking.

Table 2

An Integrative Conceptual Framework: Set Actor Camera

	Set	Actor	Camera	Achieve	Example
Live action	Physical	Physical	Physical	On set and in camera	<i>Oppenheimer</i> (2023)
VFX Production – No real-time technology involved					
Set extensions (Green screen VFX production)	Post-produced	Physical	Physical	Post-production for VFX shots	<i>Avengers</i> (2012)
Rear projection	Pre-produced with 2D video footage displayed through LED wall or projector	Physical	Physical	On set and in camera	<i>Oblivion</i> (2013)
Previs/Visualisation – Real-time technology involved but in a low polygon style					
Previs for full CG	Pre-produced for high-quality render	Motion captured with live rendering	Simulcam (spatial tracked monitor as viewfinder)	Layout for Previs, but post-production is needed.	<i>Avatar</i> (2009)
	Pre-produced for high-quality render	Animated	Simulcam (spatial tracked with camera tool)	Motion is captured instead of imagery.	<i>The Lion King</i> (2019)
Previs for live-action	Pre-produced for reference	Physical	Virtual	A visual reference for physical shooting.	<i>World War Z</i> (2013)

On-set pre-visualisation	Real-time generated virtual background with real-time keying	Physical	Real-time tracked physical camera	Real-time compositing for pre-vis	<i>A.I. Artificial Intelligence</i> (2001).
VP - Real-time technology involved and aiming to achieve “What you see is what you get”					
Virtual Studio	Game engine-generated virtual background with real-time keying	Physical	Real-time camera tracking	Real-time compositing of final result	TV programs
ICVFX	Game engine-generated virtual background -Display through the LED wall -With/without physical set	Physical	Real-time camera tracking -With inner frustum	On set and in-camera	<i>The Mandalorian</i> (2019), <i>1899</i> (2021)

Whether used individually or in combination, each of these applications offers a gamut of advantages across diverse entertainment productions. For instance, the broadcasting sector may leverage real-time keying for weather forecasting; Directors of CG animation and developers of triple-A games can employ visualisation and performance capture to create vivid CG animation and cinematic sequences. A VFX-laden film with thousands of VFX shots can easily be in several categories simultaneously.

All of the techniques mentioned above share a common characteristic: they are all set-extensions techniques. In the next chapter, our focus will be directed towards set-extensions, allowing us to understand how these practices have evolved alongside the advancements in filmmaking.

2.3 Brief History of Set Extensions

Set extension techniques refer to shots that cannot be accomplished solely through

standard photographic methods. Instead, they require specific equipment on set or visual manipulation during and after the shooting, either in-camera or through post-production processes (Fink, 2021; Netzley, 2000; Okun & Zwerman, 2021). As a result, filmmakers had two distinct techniques to achieve VFX shots: 1) Laboratory-generated effects and 2) On-set scenery capture.

2.5.1 Laboratory-generated VFX

The earliest visual trick can be traced back to George Méliès's silent film *Four Heads Are Better Than One* (1889). In his film, he employed "mattes" for multiple exposures, enabling combination two or more shots. In 1903, Edwin Porter used this matte and double exposure technique in his film *The Great Train Robbery* (1903), which featured a realistic train passing through a window and a moving background (Rickitt, 2000). Fifteen years later, cameraman Frank Williams invented and patented the Williams process, a travelling matte technique aimed at overcoming the limitations of camera movement. This innovation allowed actors to cross the matte-painted line, resulting in a memorable scene in James Whale's *The Invisible Man* (1933), where the invisible man reveals his transparent body when undressing.

King Kong (1933) was the first movie to use the Dunning process, invented by C. Dodge Dunning in 1925. This method was effective for black-and-white films. The bluescreening process, invented by Lawrence Butler for colour film, was first implemented in *The Thief of Bagdad* (1940). The blue colour was chosen as the backdrop because it is the furthest colour from human skin. In the 1950s, Petro Vlahos patented a process known as the blue-screen colour difference process. Despite its complexity, this technique successfully resolved the issues that Butler had encountered, allowing for the capture of edge details and reflections of semi-transparent objects (Rickitt, 2000). This colour difference process was so remarkable and popular, remaining in use until the dawn of the digital age (Hess, 2013).

2.5.2 On-set scenery capture.

According to VFX scholar Venkatasawmy (2013), practical effects refer to "[t]he application of visual trickery during cinematography to achieve illusion on screen." (p. 59). In the early 1900s, the invention of matte painting enabled filmmakers to create augmented sets and scenic backdrops using painted glass panels. These panels, painted with the correct perspective, size, and color, were positioned between the subject and the camera. Photographer Norman Dawn refined this technique by painting the glass in black and treating it like a matte. Dawn's matte-counter concept was widely used during Hollywood's golden age and even continued into the digital era for set extensions (Prince, 2012). *Metropolis* (1927) showcased the innovative work of Cinematographer Eugen Schüfftan. He invented the Schüfftan process, an in-camera compositing technique that involved using mirrors to combine miniature models with live-action shots and a small portion of the set. The seamless compositing allowed for real-time monitoring on the set itself (Loew, 2015), and this technique was predominantly employed for set extensions from the 1920s to the

1940s.

Another technique that offered real-time visualisation on set was rear projection. As described by Jeffery Okun and Susan Zwerman (2021), rear projection is “a compositing process in which the previously photographed background scene is projected onto a large translucent screen from behind while the foreground action takes place. The composite is thus considered an in-camera effect” (p. 823). This method involved a core crew producing the pre-recorded background, reducing travel expenses. The background is then projected onto a soundstage as a backdrop, avoiding unpredictable weather during filming and reducing the need for reshooting. Due to its efficiency and cost-effectiveness, rear projection became a widely used technique in Hollywood filmmaking from the 1930s to the 1970s (Bode, 2017). It later served as inspiration for the development of front projection, the Zoptic process, and Introvision.

As technology evolved, digitalisation revolutionised how filmmakers create VFX. Software enables filmmakers and VFX artists to modify and manipulate digital environments to serve the narrative and match the visual elements, such as lighting and atmosphere, with the original footage (Dinur, 2017). VFX in this digital realm is not created *ex nihilo* but rather inherits the foundational essence and core concepts from the pre-digital era.

A significant milestone in this evolution was *Mission: Impossible* (1996) (Vaziri, 1998), which adeptly integrated a live-action sequence with a partially photorealistic environment. In the climactic chase sequence of the film, the helicopter and the bullet train were composited and realistically match into the live-action plate. This shot was achieved by Tom Cruise and Jon Voight performed on a blue screen and keyed them on the top of a digitally rendered train. As mentioned by Vaziri (1998), this invisible compositing allow the movie to maximise the use of the virtual background.

Towards the end of the 20th century, the accessibility of user-friendly and cost-effective equipment provided filmmakers with enhanced capabilities to manipulate and enhance imagery, thereby unlocking new dimensions of quality and creativity within the realm of cinematic storytelling.

Ben Cole, who has a decade of experience working as head of software research and development at a VFX studio MPC (Motion Picture Company) Vancouver, points out that changes in VFX production are inevitable, and major changes have a profound impact downstream. He suggests that the production pipeline should enhance its flexibility to withstand continuous changes (Cole, 2014). In an effort to reduce the workload for green screen workflows, the industry has revisited and modernised rear projection techniques.

2.4 Brief History of In-Camera Visual Effects

The history of special and visual effects begins with the visual tricks achieved through in-camera methods, but in the context of VP, ICVFX is encapsulated with LED walls, real-time game engine and camera tracking. These development have several innovative predecessors in filmmaking.

2.4.1 Pre-Visualisation/Pre-Vis

Pre-visualisation, or Pre-vis for short is conducted at the beginning of film production. Its significance lies in the planning and execution of complex and cost-intensive VFX shots (Venkatasawmy, 2013). A joint definition by the Visual Effects Society, the Art Director's Guild, and the American Society of Cinematography provides the following comprehensive definition:

Pre-vis is a collaborative process that predominantly uses 3D animation tools and a virtual environment to generate preliminary versions of shots or sequences. It also enables filmmakers to visually explore creative ideas, plan technical solutions, and communicate a shared vision for efficient production. (Okun & Zwerman, 2021, p. 821)

The purpose of pre-visualisation is clearly described by Keil and Whissel (2019) in their book *Editing and Special Visual Effects*, wherein they state:

Pre-visualization renders the entire film (or select sequences) in low-resolution digital animation so that directors, visual-effects supervisors, and other members of the production can see each shot and plan accordingly for each of the elements that will go into it—practical camera movements, virtual camera movements, CG elements, digital matte paintings, miniature models, live-action elements, and so on. (p.180)

The pioneering use of on-set pre-visualisation during the shooting phase was exemplified by the film *A.I. Artificial Intelligence* (2001). This camera-tracking approach is illustrated in Figure 1 below, where Director Steven Spielberg could grasp the visual idea and focus on the composition of synthetic shots, even as the cameraman captured actors against a blue screen. It's worth noting that despite the limited graphic quality of pre-visualisation, the created 3D software scene files, including the pre-vis motions and camera positions, can be file-shared as references with on-set camera positioning.

Figure 1

The On-Set Pre-Visualisation Setup from A.I. Artificial Intelligence (2001)



Note From *A.I. Artificial Intelligence - Behind the Scenes*, 2001,
(<https://www.youtube.com/watch?v=pnD7RHXU43o>)

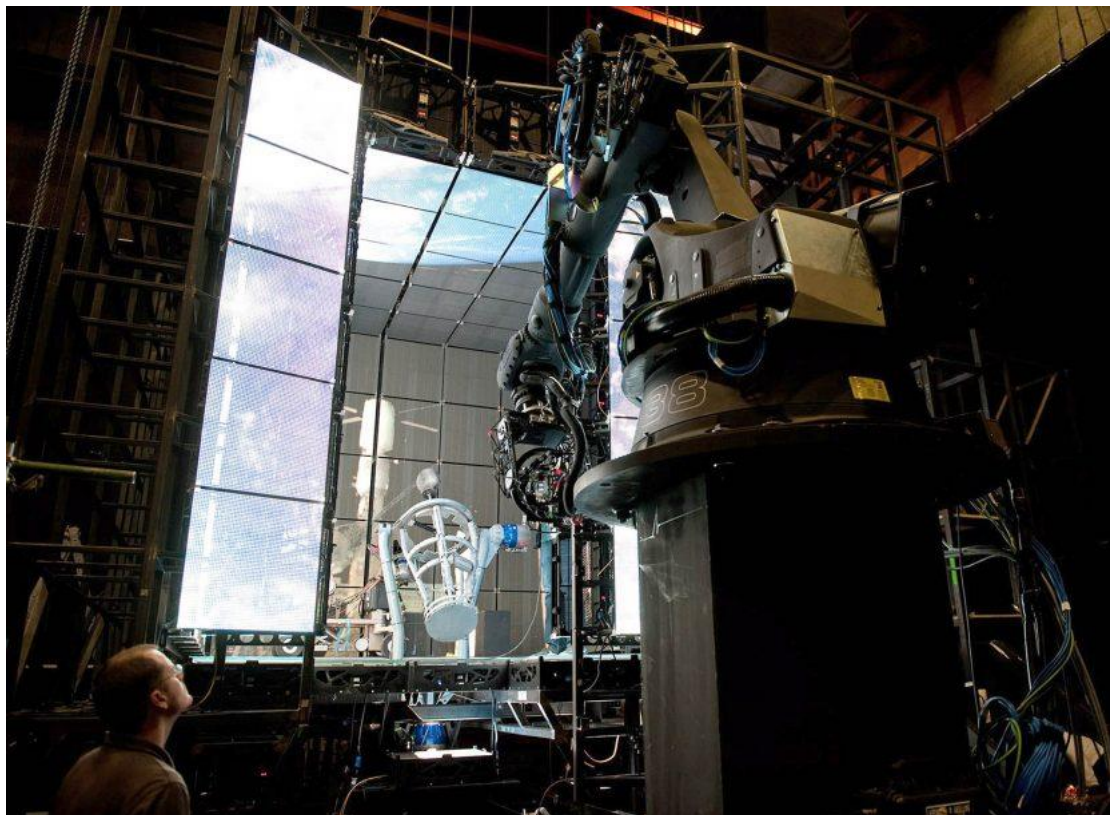
2.4.2 LED Wall as Background Display

The film *Gravity* (2013) serves as a compelling example of this technological evolution. Positioned within the science fiction genre and centred on the perils of outer space, “Gravity” won seven prestigious Academy Awards, including the accolade for Best Visual Effects. One of the standout innovations was the incorporation of a unique 20-foot tall, 10-foot-wide “lightbox”, akin to a cube, as depicted in Figure 2 below. The lightbox’s primary objectives encompass content visualisation and the illumination of actors positioned within its confines. Comprising an extensive array of inward-facing LED screens, the lightbox displayed meticulously controlled content, masterminded by Director Alfonso Cuarón and VFX Supervisor Tim Webber. The actors were able to immerse themselves in the rendered digital world through this installation, thereby gaining a tangible sense of spatial orientation and situational dynamics, diverging from the stark confines of a traditional green or blue screen. For example, during flight sequences towards a space station, actors could perceive the virtual environment’s depiction of the station and its surroundings (Seymour, 2013). Beyond its role in content visualization, the lightbox also served as a source of luminance and hues, facilitating the natural reflection of the virtual surroundings onto the actors, and enhancing the integration of the digital and physical elements. This dynamic interplay between the LED lightbox and the actors

fostered a seamless on-set embedding, harmonising the actors with the cinematic environment from the perspective of both the director and the DoP (Bode, 2017). Furthermore, this device saved time and money during on-set shooting. Instead of relocating the physical lighting, filmmakers could swiftly achieve the desired lighting effects through alterations to the display image via computer programs. From a crew management standpoint, the lightbox minimised the need for additional crew members, with only actors, creative personnel, technicians, and the specialised lightbox apparatus, complete with its set of rails and a robotic arm for camera control, constituting the necessary on-set ensemble (Seymour, 2013).

Figure 2

The Lightbox Setup from Gravity (2013)



Note From Gravity: VFX That's Anything but Down To Earth, by Mike Seymour, 2013, FX Guide (<https://www.fxguide.com/fxfeatured/gravity/>)

The film *Oblivion* (2013), directed by Joseph Kosinski, stands out as another instance in this cinematic landscape. The narrative primarily takes place within a military outpost-like sky tower, which is 3,000 feet tall and mainly constructed from glass and reflective materials. The main concern that anticipated was overcoming the challenge of capturing scenes with actors at different times of the day while evading the halo effect caused by the blue screen on reflective surfaces, which could have posed significant complications during post-production, particularly in the context of keying. In response, Kosinski astutely opted for the deployment of the rear projection technique. He captured a range of natural phenomena as projection footage, ranging

from sunrise, sunset, and nighttime, to varying weather conditions, such as sunny, cloudy, and rainy scenarios. These real-world phenomena videos were projected onto an expansive 500-foot-wide screen positioned on set, as depicted in Figure 3 below. This massive screen surrounded the physical set and the actors, creating an immersive and realistic environment. The inclusion of such a vivid backdrop resonated profoundly with the actors, including Tom Cruise, significantly mitigating their sense of uncertainty when confronted with the traditionally disorienting green void.

Similar to the lightbox in *Gravity*, this huge screen emitted lighting that corresponded to the displayed footage itself, allowing for the natural capture of reflections from the actors' eyes and the set. Moreover, the screen wall enabled the director to control and project the desired weather background, reducing reliance on natural weather conditions. Through the use of rear projection, the director could achieve shots with background on set (Failes, 2013; Kosinski, 2014).

Figure 3

The Rear Projection Setup from Oblivion (2013)



Note From *Oblivion*, by Joseph Kosinski, 2013

(<https://www.youtube.com/watch?v=i9m6KzRMWnA>)

This screen projection approach provided a new alternative to green screen VFX production. The Academy Awards won by films like *Gravity* and *First Man* (2018) demonstrated the promising future of this approach. Pioneering works such as *Rogue One* (2016) and *Solo: A Star Wars Story* (2018) further advanced this paradigm by using LED walls as a backdrop to display light-speed travel footage and create high-quality shots devoid of reliance on traditional green screens (Bredow, 2022). This resonates with Bordwell et al.'s (1985) assertion regarding Hollywood's assimilation of technology: enhancing production efficiency, fostering distinctiveness, and simultaneously upholding quality benchmarks. However, the industry continued

to seek solutions to address lingering challenges, particularly in combating visual parallax and enabling the real-time generation of backgrounds within a more flexible workflow. The adoption of VP gained traction within the VFX industry in parallel with the rise of real-time rendered computer graphics.

2.4.3 Antecedent of ICFX: Game Engine and Machinima

While traditional live-action filmmaking endeavours to achieve high-quality realism through CGI, the release of the first feature-length CG animation *Toy Story* (1995) indicated the enormous potential of using virtual environments to create cinematic narratives, eventually leading to the intertwining of the film and video game industries.

During the 2000s, Machinima emerged as a video game player-driven innovation, allowing video game enthusiasts to record and create their original content using a game engine and in-game assets in real-time. It offered an accessible and cost-effective medium for facilitating real-time interaction within virtual filmmaking (Champion, 2011; Davis, et al., 2011; Yi, 2022), Machinima encouraged “game players” to become “filmmakers”. The term “Machinima” is a blend of “machine”, “animation” and “cinema”. Paul Marino, the founder of the Academy of Machinima Art and Science, defined Machinima as the following:

Machinima is filmmaking within a real-time, 3D virtual environment, often using 3D video-game technologies ... It is the convergence of filmmaking, animation, and game development. Machinima is real-world filmmaking techniques applied within an interactive virtual space where characters and events can be either controlled by humans, scripts or artificial intelligence. (Norman, 2002, para. 3-4)

With specific video game engines such as *Quake* (1996), video game enthusiasts can record their demos and create their films by manipulating the virtual environment, characters, and camera in real-time on a computer (Davis, Boyang, Riedl, O'Neill, & Nitsche, 2011; Fosk, 2011). A Machinima movie named *Quad God* (2000), directed by Joe Goss, marked a significant milestone by producing a groundbreaking 45-minute film that was distributed as a standalone video file, eliminating the requirement for viewers to have the game engine installed to watch it. Furthermore, the enduring success of *Red vs. Blue* (2003 – present, Burnie Burns), depicted in Figure 4 below, serves as another example of Machinima's impact. This machinima sitcom series stands as a testament to the possibilities and potential inherent in this distinctive mode of visual storytelling.

Figure 4

A Screenshot from Red vs Blue (2003 - present), a Machinima Production



Note From Red vs Blue, by Rooster Teeth, 2003

<https://www.youtube.com/watch?v=XnsRdaZTMas>

The main drawbacks for Machinima were the limited availability of assets and low-quality graphics. Game assets only provided a limited range of characters, pre-set animations, sets and props, thereby constraining narrative flexibility unless Machinima creators imported their own custom 3D assets. The graphic quality of Machinima was compromised to achieve better real-time performance. Subtleties such as high-quality human facial and emotional depictions were replaced with an unblinking eye and limited body gestures. Accurate shadows, reflections and fine details were also sacrificed (Kelland, 2011). Moreover, in the realms of virtual cameras, Machinima lacked essential attributes akin to physical cameras, such as focal length, film back, depth of field and shutter speed (American Cinematographer, 2020). Therefore, Machinima did not fulfil the role of delivering final pixel quality for live-action films.

Nevertheless, the game engine-based functionalities embedded within Machinima, including real-time visual feedback and intuitive control over virtual elements such as mise-en-scène, environment, scripting, and playback, share conceptual parallels with physical film production. Later, this technology laid the foundation of the development of VP, significantly removing bottlenecks of VFX productions such as keying and rendering, enabling film directors to perceive the digital environment in real-time. Most importantly, Machinima laid the technical groundwork and introduced an agile workflow for VP, potentially providing a cost-effective and creative adept alternative for both industry professionals and enthusiasts (Harwood & Grussi, 2021).

This represents the translation of cinematic grammar into computer software and hardware, as predicted by new media scholar Lev Manovich: “The visual culture of

the computer age is cinematographic in its appearance, digital on the level of its material, and computational (i.e., software-driven) in its age.” (2001, p. 180)

Fast forward to the success of *The Mandalorian* Season 1 (2019), a *Star Wars* spin-off TV series directed by Jon Favreau, which created a huge splash in the industry. Prior to *The Mandalorian*, when Favreau was working on his film *The Jungle Book* (2016), he was frustrated with the time needed for post-production, mainly due to the extensive use of green screens and the reliance on post-production decisions rather than on-set decision-making. To address these frustrations, he and his creative team fully embraced VP with Unity, a real-time game engine, VR world and VR headset, resulting in the production of *The Lion King* (2019) (Baver, 2020; Failes, 2019).

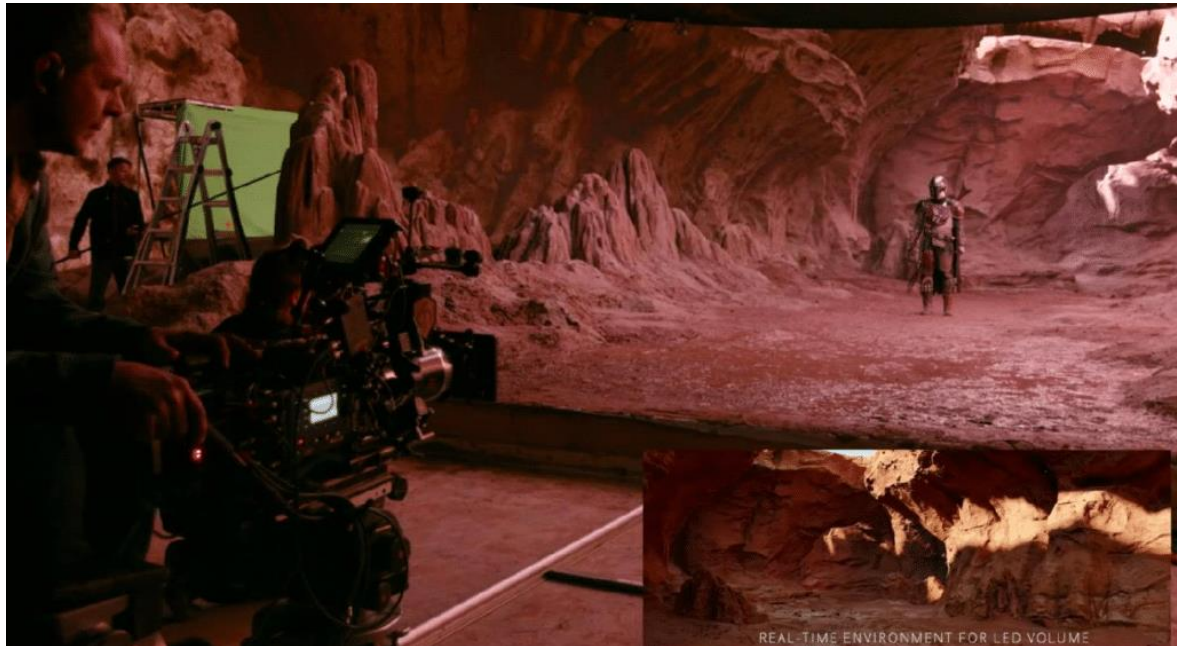
Unlike *Avatar*, where the motion capture system was attached to an actor, in *The Lion King*, the system was attached to tangible and conventional cameras and equipment such as a crane, drone and dolly. These physical cameras and equipment drove the spatial movement of the virtual camera in a real-time game engine. This real-time synchronisation provided the desired live-action shooting style for the director.

2.4.4 Emergence of LED Wall and Game Engine

The phenomenal success of *The Mandalorian* Season 1 can be attributed to the concerted efforts of Jon Favreau, ILM and Epic Games, who effectively demonstrated the feasibility of an alternative approach of VP by converging and reconfiguring different technological components. Illustrated in Figure 5 below, the methodologies employed in *The Mandalorian* improved VP in several ways: 1) Actors were able to act without controlling a digital character via mocap suits. Unlike in *Avatar*, where the actors in motion capture suits were essentially puppeteers, controlling their virtual characters' bodies and facial movements. 2) In *The Mandalorian*, the photorealistic virtual set was displayed on set through huge and semicircular LED panels, powered by an array of the newest graphic process units. This LED wall technique inherited the benefits from the previously mentioned *Gravity* and *Oblivion*, creating an immersive photorealistic environment for the whole crew and actors. The main improvement was its real-time interactivity. The displayed background was generated from a real-time game engine rather than just pre-recorded footage, allowing the background content to update accordingly whenever the motion-captured camera moved spatially, consequently enabling the correct creation of visual parallax. 3) The displayed virtual set could be fully manipulated by the game engine artist on set to fulfil the director's improvised decisions. This technique allowed for real-time set extensions with the physical set on the soundstage, reducing the need for location shooting (Coldeway, 2020; Failes, 2019). In this setup, the DoP could film the actors with the displayed background and finish the shot in-camera on set, profoundly reducing the workload of post-production (Seymour, 2020).

Figure 5

The ICVFX Setup with LED Wall from The Mandalorian (2019)



Note From *The Virtual Production of The Mandalorian Season 1*, by ILM, 2021, (<https://www.youtube.com/watch?v=gUnxzVOs3rk>)

Since then, an increasing number of movies and TV titles have been produced using ILM's LED stage StageCraft, including *The Mandalorian Season 2* (2020), *Thor: Love and Thunder* (2022), *The Batman* (2022) and more to come. Other major VFX companies and production houses from the United States and Europe are embracing this technology and implementing their custom LED stages (McGowan, 2021). The Dark Bay created a bespoke turntable set with surround sets for the Netflix TV drama *1899* (2022) (Kadner, 2023b). VFX companies such as Weta Digital and Pixomondo are experimenting with a production-ready game engine and building their customised LED stage for projects, such as *Star Trek: Discovery* (2022). DNEG (Double Negative) and Framestore are diving into their proprietary virtual camera and scouting system, with the former focusing on utilising LED volumes for real-time environments and the latter developing a toolset for completing entire movies. These reflect how ICVFX was embraced by Hollywood-centric production.

Behind the camera, ICVFX radically shifts professional practices in terms of mindset, workflow and departmental structure. In the next chapter, we will focus on identifying the ICVFX workflow and how this new ICVFX workflow differs from green screen VFX production.

2.5 Chapter Summary and Discussion

In conclusion, this literature review chapter has explored various concepts, including VP, set extensions and ICVFX. By tracing the evolution of the VP concept, we can

realise that it encompasses a wide scope of applications driven by real-time technology. Hence, an integrated theoretical framework called *Set, Actor and Camera* has been proposed to reduce confusion. This framework supports clarification of the term ICVFX within the VP terminology. Furthermore, this chapter also retraces the historical development of set extension and ICVFX, illustrating the emergence of game engine technology and its increasing demand in filmmaking practices.

Chapter 3. Examining the Differences in Workflows between Green Screen VFX Production and ICVFX

Production.

Similar to the transformative influence of other digital technologies, the advent of ICVFX has also played a pivotal role in reshaping the roles and responsibilities of individuals involved in the filmmaking process. To comprehend the extent of these changes, it becomes imperative to first identify the production workflow of ICVFX.

A production workflow serves as a structured and systematic approach, encompassing working procedures, tasks, and deliverables (Bugaj, 2021). Its indispensable role lies in optimising production efficiency and effectively conveying the creative team's vision (Dunlop, 2014). In this context, every production necessitates the adoption of a well-defined workflow to facilitate the realisation of artistic objectives.

In the following sections, an elucidation of the set extensions workflow will be presented, focusing on both green screen VFX production and ICVFX contexts. The former is constructed based on a documentary analysis from *Star Wars: Episode III* and related literature, while the latter is an aggregated description from personal interviews with EA and SEA professionals and works of literature to provide a detailed the ICVFX workflow. A comprehensive analysis will be conducted to discern how the advent of ICVFX has substantially transformed the mode of production.

3.1 The Workflow of Green Screen VFX Production

Within the realm of VFX production, the conventional practice entails the creation of photorealistic set extensions composed of a multitude of individual assets. These assets are meticulously crafted by exceptionally skilled artists and subsequently integrated by compositors within a linear workflow.

The in-depth documentary, “*Within a Minute: The Making of Episode III*” (2005), discusses how 26 VFX shots of a climactic duel in *Star Wars: Episode III – Revenge of Sith* (2005) were produced within the industry’s mode of film production. As outlined in the documentary, the entire film production starts with the script, which serves as the blueprint of the film. Director George Lucas has to make decisions regarding the story’s development. The concept artists from the art department create and design multiple versions of each visual element, such as creatures, weapons, spaceships, and planet environments based on the script. Lucas reviews these visual element designs along with script modifications. Combining the art design from the art department, the storyboard from other departments, and live-action footage, the pre-visualisation department creates a preliminary moving

storyboard with lighting and texturing in a 3D digital space. Computer technology allows Lucas to explore and design the shots and overall sequences at a low cost. Test shots with actors are also produced to edit the sequence before the actual production. The production design department works in collaboration with the construction department and props department to build all physical sets and props based on the concept. During the actual shooting phase, actors perform on a set against a green screen, under the direction of the Directing department. These shots are then passed to the editorial department and Lucas for editing, where they determine if reshoots are needed to enhance storytelling.

From a VFX production perspective, the VFX executive producer formulates the plan after receiving the storyboard and animatics. Production coordinators manage the daily production with VFX post-production from start to finish. Typically, VFX supervisors lead the creative works in two ways: by working on set with the film crew to ensure quality control and by supervising the actual VFX production with hundreds of VFX artists (Caldwell, 2008). The VFX supervisor places visual reference points and markers for a green screen shooting, which are used by the match-move department to accurately recreate a virtual camera with movement, correct focal length, perspective and angles through a tracking system. These camera data are essential for lower-stream VFX departments to seamlessly merge VFX and live footage. CG modellers build and texture all the 3D assets, while animation artists are responsible for creating believable digital characters and virtual sets. The animated sequence is sent to the lighting rendering and VFX simulation department for creating convincing lighting and simulation. At the same time, the matte painting and digital environment department creates the virtual world backdrop based on real-world references or concept art. ILM's rotoscoping department creates isolated elements from the green screen shots for VFX compositors to remove and then overlap onto a specific shot. After numerous hours of rendering, the compositing department receives the joint effort from the upper-stream departments. The VFX compositor combines all the separate elements and blends them into a seamless final shot.

The post-production process typically involves a crucial session referred to as "dailies", during which the post-production department head and VFX supervisor convene to review the completed shots. This review takes place at the end of each post-production day or at the beginning of the subsequent day.

The dailies session facilitates effective communication and exchange of feedback between the post-production team and the VFX supervisor, ensuring that everyone involved is aligned with the project's goals and standards. By regularly reviewing the work-in-progress shots, the team can swiftly address any issues or discrepancies, thereby maintaining a smooth and efficient post-production workflow.

3.2 The Workflow of ICVFX Production

In traditional green screens, shots are only finalised in post-production, where the iteration happens. In contrast to the traditional waterfall pipeline, ICVFX represents a paradigm shift towards a more collaborative, agile, and iterative workflow before and during the shooting process. This innovative approach fosters dynamic interactions among various production teams, enabling real-time visualisation and facilitating creative decision-making during filmmaking. The following sections articulate the workflow for ICVFX.

3.2.1 Script Breakdown

The ICVFX production commences with the script, typically structured from a narrative timeline standpoint. Subsequently, several departments undertake the task of deconstructing the script to facilitate effective management and logistical coordination. For instance, the VP supervisor meticulously analyse and categorise the script according to distinct sequences. Collaborating closely with the director, assistant director (AD), DoP, and visualisation company(s), the VP supervisor engages in designing the virtual world that will serve as the backdrop for the production (Weaver, et al., 2021).

During this phase, these creative heads also discuss and decide on the usage of an LED wall, considering any specific requirements involved, such as high-speed shooting or rapid camera movement (Evelyn Wu, Appendix A). Meetings and discussions ensue regarding the inclusion of a midground and foreground within the LED wall configuration, alongside determining the content to be displayed. Once these critical determinations are made, the creative heads relay the necessary information to the LED construction team, providing guidance on the elements to be constructed within the LED volume (Geduldick, 2022).

3.2.2 Concept Art and Storyboard Creation

Storyboarding plays a crucial role in facilitating the positioning of the virtual camera in the virtual environment and determining which asset requires refinement for the asset creation team (Evelyn Wu, Appendix A). Without a storyboard, it is difficult for VAD to understand the specific shot requirements and allocate appropriate time for the refinement of designated assets.

In contrast to conventional film and VFX production practices, ICVFX requires the active involvement and collaboration of various departments, including production design, art department, VAD and VFX department. These departments constitute an integral part of the consulting and working team (Geduldick, Thomas, & Holland, 2022; Kadner, 2021c; ScreenSkills, 2022).

With a particular focus on the VAD, its responsibilities encompass the construction of the virtual environment to serve two primary objectives. Firstly, VAD undertakes pre-visualisation of key shots, ensuring optimal timing and framing for the desired visual impact. Secondly, the VAD engages in technical visualisation (tech-vis), exploring innovative approaches to realise and accomplish the envisioned shots during the actual shoot. VAD artists may also need to 3D scan assets when necessary.

3.2.3 3D Photorealistic Assets Creation

Upon reaching this stage in the ICVFX production, the creative process evolves into an iterative approach, affording the flexibility to backtrack if necessary. Based on the previously created storyboard, the VAD embarks on the creation process (Evelyn Wu, Appendix A). The resulting assets and scenes take center stage, serving as the visually immersive backdrop during on-set filming and effectively functioning as light and reflection sources to enhance the realism and coherence of the production.

To achieve 3D photorealistic assets, three methods can be employed: 1) The process of modelling involves crafting assets from scratch, providing full creative control and customisation. 2) Photogrammetry utilises advanced imaging technology to capture real-world objects and environments in precise detail, producing highly realistic assets. 3) Ready-made assets can be acquired through downloading from external sources, offering efficiency and convenience in situations where time constraints or resource limitations are present.

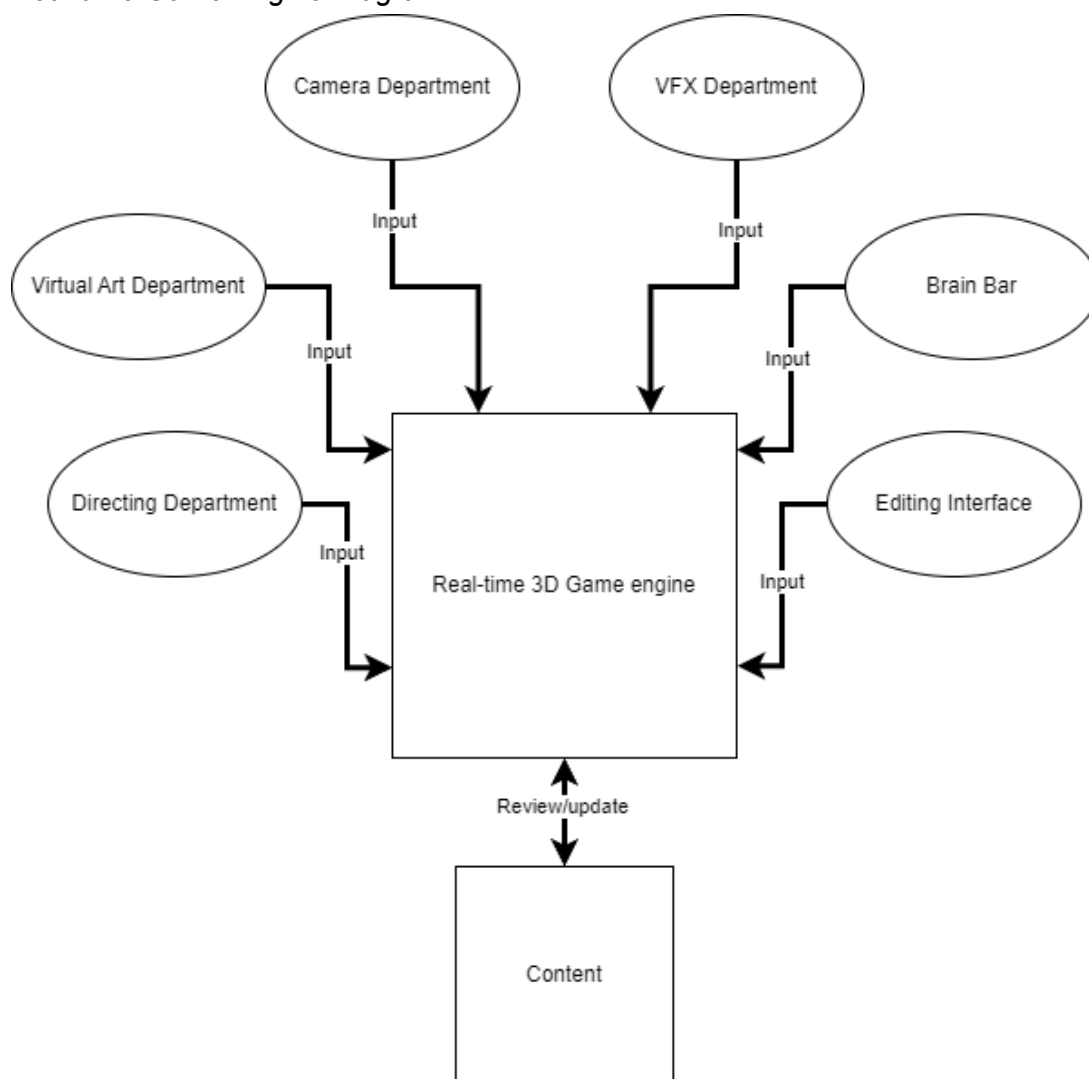
3.2.4 In-Game Engine Pre-Visualisation

The in-game engine pre-visualisation phase serves a multifaceted role, encompassing functions akin to pre-vis, look development and tech-vis. Following the completion of the asset creation stage, the 3D assets and environment are seamlessly imported directly into the game engine, facilitating a true-to-life 1-to-1 scale visual representation. The significance of real-life scale visualisation lies in its ability to accurately depict the landscape and environment, aligning with the specific conditions for actual filming, including camera settings and environmental factors. This level of precision enables filmmakers to gain an insightful understanding of how the final setup will appear and anticipate potential challenges or opportunities that may arise during the filming process. By proactively addressing these aspects, uncertainties can be minimised, fostering a more efficient and effective production workflow.

As shown in Figure 6 below, the integration of in-game engine visualisation allows various departments to collaborate and coordinate seamlessly, promoting a cohesive and comprehensive understanding of the project's vision and requirements. This collective preparation empowers filmmakers to make informed decisions, optimise creative choices, and ultimately enhance the overall quality and impact of the ICVFX

production, as highlighted by highlighted by Dunlop (2014) and Orloff (2022).

Figure 6
Real-time Game Engine Diagram



Furthermore, it is worth noting that pre-visualisation phase shares a similar production duration as the practical set, affording ample time to iterate and enhance the 3D assets and environment for ICVFX (Geduldick et al., 2022; Rank, 2021). This extended timeframe allows for an iterative and malleable approach, enabling continuous refinement of the virtual elements until the shooting day is imminent. Consequently, this reciprocal cycle of improvement and adjustment ensures that the ICVFX elements are finely tuned and seamlessly integrated into the production, optimising the overall visual impact and storytelling potential of the final project. The alignment of the production timelines for the practical set and the ICVFX stage further enhances efficiency and collaboration, facilitating a cohesive and harmonious production process.

3.2.5 Stage Realisation

Stage realisation constitutes a crucial phase specifically for ICVFX production, encompassing technical screen testing, calibrating, and projecting content onto the LED stage (Evelyn Wu, Appendix A). The responsibility of managing this phase lies with the dedicated “Brain Bar” team, which is responsible for operating the stage and displaying the content on the LED wall.

To ensure seamless integration, the camera tracking system and frustum are also calibrated by the “Brain Bar”. This stage demands close collaboration between departments, particularly the VAD and the art department. These teams convene to address LED wall-related challenges, such as colour calibration, scale matching, alignment, set perspective and assets optimisation. Through iterative interactions with the preceding phase, technical issues such as low frame rate on LED walls are identified and resolved, while efforts are made to enhance the quality of assets (Evelyn Wu, Appendix A).

3.2.6 Rehearsal and Blending

The technical testing or rehearsal day is the final adjustment phase before the actual shooting (Evelyn Wu, Appendix A; Miura, Appendix A). This integration is the most challenging task for ICVFX as it requires effort from all aspects of production such as hardware and software, real-time departments and film departments (Bennett, Heath, Kilkelly, & Richardson, 2021). Typically, this phase will require a few days focusing on creating seamless integration between LED virtual background and physical foreground, aiming to ensure a smooth shooting schedule on the shooting day (Bredow, 2022b; Kadner, 2022).

This phase consists of numerous collaborative processes among different departments. The “Brain Bar” and VP supervisor are in charge of projecting the game engine content on the LED wall, refining camera tracking smoothness and system optimisation (Evelyn Wu, Appendix A). The actor, director department, photography department, lighting department, and art department focus on confirming the shots, camera angles, camera movement and colour temperature (Kerekes, 2022; Miura, Appendix A).

Multiple rehearsals are required between departments to align information and ensure achieving the director’s requirements. The more familiar the engine operator is with the virtual scene, shot list, and the progress of shooting, the more smoothly they can react and update the set with the production.

During blending, meticulous attention is given to fine-tuning the alignment, visual coherence, and overall harmony between the virtual and physical elements. It requires collaboration and synchronisation among various production teams to achieve a cohesive and visually cohesive result, including but not limited to virtual lighting and physical lighting integration to generate shadow for both virtual objects

and physical actors (Evelyn, Wu, Appendix A).

The colour grading session is a challenging process that incorporates input from most, if not all, decision-makers, from traditional filming departments to ICVFX departments. This session aims to ensure colour calibration among the content, the LED wall, the physical set, and the camera, or at least the final outcome monitor. To achieve seamless virtual and physical integration, repainting or redecorating both virtual and physical sets is commonly seen in this stage (Rank, 2021). According to one of the interviewees, Chris Yan, the process begins with confirming the LED background, followed by repainting the colour of the physical set. However, if further subtle changes are required, the LED background is subsequently adjusted to align with the newly painted set.

3.2.7 Principal Photography

Even with a planned shot list and schedule, the actual shooting progress is much more complex and dynamic. Last-minute adjustments and subtle tweaks, such as repainting and nuances changes, are to be expected. However, in more extreme cases, major alterations may also arise just before the camera starts rolling. As a result, effective negotiation and communication between departments emerge as important factors during on-set shooting.

3.2.8 Post-Production

Some productions do not end with the shooting, especially in multi-vendor projects. In a multi-vendor project setting, retouching or post-processing is required by other studios. Shots, game levels and related metadata such as camera tracking and animation information need to be delivered to vendors after ingestion and optimisation. Workflows and pipelines may need to be extended and modified to adapt to external clients, facilitating a smooth transition for editing and colour grading (Gedulick, Thomas, & Holland, 2022).

Post-production in ICVFX is used for three main purposes: 1) creating a full CG shot that cannot be accomplished in-camera; 2) shooting the enhancement unrelated to the LED content. (such as adding CG props for actors to interact with, adding logos to the practical set, or adding costume details) and 3) fixing minor technical errors in shots such as rotoscoping out the in-shot production equipment, and adjusting the exposure/colour to improve the shot (Weaver, et al., 2021).

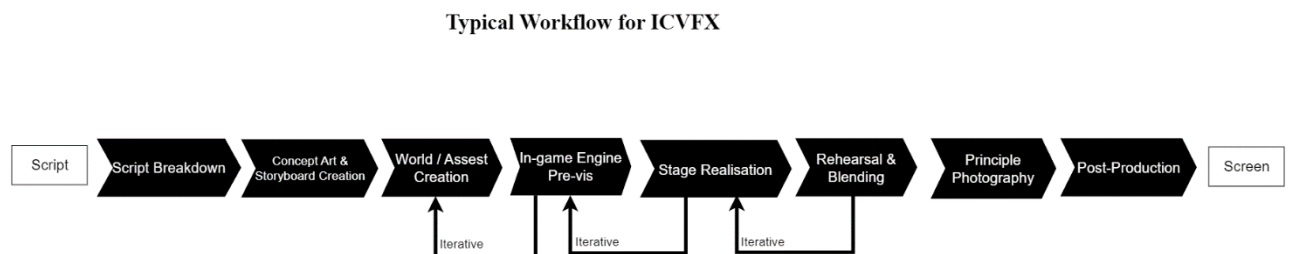
3.3 Chapter Summary and Discussion

In summary, as outlined in Figure 7 below, ICVFX harmoniously merges VFX and game development steps. The initial two phases of the production process adhere to

traditional pre-production methods, followed by two phases focused on game engine-based creation and review. Principle photography commences after a two-step process utilising the LED wall technology.

Figure 7

An Overview of the Production Phases for ICVFX



With the understanding of both workflows, the following sections discuss the pros and cons of both techniques:

3.3.1 Rendering

In green screen VFX production, rendering time is a significant bottleneck, causing delays and increased costs. Minor adjustments or major changes often require re-rendering the entire CG sequence, consuming time and resources.

On the other hand, real-time rendering is defined as displaying images at the same speed as the final form and nearly instantaneous processing. It saves time, improves back-and-forth communication, and eventually provides a more interactive process (Okun & Zwerman, 2021; Dinur, 2017).

3.3.2 Workflow Structure

In green screen VFX production, a VFX shot is completed in post-production. The entire process is constructed in sequential phases which means the next phase must use the completed work from the previous phase.

As shown in Figure 8 below, the creation of a set extension shot involves a multi-stage assembly process with contributions from a diverse array of professionals, including artists, technicians, and engineers (Manovich, 2001; McClean, 2007; Pierson, 2002). The post-production structure in VFX-based filmmaking mirrors the principles of Fordism's division of labour, adopting a factory-style assembly-line approach where specific departments are assigned distinct functions and supervised by department leads. This organisational framework aims to optimise production efficiency, fostering differentiation among tasks while upholding high standards of quality (Bordwell & Staiger, 1985).

While a linear workflow is commonly practised due to its benefit of maximising efficiency, film production may not be as straightforward as manufacturing a product on an assembly line. This is because creative artistic changes are unavoidable. Requests from the clients are handled from the top of the production chain, and the workload varies according to the pipeline procedure. For example, if a client requests colour grading, it only requires effort from the compositing department, which is located at the end of the chain. But if the note mentions a change in camera movement, then the shot is sent to the top of the chain and requires input from every department and numerous iterations along the stream to make a shot perfect. Walt Jones, a former CG supervisor at Rhythm and Hues, explained the laborious top-to-bottom process:

So now we go back, we do that work that we think we're supposed to be doing. We present it [the shot] again; it goes back through the chain of approvals. The decision-maker sees it, and they (the client) give their feedback. Then it goes through the chain of the other direction, and we find out whether or not we're done, or we have to keep going. (Leberecht, 2014)

To solve this frustration, a shift in the workflow was accompanied by the decline of offline rendering, leading to the implementation of real-time technology.

ICVFX overcomes the drawbacks of conventional production by centralising the game engine as the main creation tool, providing a more flexible workflow for non-destructive asset creation. The revised ICVFX workflow outlined in Figure 9 below aims to provide a direct comparison with the VFX workflow in Figure 8 below.

Figure 8

An Overview of Production Stages for Green Screen VFX Production

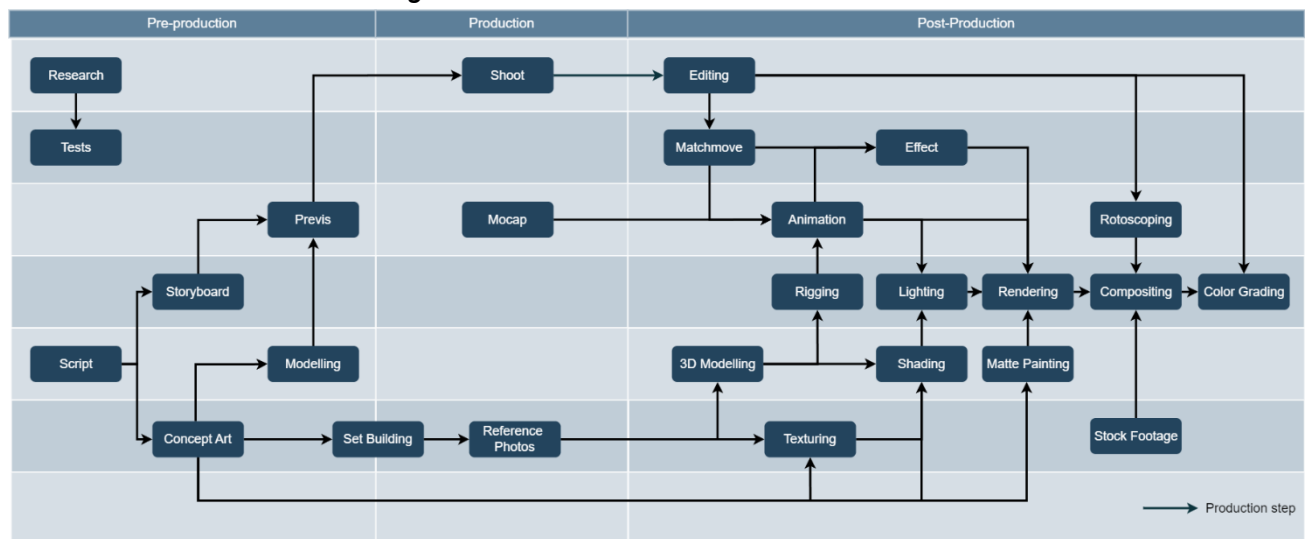
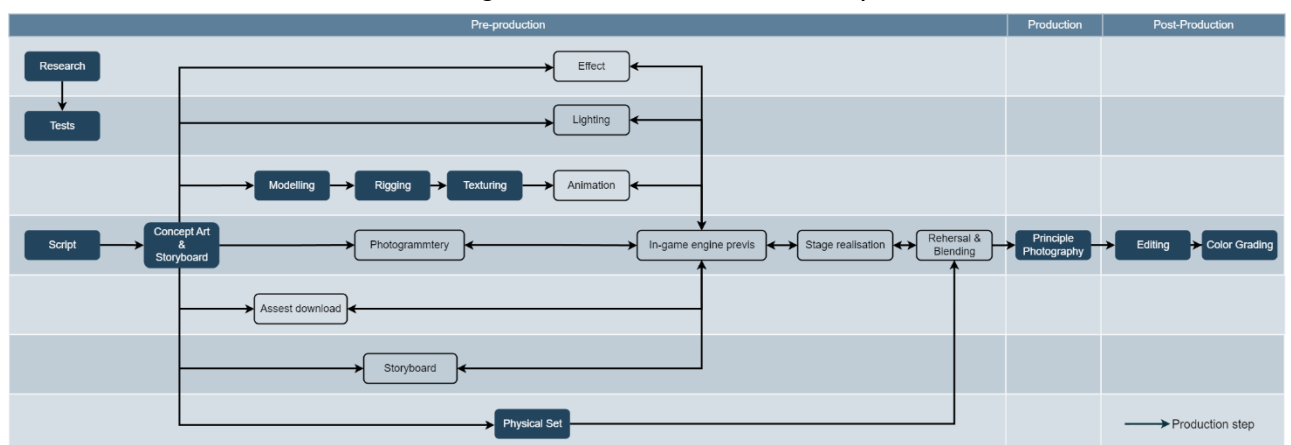


Figure 9

A Revised Version of Production Stages for ICVFX for Direct Comparison



The interactive and iterative processes in Figure 9 are represented by transparent boxes with two-sided arrows, indicating that the traditional waterfall pipeline is largely reduced.

This game engine-centric approach leads to two properties: 1) world-orientated creation and 2) workload parallelisation. Instead of the shot-based creation, the ICVFX workflow begins with virtual world-building, and the render camera is placed after the world is built. This approach fundamentally changes how a shot is achieved. Decision-makers can modify, update or choreograph the camera without having to wait hours or days for re-rendering, resulting in significant time saved during production. Secondly, all department can initiate their work much earlier with a bigger picture. With a parallel workflow, departments such as lighting and effects, become relatively dependent and can start their work once the project is initiated.

Additionally, there are a few significant changes in the ICVFX production workflow compared to green screen VFX production: 1) the need for a match-move department is largely reduced due to the implementation of real-time camera tracking and 2) the workload of rotoscoping out a person for background replacement is much less needed because the usage of LED wall.

3.3.3 Why Green Screen VFX? Why ICVFX?

Cost is the predominant concern of each production. Typically, in film production, a budget breakdown includes items such as shooting days, scouting days, set or location building, travel and transportation costs and post-production (Ryan, 2017; Wasko, 2008).

Green screen VFX production is widely accepted by the industry as a budget approach due to its high mobility and flexibility. These backdrops are portable, and fast to set up and dismantle, allowing filmmakers to shoot on location. However, the cost of VFX creation after shooting can consume a significant portion of the budget. The pursuit of higher-quality VFX rendering requires time and investment in research and development, not to mention the costs associated with cast and crew coordination, on-set practical effects, and even re-shooting.

There are six reasons why ICVFX production outperforms green screen VFX production:

1) Controlled reflections

Reflection is one of the important visual elements for creating seamless integration. In conventional practices, VFX compositors face challenges during green screen keyings, including color value, spill, and non-solid edges (Dinur, 2017). Achieving perfect integration requires addressing issues like matching color values, avoiding spills, and handling soft and semi-transparent edges. Reflective and metallic objects pose additional difficulties, often requiring digital recreation in post-production.

ICVFX addresses these challenges by using an LED wall backdrop that accurately reflects the background of the set and actors.

2) Interactive modification

Benefiting from real-time game engine, the virtual scene can be manipulated at the director's behest, allowing fine-tuning of terrain and props, texture modifications and location switching within a short period of time.

3) Infinite magic hour

ICVFX provides filmmakers with full control of time and space. A specific time of the day and weather can be designated and last as long as the director wishes. Filmmakers can virtually recreate the golden hour of the day whenever required,

rather than waiting for the sunset the next day. Virtual objects such as the sun can be pre-programmed with the desired duration to produce a day/night switching time-lapse effect in-game engine.

4) Scheduling

From a project management point of view, ICVFX also provides a manageable schedule. The crew can better manage the number of hours working overtime, eventually reducing the hourly expenditure for venue rental, cast as well as crew (Nicholas Tan, Appendix A; Sawetprom, Appendix A).

5) Travel cost

The cost of transporting a large crew and shooting on location is drastically minimised, along with associated peripheral expenses such as accommodation, air tickets, food arrangements and administration-related permit fees (Nicholas Tan, Appendix A).

6) Reshoot

Moreover, reshoots also become easier because the background can be reopened and modified digitally in game engine rather than painstakingly relighting the location or dealing with permits. The director and crew can fully manipulate the shooting environment rather than passively adapt to it (Coldeway, 2020).

3.3.4 Communication

Communication is a crucial process in collective filmmaking. In VFX, feedback relies heavily on a “telephone game”. Misunderstanding and miscommunication can lead to incorrect decisions, wasted time, and budget overflows (Dinur, 2017, p. 180). Unlike reviewing immediate results from sound design, editing and colour grading departments, clients often receive delayed results for green screen VFX production as it takes several days or weeks to render a version for review. This leads to indirect or impersonal feedback via written email (Dinur, 2017). The feedback, if vaguely written, has to be second-guessed and interpreted by the VFX vendor. Based on their understanding, VFX artists have to change the shot according to the note, re-render the CG elements, deliver to the end of the production chain and obtain internal approval. This process increases the chances of wasted effort and costs due to miscommunication between the VFX vendor and the client.

ICVFX effectively reduces uncertainty and guessing (Chyi Kei, Appendix A). It saves time and effort by allowing for clearer communication and confirmation. Unlike traditional verbal and text communication, real-time collaborating interactive systems provide immediate visual feedback, allowing artists to address changes visually and multiple notes more efficiently, rather than passing through conventional VFX departments one by one (Rank, 2021). The result displayed on the LED stage ensures that both crew members and actors have the same visual context without

relying on guesswork.

3.3.5 Actor and Performance

Meryl Streep and Liam Neeson have both complained that their acting process was suffocated by the green screen, diminishing the spark of performance interactions and energy, and causing them to feel disoriented and disillusioned. Ewan McGregor, who portrayed Obi-Wan in the *Star Wars* franchise, felt disillusioned and confused when shooting the closing scene of *Star Wars Episode III – Revenge of the Sith* (2005). He had to hold a plastic baby in front of a featureless green screen with a slightly elevated green platform indicating a hill. He recalled feeling bewildered and helpless as he looked around wildly and assumed there was a moon (Bode, 2017). Similarly, when Sam Neill was shooting for *Jurassic Park III* (2001), the green screen stage made him uncomfortable because the entire set and the creatures had to be conjured through imagination. As a result, it became embarrassing for actors to overact or underreact in a startling scene (Mallory, 2001) and have mismatched eye lines (Venkatasawmy, 2013).

To ensure actors' performances align with the environment, directors may bring the entire crew and actors to physical locations with extreme weather conditions to enhance their performance. For example, in the film *The Revenant* (2015), Director Alejandro Iñárritu and his crew spent weeks immersed in the wild, enduring amidst minus-20-degree Celsius weather to capture the characters' struggle between humans and nature through physical pain (Bode, 2017).

In ICVFX, actors and the crew can stay indoors in controlled environments, allowing them to focus on their performance and shoot. Extreme weather conditions such as cold, rainstorms and mud can be significantly reduced by using a huge immersive LED setup that displays the 3D photorealistic world. This setup helps energise actors in portraying their emotions and performing (Dunlop, 2014; Geduldick et al., 2022; Kadner, 2019; Jacobson, 2022). The *Star Wars* spin-off TV series *Obi-Wan Kenobi* (2022) was filmed with such an LED setup. The main actor, Ewan McGregor (2022) expressed his joy and satisfaction with the shooting experience compared to the production of *Star Wars* 20 years before. He said:

I'd never worked on the StageCraft set before, and it's just such a game-changer for us. The experience of the first three, especially Episodes II and III, was so much blue screen and green screen, and it's just very hard to make something believable when there's nothing there, and here we were in this amazing set where if you're shooting in the desert, everywhere you look is the desert, and if you're flying through space, the stars are flying past you, it's so cool. (Radish, 2022, para 53)

Likewise, positive feedback has been witnessed from EA and SEA professionals,

where the use of LED stages to visualise backgrounds has proven beneficial in helping actors quickly immerse themselves in their characters (Evelyn Wu, Appendix A; Miura, Appendix A; Sawetprom, Appendix A). Some actors may require some time to adapt to the LED stage (Nicholas Tan, Appendix A) or become curious about the technology behind it (Miura, Appendix A). Actors also feel safer being filmed in extreme weather or dangerous environments with the LED stage (Evelyn Wu, Appendix A). Additionally, they are pleasantly surprised to watch their final outcome directly on set (Chris Yan, Appendix A). This immediate feedback allows them to view playback on set, communicate with the director and gaffers (Chyi Kei, Appendix A), or even request a reshoot immediately if necessary.

3.3.6 Safety Concerns of ICVFX

The photorealistic LED immersive environment, such as ILM's StageCraft, may potentially lead to a safety issue: the Wile E. Coyote and Road Runner situation. This can occur after a long day of shooting when the crew and actors may become mentally exhausted and mistake the displayed photorealistic content for part of the physical world. This illusion may result in them physically hitting the LED wall without noticing the edges (Pires et al., 2022; Vox, 2020).

To conclude, this chapter compares the difference between green screen VFX production and ICVFX production workflows. With their own advantages and limitations, each production technique should be considered as a separate tool instead of completely replacing the old with the new.

In contrast to a waterfall creation process that relies on lengthy rendering times and indirect communication, causing delays and misinterpretation of feedback (Dinur, 2017; Orloff, 2022), the ICVFX workflow encompasses an agile and iterative feature. It allows different practitioners to contribute their efforts simultaneously and in parallel within the same game engine environment. Traditional departments such as match-move and roto are less in demand in ICVFX, as the entire CG creation occurs before the principal photography starts.

How does this new workflow influence individual roles and responsibilities? To answer this question, the next chapter focuses on comparing the occupational roles between green screen and ICVFX production.

Chapter 4: Examining the Differences in Occupational Roles between Green Screen VFX Production and ICVFX Production.

In the ICVFX workflow, there is a shift in the workload between set building and VFX production, leading to a decrease in demand for two departments that were prominent in the green screen VFX production workflow. However, this shift creates the need for the establishment of three new departments and requires the remaining roles to adapt accordingly.

To conduct a systematic analysis of the roles involved in both productions, this chapter focuses on four specific roles from green screen VFX production: environment artist, VFX compositor, VFX supervisor, and technical director. These roles encompass responsibilities related to set building, VFX integration, and technical support within the green screen VFX production workflow. To examine how these roles adapt to ICVFX production, four roles from a typical ICVFX production are selected and described based on existing literature and insights gathered from personal interviews. The purpose of this examination is to provide a systematic comparison between the roles in these two production approaches.

4.1 The Occupational Roles in Green Screen VFX Production

The “credit list” of a production explicitly outlines the departmental structure. For this chapter, the VFX-laden superhero film *Avengers 4: End Game* (2019) was chosen as an example, as shown in Figure 10 below. This list illustrates the occupational roles required for a green screen VFX production.

Figure 10
The Credit list from *Avengers 4: End Game* (2019)

	Supervising Art Director Set Decorator	RAYMOND CHAN LESLIE A. POPE		
Art Directors	JULIAN ASHBY • TOM BROWN JORDAN CROCKETT • JANN ENGEL BEAT FRUTIGER • KEVIN HOULIHAN CRISSY JO HOWES • MIKE STALLION BRIAN STULTZ • DAVID E. SCOTT		Storyboard Artists	BRYAN ANDREWS • DARRIN DENLINGER TODD HARRIS • DAVID KRENTZ SUSAN BURIG • JENN MOYE TINA CHARAD THERESA GREENE
On-Set Art Director	SEAN RYAN JENNINGS		Graphic Designers	JOSHUA SANKAR
Assistant Art Directors	LAUREN ABIOUNESS • JENNIFER BASH KEVIN GILBERT DEREK PENDELTON JEP WYATT		Art Department Coordinator	TONY BOHORQUEZ • NELLIE WATSON
Digital Modeler			Digital Asset Coordinator	BRETT DAVID PHILLIPS
Key Art Department Assistant			Model Makers	MARYELLEN HENDRICK • KATY LOWE MICHAEL NAVARRO
			Art Department Production Assistants	
	Concept Artists	BOB CHESHIRE • SEAN HARGREAVES • ANDREW REEDER • PAUL CATLING • PAUL CHANDLER • ROBERTO FERNANDEZ CASTRO TIM HILL • CHRIS KESLER • OLIVIER PRON • PETE THOMPSON • IVAN WEIGHTMAN		
	Set Designers	CHRIS ARNOLD • JOHN BERGER • TIM CROSHAW • KEVIN CROSS • TIMOTHY EARLS • ROBERT FECHTMAN • ERIK HARALDSTED • ROB JOHNSON BRIA KINTER • PATRICIA KLAOWNN • JEFF MARKWITH • KARL J. MARTIN • RON MASON • MASAKO MASUDA • ANNE PORTER • JULIEN POUIGNIER ED SYMON • JUSTIN TRUDEAU • BRIAN A. WAITS • HAIJU WANG • C.L. WARD • ROBERT WOODRUFF		
Visual Development Manager	AJ YARGAS		Digital Sculptors	JOSH HERMAN ADAM ROSS
Visual Development Coordinator	BOJAN YUCICEVIC			
	Visual Development Concept Illustrators	ANTHONY FRANCISCO • RODNEY FUENTEABELLA • IAN JOYNER • ALEXANDER MANDRADJIEV • JERAD MARANTZ • FAUSTO DE MARTINI JOSH NIZZI • ANDY PARK • PHIL SAUNDERS • CONSTANTINE SEKERIS • TULLY SUMMERS • JUSTIN SWEET • JACKSON SZE		
	Visual Development Concept Artists	WESLEY BURT • ALEKSI BRICLOT • MELISSA ENCINAS • ADI GRANOV • RYAN LANG • IAIN MCCAIG • KARLA ORTIZ • STEPHEN SCHIRLE • JOHN STAUB		
VISUAL EFFECTS AND ANIMATION				
	Visual Effects and Animation by DIGITAL DOMAIN			
	VFX Supervisor	KELLY PORT		
VFX Producer	ERIC SCOTT	Digital Effects Supervisor	SCOTT DMAB EDELSTEIN	
Animation Supervisor	JAN PHILIP CRAMER	Digital Producer	GEORGINA STREET	
CG Supervisors	MARTIN JOHANSSON • HANNES POSER GREG TEEGARDEN	Compositing Supervisors	ERIC KASANOWSKI MICHAEL MELCHIORRE	
Character FX Supervisor	NATHAN FOK	Conceptual Artists	ALEX RUIZ • NICK LLOYD	
Facial Modeling Supervisor	RON EJ MILLER	Pipeline Supervisor	PETER RABEL	
Rigging Supervisors	ERIC TANG • DAVID CORRAL	Integration Supervisor	SAM NIXON	
Digital Effects Supervisor	DARREN HENDLER	Stereo Supervisor	BRYAN SMEALL	
	Lead Artists			
	BUSHRA AL-MAZLOUM • JONATHAN BERRY • FERNANDO BRANDAO DE BRAGA • CHUN PING CHAO • PAUL CHAPMAN • RICKEY CLOUDSDALE • BRETT ELLIS NATHALIE GONTHIER • VICTOR GRANT • ELLEN HOFFMANN • HEATHER HOYLAND • VIV JIM • ANDREW LEMA • JACOB MILLER • REMI MUNIER • CHRIS NICHOLS KYM OLSEN • TOBIAS OTT • CHRISTOPHER RICKARD • KEITH W. SMITH • FRANKIE STELLATO • KATIE WILLIAMS • BRIAN ZHENG			
	Production Staff			
	NALINE AMARAL • YENEY AMARO • DANIEL BAKER • STEPHEN BASSETT • LUKE BOTTERON • ANDREW CHENG • CAITRIONA CURRAN • CURTIS DOHERTY REBECCA FAIR-LIEN • BRENDAN GRADY • ADRIANNA GRANVILLE • ALLISON HARBIN • KELANI LIM • ALISON LUONG • DAVID McPHAIL • KAILENE MURRAY • NICOLE MYERS ALDI PURNAMA • NOHEMIE RACINE • ALVIN ROXAS • CRAIG SHEPPARD • JULIA TOMPA • MATT VOYNOVICH • HENRY WAN • CHENYU WANG • BRITT ZELINSKI			
	Animators			
	OMAIKEL ALFARO • ALFONSO ALPUERTO • TOM ST. AMAND • ELIZABETH BERNARD • DAN BROVERMAN • JEREMY BROWN • BUCK BUCKLEY JASON THOMAS CAMPBELL • MAN JOE CHAN • JOEY CHANG • AUGUSTE CHANG • ELISABETH FRANKLIN CONSTANTINE • CHRIS ENDICOTT PAOLA CERVANTES ESPINOSA • VICTOR FLEMING • JAMES GROW • CHIEN-CHIA HUANG • BRANDON HUANG • ANDREW LAM • MARK LIN • BRAD LINCOLN SACHIN MATHEW • PERICLES MICHELIN • BRAD SHARE • MARCO LA TORRE • CAMILLE TURON • CHRISTOPHER ERIN WALSH • KENT YOSHIDA			
	CG Artists			
	DAMIEN ABOOD • FRANCISCO ALVAREZ • CHRIS BOSTJANICK • ALVARO CLAVER • TRISTAN CONNORS • NICOLAS V COSMI • CLARA COULTER • BRIAN CREASEY GEOFF DIAMOND • RAFFAEL FRANK • LUCAS GODINEAU • BRENO GUINART • MARTY HON • LINA TOYLINE HUM • WALTER HYNEMAN • MLADEN JOVICIC • ANTO TONY JURIC THOMAS KERNAN • BO KWON • KUI HAN LEE • DAVID McLEAN • MAURIZIO MEMOLI • MAKARAND NAZIRKAR • CATALIN NICULESCU • MELANIE OKAMURA • ARTUR OWNSNIKI PATRICIA PAWLAK • FREDERICK RICHARDS • DERRICK SESSON II • CHRISTIAN VERA SILVA • NELSON SOUSA • JOSEPH D. SPADARO • ADRIENNE STANGER HANZHI TANG • VINCENT TOUACHE • LUKE WAKEFORD • TREVOR WIDE • CAROLYN WONG • VINCENT YAN • CHAN WING YIN			
	FX Artists			
	NAGENDER RAJU BOGA • SIMON BÜTLER • CHARLES-FÉLIX CHABERT • DEREK CHEUNG • JOHNSON CHUANG • JAMES HALVERSON • JEREMY HAMPTON SHO HASEGAWA • JEFFREY CHARLES HIGGINS • PEI ZHI HUANG • HAN JOO JEONG • SKEEL LEE • KEVIN MITCHELL • TOM NIXON • HIROYUKI OKUBO SAI WIN MYINT OO • NEMA SAFVATI • EDMOND SMITH III • JOHN SPARKS • RAN WANG • MASAHITO YOSHIOKA			
	Composers			
	KHARI ANTHONY • FELIX B. LAFONTAINE • ADAM BACON • ERIC M. BEAVER • BOGDAN BONDARCHUK • KEVIN BOUCHEZ • J. CHRISTOPHE BOUE • JOHN BRENNICK ANDRE BRUTO • CHAD BUEHLER • COLIN CAMPBELL • MARCO CANTALUPPI • SARAH CHANG • EUNJUNG EUNICE CHO • RAFAEL FRANCISCO COLON TRAJAN CONSTANTINESCU • DAN CREGAN • DEXTER DAVEY • MARIE VICTORIA DENOGA • SPENCER DINNEY • JOE ENGELKE • JOHN FUKUSHIMA • TOMI GEORGE EDDIE GUTIERREZ • HEIDRUN TINNA HARALDSDOTTIR • DANIEL HARKNESS • PETER HERLEIN • ESTEPHANIA HERNANDEZ • WERNER TEN HOEVE • BOB HOMAMI STEVEN (ZI LIN) KONG • PETER KOSS • PAUL KULIKOWSKI • NICHIA KUMKEAW • AARON LE KUPFERMAN • EVAN KWAN • DELPHINE LAURENT • SAMUEL LEE SEUNG JOON LEE • DANNY LEE • BRENDAN LLAVE • FALK LÜDE • KEYWAN MAHINTORABI • BRUNO MARTINS • SAKANTHA MCCONNELL • ZOUBAIR MOOSUDDIE VINH NGUYEN • FRANCISCO PANZERI • FRANCIS PUTTANANGADI • MAICKEL QUINET • TIN LORRAINE RANGEL • JOSHUA RIVAS • BOB ROESLER • RANDY RUAN VANIA RUANO • BRIAN RUST • OLIVIER P. SARDA • CHRISTIAN SCHERMERHORN • JASON O. T. SELFE • ROMMEL SHAMOUN • JOSEPH SILVA • R. MATT SMITH ROBERT SNYDER • DANIEL SUNWOOD • MARC TAGANAS • DAVE TAKAYAMA • TOM TRUSCOTT • SIMON TWINE • BRITTANY WETZEL MARKUS WHITE • ERIC WILSON • JAMIE WONG • SOMYI YANG			
	Lights			
	ELLA ADAMS • WEVERTON ALVES • HITESH BHARADIA • KAMAL BHARDWAJ • JONATHAN BOISVERT • JORDAN BROOKES • JEREMY BUTTELL • MICHAEL CABRERA KITTTITUS KIT CHINATWORN • CHI-CHANG CHU • FABRICE DI CICCO • JOAKIM ERIKSSON • ROBERT ANDREW DAVID FRICK • TOBY WILSON GAINES • JAVIER GARCIA FRANÇOIS GENDRON • JOSEPH HAYDEN • KAREN HULSE • JD IMHOF • ASUKA TOHDA KINNEY • SCOTT KNAPP • ETIENNE LECLERC • JAEMIN LEE • KEN K. LEE WAI HUNG (DANIEL) LEUNG • SON T. LY • SHOICHI MATSUBARA • SABRINA NUNES • MARK RODAHL • ADRIEN VALLECILLA GIDEON W. VANDEGRIFT • GABRIEL WHITE • FARID YUZAMI (TATAK)			
	Character FX Artists			
	OBA AMEZIANE-HASSANI • MATT BROWN • DAVID DEBACKER • JAY GAMBELL • JUAN CARLOS DELGADO GONZALEZ • JESSICA AMBER HURST • GIORGIO LAFRATTA JOSE LOPEZ • JOSH METHVEN • KIM ALEX NIELSEN • ERIC OJONO • EDUARDO DIOSES OROZCO • NAVIN PINTO • KAITLYN PELOW PRESTIA • ANDY ROMINE DELINOR DUNCREASE SMITH II • BONGKEE SOHN • H. DANTE TANTOCO • YANN VANLERBERGHE • DULCE VELAZQUEZ • SEAN M. WHITE			
	Environmental Artists			
	JUAN PABLO ALLGEIER • NIALL BOOKER • ALBERTO CASU • ZACH CHRISTIAN • ERIC DIMA-ALA • ROB FITZSIMMONS • JONATHAN GREEN • THEA LUCHAK • KRISTA McLEAN ZACH MANDT • LEON MCCORMICK • CONRAD MELVIN • BENJAMIN NOWAK • ÉMILE POISSANT • GEOFFROI RIDEL • OLIVER SEEMANN • DANIEL THRON • JOELL XIN ZHOU			
	Integration Artists			
	JON AGHASSIAN • VIKI CHAN • VINCENT KS CHENG • SCOTT INKSTER • EMMANUEL DE LANGE • SUNGMIN LIM • ROSS MACKENZIE ALE JANORA MARQUEZ • JIM MOORHEAD • SOM N SHANKAR • PAUL SCHMITKE • ROBYN SPENCER • CHANTHI VIJAYAPALA • AIDEN WILK			
	Roto / Paint Artists			
	AMIRAH BUSAIRI • MEAGAN BYRT • HOWARD CABALFIN • MARCUS CARTER • SCOTT CRAFTORD • JANET FREEDLAND • JONI GOLLEY • MARLAN HARRIS MARVIN JONES • ADRIAN RIVERA LOZANO • CONNOR MCCOSHEN • VICTOR HUGO RODRIGUEZ • HEATHER MACPHEE RYAN • AZHAR SALIM ADRIAN CABALLEROS TENG • BRIAN THOMASON • CYNTHIA ARAÇÓN TREVIÑO • JESSICA TUE • DAWN WELLS			
	TDs			
	KENNETH VAN AKEN • NICO DUFORT • DIMITRY KACHKOYSKI • DAVID KENLEY • NICOLAS KOUBI • BRUNO NICKO • REMI PIERRE • RAFE SACKS • ELYSE WEI • DARREN WILLIAMS			
	Production Support			
	AMIR AZAR • PETER COUCH • KENZIE FISHER • LALA GAVGAVIAN • JONATHAN GERBER • BRET GOLDHORN • JIMMY GORDON • ROGER VAN HELDEN • WILLIAM G. HIGGINS JASON IVERSEN • ALEX KUNG • KAREY MALTZAHN • JOSEPH SANTA MARIA • MELLISSA McAULEY • CARRIE GRACE McLAY • FAZRAN NIJABDEEN • FERGAL O'BRIEN CHRISTOPHER ORELLANA • MARC OSTROFF • OMAR PAREDES • BHAKTI PATWARDHAN • ANDREW PAVELL • AMANDA JANE PORTER • FERREOL PRADO • MICHAEL QUAN NATHANIEL RAMSEY • PHILLIP GLENN REED • JACQUELINE ROSADO • ODED ROSENBLUM • KEN ROUPENIAN • DAVID SAMIJA • MICHE SAUVEUR • MATTHEW SEALOCK MANESH SHAFIEI • KAREN SICKLES • WERI SIN • AUSTIN SMITH • ANDREW TENNANT • MIKE THOMPSON • JOSE VALENCIA • CATHERINE WONG • CANDICE WOOTEN • STANLEY			

Note A selected credit list captured from *Avengers 4: End Game*

4.1.1 Environment Artist

Originating from “matte painting”, digital matte painting empowers environment artists to “paint” on a computer with photographic material by editing, manipulating, and assembling different photo real images, rendered CG elements and live-action footage. Digitalisation enables environment artists and matte painters to create a wide range of backdrops from 2D, 2.5D and 3D projections such as landscapes, skies and interior environments. Generally, environment artists come from a fine arts background or have a strong foundation in drawing. They also possess good knowledge of photography, lenses and perspective; as well as the ability to work with 2D and 3D digital content creation software.

In a production situation, environment artists receive the 3D files and 2D files from upper-stream departments, such as camera tracking data from the layout department, Maya files from modelling and Houdini files from the lighting department. They then use this information to create the extension backgrounds with that information. Once the background is completed, they integrate it into a Nuke file as a pre-comp file and pass it to the VFX compositing department.

4.1.2 VFX Compositor

VFX compositors act as the gatekeeper at the end of a VFX shot production chain, regardless of the shot’s complexity (Dinur, 2017). Typically, this role requires adequate experience in camera operation, a solid understanding of colour and frame composition, and sensitivity to these aspects. Compositing tasks can range from minor enhancements to sky replacement to adding CG performances and even creating full CG realities (McClellan, 2007). Dinur further explains the importance of compositing:

Compositing is where green and blue screen extractions take place, where roto is created and adjusted and where a plethora of 2D and 3D elements such as lens flares, smoke, fire, explosions, debris, and dust are added and refined. It is where the final (and sometimes most crucial) steps toward photorealism and integration are performed through careful adjustment of colour, contrast, light and depth ... in many pipeline configurations, compositing is the converging point of all other crafts. (p. 89)

VFX compositors are also responsible for recreating camera and lens properties accurately, for instance, focus, depth of field and flare.

4.1.3 VFX Supervisor

The VFX supervisor is a critical creative department head responsible balancing

creative and technical considerations, aiming to maintain quality while minimising costs from pre-production to post-production by working closely with directors, producers and DoP (McClellan, 2007). Typically, there is at least one VFX supervisor on set, although this role may be omitted in small-scale projects with limited budgets (Magary, 2022; Maierhofer, 2017).

As highlighted by Cram (2012), this role should have a strong background in camera work and be sensitive to photographic principles such as light, shadow, atmospheric depth and colour tone. Equally important is an eye for recognising the characteristics of the camera lens, such as blurriness. Typically, a VFX supervisor evolves from a VFX compositor with in-depth knowledge of CGI. With prior knowledge and experience, the VFX supervisor can estimate the number of man-hours required for each type of VFX shot, assisting in the scheduling and budgeting for filmmakers.

The VFX supervisor is responsible for delineating and evaluating what to shoot and how to shoot a VFX shot with the right tools, realising the director's vision with quality while staying within the budget (Cram, 2012; Squires, 2021). With pre-vis, they discuss and test the overall look of a wide range of visual effect-related issues with the director, as well as coordinate shooting schedules with AD, DoP and producer (Keil & Whissel, 2016). In the context of green screen VFX production, the VFX supervisor also needs to make decisions regarding which parts of the set will be physically constructed by the art department, which parts will be extended in CG by the post-production team and whether practical effects are needed from the special effects team (Cram, 2012). They also collaborate with the costumes department and the set department to ensure that the materials used for the costumes will not cause problems during keying. Additionally, if a digital version of the actors is required for the shot, the VFX supervisor will arrange for 3D scanning.

During the shooting phase, as mentioned, the roles of the VFX supervisor are divided into two: the on-set VFX supervisor and the VFX production supervisor. The former needs to share the same goal as the first AD and the DoP, while the latter focuses on post-production. One of the responsibilities of the on-set VFX supervisor is to communicate with the director and decide where to set up the green screen. Additionally, this role has to capture and collect essential camera information for post-production, such as using grey and chrome spheres and placing markers. These data are necessary for VFX artists to deliver high visual fidelity in each shot (Keil & Whissel, 2016). Furthermore, a placeholder for a CG creature will be placed in the shot for the actor's eye line reference and timing (Okun & Zwerman, 2021). This role is highly influential alongside the director because they can influence how footage sequences are outsourced to other VFX companies, consequently affecting the outcome (Cram, 2012).

In post-production, the VFX production supervisor oversees the quality of the digital assets and the finished VFX shots from different VFX departments before sending

them to the final editorial department. Typically, the VFX supervisor works with a team of CG supervisors, TDs and department leads to review the submitted digital assets and shots during a session called dailies. For projects involving multiple VFX vendors across the globe, the VFX supervisors have to check the progress and actively communicate with other VFX supervisors.

4.1.4 Technical Director (TD)

In contrast to the director and VFX artists, the TD in the field of VFX possesses a distinctive skill set characterised by proficiency in computer programming, visual arts, and a comprehensive understanding of graphic design and filmmaking techniques (Venkatasawmy, 2013). The primary focus of the TD revolves around resolving software malfunctions and devising and implementing new workflow features, plugins, and tools aimed at enhancing the productivity of VFX artists and enabling the creation of intricate content (Dunlop, 2014).

In an ideal scenario, having a dedicated TD for each VFX department, such as the lighting TD, modelling TD, and compositing TD, is considered highly advantageous. This arrangement facilitates a deep understanding of the specific needs of artists within each department and enables the resolution of technical challenges germane to each artistic domain. To expedite VFX processes, the TD undertakes the development of shortcuts and scripts, alleviating the burden of repetitive tasks for VFX artists, particularly in areas like modelling and lighting (Dunlop, 2014; Richter, 2018). Additionally, the TD plays a pivotal role in structuring the workflow and providing organised project guidance, including standardised asset naming conventions and file placement protocols.

A crucial aspect of TD's role extends to research and development, wherein they assume a critical role in advancing the technical frontier of VFX software, thereby improving overall efficiency within the production pipeline. By continuously exploring novel technologies and methodologies, the TD contributes significantly to the continual improvement of VFX production processes.

4.2 The Occupational Roles in ICVFX Production

New technology tools not only enhance efficiency but also bring about changes in the organisational structure. An example of this can be seen in the ending credits of *The Mandalorian* Season 1, depicted in Figure 11 below.

Figure 11
The Credit List from The Mandalorian Season 1



Note A selected credit list captured from The Mandalorian.

In contrast to conventional VFX-heavy movies, the credit list from *The Mandalorian* Season 1, Episode 1 reveals the establishment of several roles and departments related to ICVFX: VP supervisor, the “Brain Bar” crew and the VAD. What are their roles and responsibilities in the ICVFX workflow?

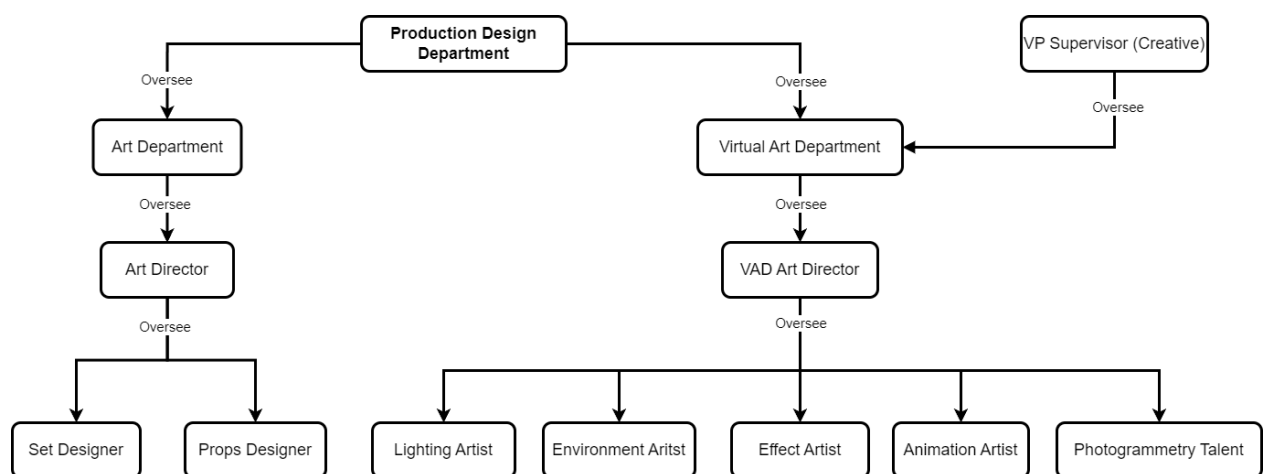
4.2.1 The Virtual Art Department (VAD) Artist

The VAD emerges as a novel and indispensable department in the context of ICVFX. Typically overseen by the production designer in a VP workflow, the VAD serves three essential functions within the ICVFX framework: 1) planning execution of visual elements, 2) producing photorealistic virtual environments and 3) ensuring design consistency. Unlike traditional art departments, the VAD engages in developing real-time 3D assets from the project’s inception during pre-production in a game engine (Teckwon, Appendix A). Their focus is on creating a production-ready environment that facilitates on-set integration and can be seamlessly detached after shooting is

complete (Failes, 2023). In large-scale productions, VAD artists typically fall under the production design department, adhering to the guidelines, designs, and aesthetics set forth by the production designer. They work bidirectionally with the art department, translating conceptual ideas into visual representations, and ensuring that the overall concept is effectively brought to life (ScreenSkills, 2022; Spillers, 2021; Weaver, et al., 2021). Moreover, the VAD acts as a bridge, facilitating communication among creatives, artists, and external vendors. Their role involves conveying feedback from these stakeholders to the asset development teams, ensuring the realisation of the project's artistic vision while upholding consistent style and high-quality standards (Holben, 2020).

Figure 12

The Hierarchy Structure of the Production Design and Virtual Art Department



The preceding Figure 12 above provides an overview of the hierarchy structure production design department. As illustrated, VAD is not a separate department but part of the production department. Led by the VAD Art Director and working in collaboration with game engine artists, the VAD department encompasses various functions related to virtual set creation and coordination with multiple departments.

The role of the VAD Art Director in ICVFX is multifaceted and requires a comprehensive understanding of the entire workflow and pipeline to effectively plan and execute shots. They are responsible for making critical decisions and addressing important questions throughout the production process. The VAD Art Director must also assess whether a shot requires virtual-physical integration. Depending on the complexity of the scene and the project's requirements, certain aspects may be better suited for virtual elements, while others may benefit from practical, physical props or set pieces. Balancing these elements is crucial to achieving a visually captivating and believable result. Another consideration for the VAD Art Director is the use of HDRI versus a full CG environment. They must evaluate whether the former alone is sufficient to achieve the desired lighting and VFX effects or if a full CG environment is necessary to enhance the scene's realism and impact.

Collaboration with the VP supervisor (creative) is essential for effective execution. Involvement in early meetings allows the VAD Art Director to contribute artistic insights and considerations, ensuring the visual direction aligns with the project's vision. Additionally, the VP supervisor (creative) quality-checks the scene during testing to identify and address any issues that may arise, ensuring the virtual environment meets the desired standards. Depending on the scale of the project, the VAD Art Director may also take on some of the duties typically assigned to the VP supervisor (creative). This flexibility allows for efficient coordination and decision-making, especially in smaller-scale productions where combining roles is feasible.

In addition, the VAD Art Director works in tandem with other roles, such as game engine artists who possess a pre-visualization background, VFX-related skills, and game engine knowledge. The expertise of artists with an aesthetic eye from the VFX industry is indispensable. This role is instrumental in modifying assets and enriching the environment to achieve a photorealistic level of quality, enhancing the overall visual experience of the project.

Furthermore, the VAD department may include a photogrammetry team responsible for 3D scanning props or producing HDRI (Rank, 2021). Photogrammetry plays a crucial role in creating photorealistic physical props and HDRI sky domes for the virtual environment (Rank, 2021). The VAD works closely with a dedicated team for photogrammetry, ensuring seamless integration with the physical set department and matching virtual lighting with the lighting department. Multiple iterations are performed to refine the direction and blending of the virtual and physical elements until the shooting day (Gedulick et al., 2022). Consequently, this process provides a natural reflection of actors' faces, costumes and props (Holben, 2020; Kadner, 2021b).

Despite the graph shown earlier, the actual production is more complicated and dynamic. In the pre-production phase, VAD artists engage in a three-stage design process: design, construction, and finalisation. During the design stage, creativity and exploration are encouraged, with low-cost and rapid iterations to explore various possibilities. VAD artists use game engine technology to craft rough layouts and set the mood of the scene based on the concept art. Through virtual scouting with the director and DoP within the game engine, camera angles, lighting, objects, vegetation, and particle systems are decided upon in real-time, facilitating valuable insights and immediate adjustments to achieve the desired visual outcome.

Once the virtual set is confirmed and locked, the game level is delivered to the control room and "Brain Bar" (Kerekes, 2022). Despite pre-planned shots, improvisations may occur during the blending and shooting phases, requiring the core team of VAD artists and the VP supervisor to be present on-set for modifications (Kerekes, 2022; Perforce, 2022). The VAD is also responsible for delivering the final scene to a VFX vendor if post-production work is required.

Overall, the VAD department serves as a bridge between the VFX and art departments, while also interacting closely with the “Brain Bar.” Collaboration and practical problem-solving are fundamental aspects of their responsibilities. Cost efficiency, time management, budget, schedule adherence, and the overall final visual output are key considerations handled by the VAD department in conjunction with the VFX and “Brain Bar” teams (Perforce, 2022).

4.2.2 The “Brain Bar” Artist

ICVFX is characterised by a complex and innovative technical framework that requires expertise and coordination from multiple technical disciplines. Each component of the ICVFX system demands a profound understanding and skill set for effective monitoring and optimisation. As a result, a team of Technical Artists (TA) and experts is essential, drawn from traditional VFX, live events, and real-time industries. Together, they form the “Brain Bar” team, working in unison to ensure seamless system performance, even under immense pressure (Beck, 2021; Geduldick et al., 2022; ScreenSkills, 2022).

This department serves as the technical backbone of ICVFX, facilitating close collaboration with the VFX supervisor, DoP, director, and VAD Art Director. Their role encompasses managing and optimising the technical aspects of the ICVFX workflow, ensuring a smooth and efficient execution of the production.

In *The Mandalorian*, the “Brain Bar” department consisted of game engine artists, VFX compositors, camera tracking experts, video I/O display experts and LED screen technicians, IT and network technicians. Richard Bluff (2020), the VFX Supervisor described the role of the “Brain Bar” crew as follows:

They are the ones that are operating the massive screens. They are bringing up all the different environments that you would see, that you would shoot against. They’re able to move mountains quite literally. They can rotate the world. They can move us from one end of the hangar to the other end of the hangar. They can add extra lighting into the scene that of course would appear to have an effect on the actors on the stage so they do many, many, many things to continue to make the camera believe the magic trick (As cited in Bayer, 2020, para. 29).

From a department structure perspective, Josh Kerekes (2022), the Head of VP from PIXOMONDO suggested dividing this department into the Left Brain and Right Brain working on the technical and creative sides respectively, as outlined in Table 3 below:

Table 3
Brain Bar Department

Brain Bar		
Name:	Left Brain (technical)	Right Brain (creative)
Main Tasks:	On-set operators, stability, technical troubleshooting	Creative collaborations, shot compositions, finalising that last 10%
Department Head:	VP supervisor (technical)	VP supervisor (creative)
Team member:	Engine operator (technical)	VAD supervisor
	Stage operator - Disguise Operator	Engine operator compositing
	Stage operator – volume control	Engine operator: lighting/shading
	Stage operator - VP technician	
	Stage operator - LED technician	

Both teams are led by the VP supervisor (technical) and VP supervisor (creative). Together, they work closely with the director, first AD and other department heads from the start of the project to communicate and resolve technical-related issues and requests (ScreenSkills, 2022).

The Left Brain team is recommended to have artists who have experience in immersive technology, Augmented Reality (AR) and live event areas. Although these sectors share the same knowledge foundation, the dominant and valued skills for ICVFX are the understanding of cameras, system optimisation, coding and R&D. This team is dedicated to ensuring the system stability, troubleshooting any ad hoc issues and managing onset operations. For example, they synchronise the timecode, calibrate the camera tracking system, and maintain the LED screen frequency and frame rate (Geduldick et al., 2022). If needed, they develop specific tools and plugins to empower the creatives and push the boundaries (Perforce, 2022). As a team, they also work with the DoP and creative team on LED colour calibration, lighting workflows and video colour spaces (Rodriguez, 2023).

Additionally, the Right Brain team handles the creative aspect of the production, such as shot composition, and finalising the last 10% of the shot. An artistic eye is crucial in this team because artists are responsible for making changes in real-time to content created in Unreal Engine. These changes can range from something simple as changing the colour of a material instance to something as complex as reworking the environment layouts (Galler, 2022). In addition, spatial sense becomes important to manipulate the spatial orientation of the virtual set to ensure continuity (Chris Yan, Appendix A). This team works collaboratively on-set to seamlessly blend the physical and virtual elements while addressing any unwanted visual artefacts such as moire, banding and scanlines that (Weaver, et al., 2021). Technically, genlock is a crucial measure taken by “Brain Bar” artists and the DoP. Genlock is a process that

synchronises the frequency and phase between the LED wall and the camera system. This synchronisation effectively reduces scanlines, banding, and flickering that may occur due to misalignment between the camera's frame rate and the LED wall's refresh rate. By ensuring precise timing and alignment between the two systems, genlock minimizes unwanted visual artefacts in the final output.

These artefacts, such as moire, banding, and scanlines, are often correlated to the camera and the LED panels used in the production. To address visual artefacts effectively, “Brain Bar” artists work in close collaboration with the DoP and take a combination of actions and considerations. For instance, nodal shooting can be employed to avoid moire patterns caused by the interaction between the camera sensor and the LED screen's pixel grid. Nodal shooting refers to adjusting the camera position and focal length so that the scene's perspective remains consistent, reducing the risk of moiré in the final image (Weaver, et al., 2021).

From a content management perspective, version and metadata management are crucial aspects of content organisation and delivery in ICVFX. “Brain Bar” artists must possess software development knowledge, particularly related to source control and quality assurance. They track and retain various versions and metadata, such as timestamps, timecode, camera tracking data and notes regarding changes made to assets or the production process (Geduldick et al., 2022; Orloff, 2022). These data are not only valuable for maintaining a clear record of the production's progress but could also be used by external VFX vendors to integrate virtual elements into the live-action footage.

It is worth mentioning that the specific name “Brain Bar” may vary depending on the company or project's context, and similarly, job titles and department structures may differ across different productions. Flexibility and adaptability are key attributes of the “Brain Bar” team, as they navigate the unique demands and challenges of each ICVFX project.

4.2.3 Virtual Production Supervisor

The VP supervisor is one of the newly established roles in ICVFX. This role plays a liaison role bridging the VP team, the art team and the director. Typically, a VP supervisor comes from a supervisor role in the VFX, live event or video game development fields (Sawetprom, Appendix A). With relevant working experience, they are equipped with production or game engine-related knowledge. These backgrounds provide them with leadership and lead the team with creative and technical vision (Weaver, et al., 2021). Nonetheless, to become a VP supervisor, one should immerse themselves in the VP field and undergo a comprehensive learning process. Technical management, content creation and communication are the three main responsibilities of the VP supervisor. It is worth noting that some production houses may have one VP supervisor, while others some may separate this role into

two: VP supervisor (technical) and VP supervisor (creative).

From a technical aspect, this supervisor role should have a comprehensive and expert understanding of the technical tools of their studio, including their potential and constraints. Monitoring and managing any ICVFX-related technology are part of their duties to ensure the system is well-functioning and robust, including but not limited to camera tracking, virtual scouting, motion capture or any other tailor-made techniques (Bennett et al., 2021; Kadner, 2021). The VP supervisor could even develop and modify new tools or plugins to the existing pipeline for better efficiency if they have an advanced coding background (ScreenSkills, 2022). Furthermore, during the production phase, when a new request comes in, the VP supervisor (technical) should be able to inform the client of the limitations of the system and present affordable alternative solutions with clear benefits and pitfalls (Teckwon, Appendix A). As described by VP Supervisor Sirasit Sawerporm: “You cannot say ‘No’ in the middle of the production. We have a rule [which is] if you say no, you have to give him why and have a solution for him.” (Sawerporm, Appendix A)

From a creative standpoint, the VP supervisor assumes the responsibility of analysing the script during preproduction, discerning the required techniques, and engaging in comprehensive discussions concerning the complexity of each shot with a “Fix-it-in-the-Pre” mindset (Evelyn Wu, Appendix A). In this capacity, the supervisor collaborates closely with the director and producer, striving to ascertain optimal solutions that align with the director's creative vision (Weaver, et al., 2021). It is noteworthy that the implementation of such solutions may potentially influence both the production schedule and budget. Additionally, the VP supervisor is expected to provide support to the VAD as required, which may involve tasks such as conducting photogrammetry. During the production phase, the supervisor's role is to ensure the accurate and seamless projection of the virtual scene generated by the VAD onto the LED wall display. This entails overseeing the technical aspects to guarantee the faithful representation of the virtual environment during filming.

Regardless of the technical or creative aspects, individuals holding the role of VP supervisor are required to possess the characteristics of a leader, a manager, and a problem-solver. Distinct from conventional frame-based rendering workflows, the VP supervisor operates under considerable pressure and must adeptly handle unforeseen and ad hoc situations. Internally, this role assumes the responsibility of overseeing their teams and proactively addressing any technical challenges that may arise during VP (ScreenSkills, 2022).

Moreover, their role extends beyond the confines of their immediate team, necessitating effective communication and negotiation skills in their interactions with other departments. A notable facet of their responsibility involves acting as a “translator” between the technical and production sides, as each domain possesses its own specialised jargon and terminology. As articulated by Sawetprom, effective

communication requires a mutual understanding of technical terms, and skillfully translating them between the respective technical and production teams: “You have to know how you translate technical terms into their technical terms and understand their technical terms to your technical terms.”(Sawetprom, Appendix A)

4.2.4 VFX Supervisor

In ICVFX, the integration of real-time game technology and LED stage has resulted in a notable shift in the responsibilities of VFX supervisors, primarily emphasising their involvement during the pre-production and shooting phases. Their key tasks now encompass overseeing the implementation of 3D visual effects and in-camera work (Failes, 2023). As part of this role, VFX supervisors are required to closely monitor and guide the real-time team's development of 3D content while also collaborating with the director and DoP to ensure alignment with the creative vision (Rank, 2021). Furthermore, VFX supervisors are actively engaged in creative decision-making processes, interacting with various departments such as camera and production design. This involvement is particularly critical as these departments play a pivotal role in refining the colouration of on-set props, thus influencing the overall visual aesthetic of the production (Failes, 2023). As a result, the VFX supervisor's role has expanded beyond its traditional post-production focus to encompass a more integrated and participatory role throughout different stages of the production process.

4.3 Chapter Summary and Discussion

In conclusion, this chapter has provided a comprehensive understanding of the roles of various key individuals in the context of ICVFX. The roles of VAD artists, “Brain Bar” artists, VP supervisor(s) and VFX supervisors have been discussed, highlighting their distinct contributions to the ICVFX workflow. The VFX supervisor holds a pivotal position, overseeing the entire VFX creation process and ensuring its cohesive integration into the filmmaking project. Their role involves maintaining control and coordination across different departments to achieve the desired visual effects. On the other hand, the VP supervisors are divided into creative and technical aspects, each with specific responsibilities. They closely monitor the real-time departments, where the integration of game technology plays a significant role in ICVFX.

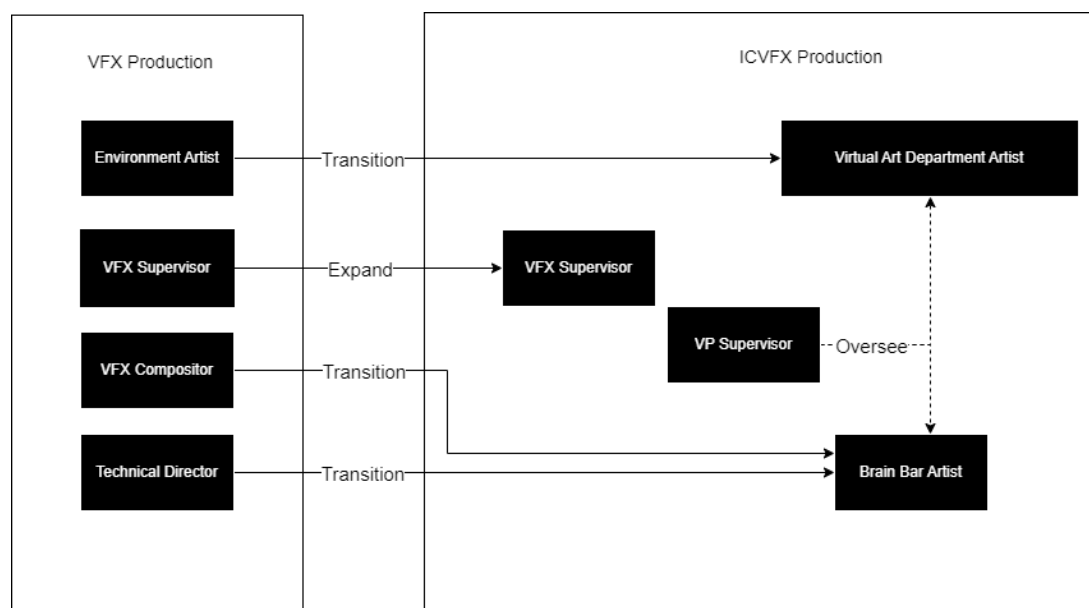
4.3.1 Impacts on Occupational Roles

This chapter reveals several notable findings about the organisational structure in an ICVFX production. The depicted changes in Figure 13 below illustrate the evolving landscape of ICVFX, with a hierarchy indicated on the right, showcasing the relative positions of various roles within the production. The transformation can be categorised into two types: expand and transition.

First and foremost, despite the VFX supervisor retaining their title within the ICVFX framework, they have to work closely with the VP crew to ensure seamless integration. Concurrently, the environment artist transforms into the VAD artist, engaged in creating environments through game engines. Furthermore, the VFX compositor and TD, now part of the “Brain Bar”, exhibit distinct responsibilities, with the former focusing on on-set compositing skills, while the latter dedicates efforts to software research, development, and the creation of production-worthy plugins over the long term. A novel role, the VP supervisor, emerges as an intermediary within the existing organisational structure, overseeing both the VAD and “Brain Bar”.

Figure 13

The Transition of Occupational Roles from Green Screen VFX Production ICVFX Production



The ICVFX encompasses a diverse array of occupations and titles, symbolising the confluence of physical art departments, VP departments (VAD, “Brain Bar”, and VP supervisor), traditional VFX roles (VFX supervisor), and traditional film shooting crew (the director, DoP). This multifaceted composition signifies the emerging integration of cutting-edge technologies with established artistic and cinematic practices within the realm of ICVFX.

4.3.2 Impacts on the Role of VFX Supervisor

In a large-scale production such as *The Mandalorian*, the role of the VFX supervisor is considered as creative head responsible for overseeing the entire VFX-related creation process and ensuring the quality of VFX. During pre-production, the VFX supervisor works closely with the producer and director to determine the most effective approach to achieve the director’s vision. This includes evaluating options such as practical effects, green screen VFX production, and ICVFX production

If practical effects are chosen, the VFX supervisor monitors the quality of on-set practical effects to ensure they align with the desired visual outcome. If green screen VFX production is the preferred method, the VFX supervisor captures camera information for post-production work (Failes, 2023) and arranges for a post-production VFX supervisor to oversee individual VFX vendors or houses, each with its own VFX supervisors.

In ICVFX, the VFX supervisor works closely with the VP supervisor on set. VP supervisor leads VP departments such as the VAD and “Brain Bar” and plays a pivotal role in realising the director’s vision. Although both the VFX supervisor and VP supervisor are jointly responsible for realising the director’s vision, they have different roles and responsibilities. VP supervisor is expected to have creative, technical and communication skills to manage the whole VP team and relevant problems. This involves constant evaluation of LED stage availability and translating the script into VP elements (CG Pro, 2023). This role also acts as a bridge between the director’s vision and the real time department’s capabilities, ensuring effective communication and collaboration (Bennett et al., 2021).

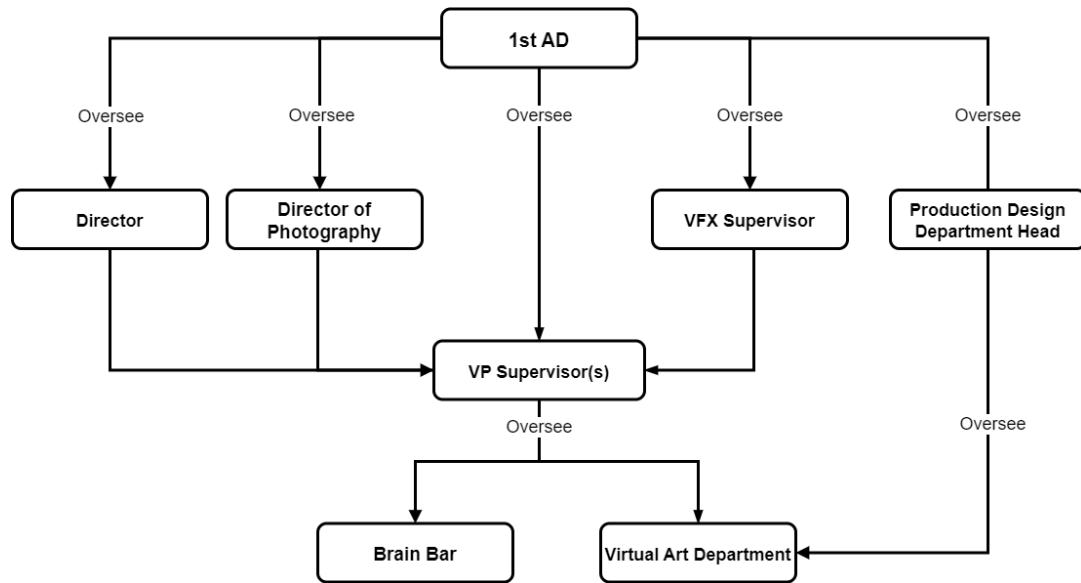
However, in productions with budget constraints, the VFX supervisor may take on the role of the VP supervisor in addition to their original responsibilities. In such cases, the VFX supervisor must acquire extensive VP-related knowledge and skills to effectively monitor the VFX creation process at a holistic level. This additional role requires them to be well-versed in VP technology, methods, and best practices, enabling them to coordinate effectively with the VP team and ensure the successful integration of ICVFX elements into production.

4.3.3 Impact on the On-set Hierarchy

As shown in Figure 14 below, the on-set hierarchy experiences a notable transformation during the ICVFX production. During principal photography, the 1st AD leads the entire production (Chris Yan, Appendix A). A new role, the VP supervisor, is included in the hierarchy, standing alongside other department heads. This pivotal role assumes oversight of both the VAD and the “Brain Bar” team while fostering seamless collaboration with the DoP, director, VFX supervisor, and production design department.

Figure 14

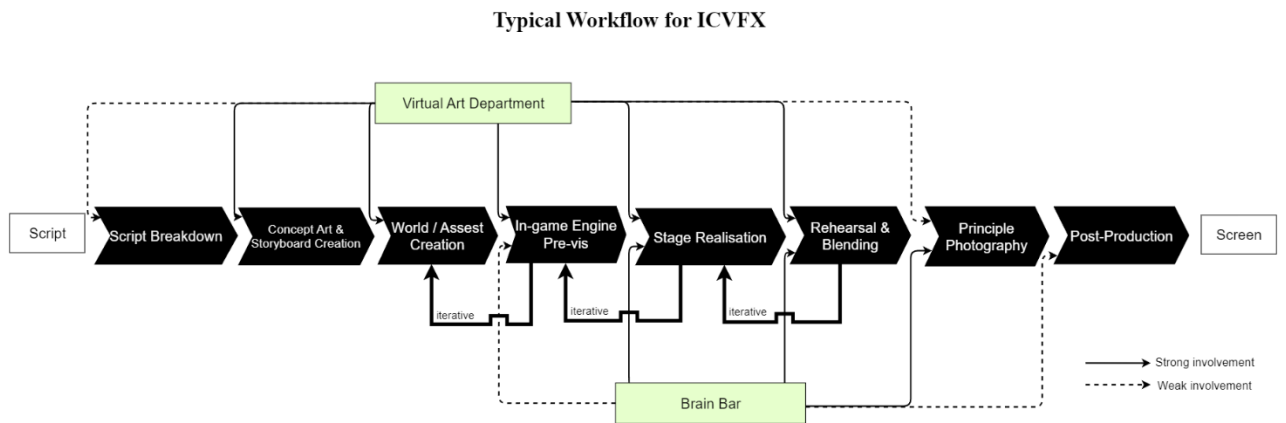
A Power Structure Diagram During Principal Photography for ICVFX



4.3.4 VAD and “Brain Bar” Involvement

Based on the understanding of the proposed workflow in the last chapter and the description of VAD and the “Brain Bar” in this chapter, these two departments exhibit a bell-shaped involvement throughout the production process. The VAD's engagement begins with the script breakdown and extends through the pre-production phase, offering artistic direction and creative input to shape the visual elements. In contrast, the “Brain Bar” artists' participation initiates during the in-game engine pre-visualisation stage, actively contributing to real-time visualisation and decision-making during filming. As post-production nears completion, their involvement gradually diminishes. To visually represent the varying levels of participation, the following Figure 15 below has been presented, illustrating how VAD and “Brain Bar” artists participate in different phases of ICVFX. Solid lines signify strong engagement, while dotted lines represent weaker participation.

Figure 15
Overview of VAD and “Brain Bar” Involvement in an ICVFX Pipeline



Chapter 5: Common Challenges: ICVFX Industry in EA and SEA Countries

Chapter 3 delves into the creation of the ICVFX workflow, which is based on real-time technology, game engines, and LED walls. In Chapter 4, the focus shifts to the newly established departments: VAD, “Brain Bar”, and VP supervisor. These two features exemplify how technology is transforming content production.

This new ICVFX workflow can be observed among Hollywood, EA, SEA professional practices. However, sampled EA and SEA-based production companies implement a slightly different division of labour style. Instead of the VAD being in charge of content creation and the “Brain Bar” responsible for technical and LED-related hardware issues, most of the interviewees claimed that their role requires working on both content creation and technical requests (Chris Yan, Appendix A; Evelyn Wu, Appendix A; Harumi Miura, Appendix A; Sawetporm, Appendix A; Teckwon Appendix A).

With an understanding of the new workflow and occupational roles, this chapter zooms in on the development of the ICVFX industry in EA and SEA countries, which possess distinct production cultures and markets compared to Hollywood. What challenges arise as these countries embrace the ICVFX industry, and how do these regional obstacles differ from those faced in Hollywood? This chapter aims to explore the shared challenges identified through interviews with 10 professionals from EA and SEA regions.

5.1 Brief Introduction of Current Development in China, Japan, Korea and Singapore

5.1.1 China

In China, content creation is driven by four major cities: Beijing, Shanghai, Shenzhen, and Zhejiang. Beijing is renowned for its numerous production studios in the film industry and post-production. Shanghai is prominent in commercial production, while Shenzhen specialises in TV drama production. Zhejiang stands out for HengDian World Studios, which is the largest film and TV city in Asia.

Following the success of *The Mandalorian*, China has swiftly embraced the use of LED volume for content production. Three leading content creation platforms, namely Youku, iQiyi, and Tencent, have adopted VP for TV dramas, short films, and event production (Nana & Qin, 2024). Each platform has established its own LED volume studios in China: iQiyi in HengDian World Studios, Tencent has converted a 3000 square meter space into a VP studio in Shenzhen, and Youku has set up digital production studios in several production-preferred cities like Beijing and Xiamen (Jie

Mian News, 2023). Additionally, VP studios such as Versatile Media and TimeAxis have successfully incorporated LED volume technology into their production of short films. In academic circles, institutions like the Beijing Film Academy have conducted extensive research in this field.

5.1.2 South Korea

South Korea, as one of Netflix's biggest TV shows and film suppliers, will receive a \$2.5 billion investment from this streaming platform over the upcoming four years to increase local content production (Bloomberg, 2023; Hyunsu, 2023). Mainstream entertainment and *chaebol* companies such as CJ ENM (Samsung, 2022) and SK Telecom (Chang-won, 2022) launched their VP studio in Korea. XON Studios, the local VP pioneer, signed a four-way memorandum of understanding (MOU) with Dexter Studios, a domestic VFX and content company, VIVE Studios, an AI-based metaverse content art tech company and Epic Games Korea to accelerate the VP industry (Dexter Studio, 2022; XON Studios, 2023).

5.1.3 Japan

In Japan, the majority of VP studios have been established within major Japanese production companies such as Toho, Kadokawa Daiei, and Nikkatsu (PRONEWS, 2023c). Hibino Corporation, a leading provider of AV equipment in Japan and a pioneer in live music and events, expanded its services by opening a new VFX studio in Tokyo called Hibino VFX Studio (Cinematography World, 2021; PRONEWS, 2023). Furthermore, Kiyosumi Shirakawa BASE, operated by Sony PCL, boasts Sony's Crystal LED B series, which is the largest domestic LED wall in Japan (PRONEWS, 2023c; Sony, 2022b).

5.1.4 Singapore

Singapore is a platform that embraces the SEA VP industry. Aux Media Group is recognised as a local pioneer in adopting VP for hybrid events. This company possesses extensive experience in organising both online and offline national events, including the Marina Bay Year-End Countdown Event. In 2023, Aux Media Group not only forged partnerships locally but also internationally. Locally, the company collaborated with Institutes of Higher Learning such as Republic Polytechnic, Singapore Polytechnic, and Ngee Ann Polytechnic for attachment programs and short film production projects (Sandberg, 2023). Internationally, Aux Media Group signed a three-party MOU with South Korea's XON studios, the first VP company established in Korea, and SK Telecom to strengthen their technical and content cooperation (BusinessKorea, 2023; Korea JoongAng Daily, 2023). Towards the end of 2023, the Infocomm Media Development Authority (IMDA), a statutory board under the Singapore Ministry of Communication and Information, announced a S\$55 million fund to support international co-production and foster the growth of the local VP industry (Infocomm Media Development Authority, 2023).

5.1 EA and SEA Countries-Based Interviewees

The ICVFX industry attracts professionals not only from the VFX field but also from various other industries. Among the interviewees, some have transitioned from filmmaking (Sawetprom, Appendix A; Teckwon, Appendix A), TV production (Evelyn Wu, Appendix A), the commercial industry (Nicholas Tan, Appendix A), motion graphics (Chris Yan, Appendix A) and live events (Chyi Kei, Appendix A; Takanori, Appendix A).

Each individual also shared a unique interpretation of VP. As discussed in Chapter 2, from a technical standpoint, VP is commonly defined as an umbrella term encompassing various techniques, with LED wall ICVFX frequently mentioned. Furthermore, the interviewees discussed different aspects of ICVFX, including its purpose, technology and knowledge requirement: 1) VP is used to mimic on-location shooting (Chris Yan, Appendix A; Nicholas Tan, Appendix A), 2) VP is a kind of filming technique through real time visualisation and forward shifting post-production (Evelyn Wu, Appendix A). And 3) VP involves knowledge, skill set and talent from four different fields: film production, VFX creation, game development and live events (Sawetprom, Appendix A).

Regardless of their original fields, the interviewees commonly identified game engine-related knowledge, and LED stage-and-camera-related knowledge as new skills they acquired, including hardware, networking, visual artefacts, Genlock and color management (Chris, Appendix A; Evelyn Wu, Appendix A; Miura, Appendix A; Yuki, Appendix A).

Aux Media Group and Hibino VFX Studio, originating from the concert and live event industry, have had to adapt the workflow for ICVFX production (Chris Yan, Appendix A; Miura, Appendix A). Higashida Takanori, the VFX Producer from Hibino VFX Studio highlighted the difference between live events and commercial production:

When a show starts, it keeps going, the audience are getting excited and after two or three hours, everyone is satisfied and goes home. [...] But in video production, take CM (commercials) as an example, you have to concentrate on a 1-second or 0.5-second cut. 10-20 people gather together around the monitor and discuss how to do this, and how to do that. Also, when someone says “OK”, we finish that work without knowing the reaction of the audience, but up until now we’ve all been looking for a real reaction, so it’s completely different. (Appendix A)

In addition to sharing their professional insights on workflow and division of labour, the participants also expressed their concerns and highlighted the challenges they face. The following sections are dedicated to discussing these unexpected findings.

5.2 The Bargaining Power of VP Studio

In a UK-based survey, a VP supervisor Russell Shaw stated that there is an emerging culture between the director, VFX supervisor and the Unreal Engine team, indicating a shifting power dynamics between traditional and VP crews. This is due to the technology is integrated within a game engine, granting the Unreal Engine team the power to have a say in the filmmaking process (As cited in Bennett et al., 2021). Kadner (2019) further illustrated that the VP holds a leading role in the production process and has the authority to negotiate with directors, enabling them to modify the script.

In EA and SEA countries, most of the interviewees (Chyi Kei, Appendix A; Nicholas Tan, Appendix A; Teckwon, Appendix A) resonate with the first part, acknowledging that VP studios may have a certain power to influence decisions but generally do not have the ability to exert influence over the script. EA and SEA-based production companies often find themselves in a supporting role as an equipment rental house, primarily tasked with facilitating the realisation of the director's vision, unless the project is initiated by the studio itself.

The power and workload of VP studios can be influenced by varying production cultures within production crews. In Korea, gaffers tend to work collaboratively with the VP crew, addressing both physical and virtual lighting challenges. On the other hand, Chinese gaffers often exhibit a more assertive approach, leaving the VP crew with little choice but to adapt and follow their lead (Evelyn Wu, Appendix A).

5.3 Misconceptions from Directors and Producers

ICVFX production could be much easier to implement from a top-down approach with a decision-maker who knows the capability of this method. As mentioned earlier, the success of *The Mandalorian* was not solely due to the effort of the VFX production house, game engine and LED panel provider. It was the result of the entire team being guided by the film director, Jon Feavur. This success has inspired new directors and producers in EA and SEA regions to embrace ICVFX in their content and position themselves as pioneers. However, amidst this enthusiasm, several misconceptions surrounding this innovative technique have emerged during the process of understanding ICVFX, as highlighted by interviewees.

Interviewees (Evelyn Wu, Appendix A; Nicholas Tan, Appendix A; Sawetprom, Appendix A) claim that they often encounter significant last-minute changes. The main reason behind this is the misconception that real-time technology can generate every virtual element instantaneously, leading to an intensive production period. Interviewees revealed that EA and SEA clients and directors lack a comprehensive understanding of how game engines function and tend to overestimate the capabilities of real-time technology. They expect that any modifications can be effortlessly made in real-time, including substantial rework before shooting such as adding 20 unplanned shots at the last minute (Sawetporm, Appendix A) or radically

rebuilding a scene from a forest to a desert (Evelyn Wu, Appendix A).

Additionally, the VP crew needs to collaborate with the film crew in pre-production. However, producers often minimise equipment rental and crew costs, resulting in a compressed timeframe for the VP crew to work with DoPs and gaffers. A full crew with equipment is typically only assembled during the principal photography phase, leaving only a limited number of hours for the VP crew to refine assets and lighting with the film crew. Consequently, the assets may not achieve the desired level of cinematic quality and may not meet the directors' expectations (Evelyn Wu, Appendix A).

From a technical perspective, the overall compiling time in the "Brain Bar" is determined by both the computer performance and the complexity of the scene being handled. In worst-case scenarios, unexpected massive on-set changes might result in a compiling time of up to 2-3 hours, causing significant disruptions in the shooting schedule.

Interviewees (Chyi Kei, Appendix A; Evelyn Wu, Appendix A; Nicholas Tan, Appendix A; Sawetporm, Appendix A) point out that directors need to understand the importance of a "Fix-it-in-the-Pre" mindset: locking their shot list before the shooting. Minimal modifications are expected if additional pre-production time is not provided.

In contrast, according to Nicholas and Sawetporm, both South Korean and high-budget Hollywood film production follow a similar production culture where a considerable amount of time is typically allocated during the pre-production phase to verify and finalise shots. As a result, shots can be pre-planned, ensuring a smooth and effective shooting phase.

Therefore, it is essential to recognise that real-time technology does not necessarily entail the instantaneous generation of every virtual element. Instead, its strength lies in providing rapid feedback and interactive control during the creative process.

The LED wall has become an emblematic and well-known feature of ICVFX, potentially leading laymen to misconstrue its usage as merely displaying pre-recorded footage (Sawetporm, Appendix A; Takanori, Appendix A; Teckwon, Appendix A). In fact, ICVFX is a complex technological system incorporating real-time technology. The most effective approach for clients, directors and producers to comprehend ICVFX is, as suggested by interviewees (Chyi Kei, Appendix A; Evelyn Wu, Appendix A; Nicholas Tan, Appendix A; Sawetporm, Appendix A; Takanori, Appendix A; Teckwon, Appendix A) to experience the technology firsthand by physically standing on the LED stage to immerse themselves in its capabilities. If these key stakeholders do not fully understand the benefits, potential and limitations of ICVFX in enhancing the creative process and final output, they might be more inclined to choose traditional post-production VFX methods.

ICVFX encompasses the process of world creation and ends with in-camera shooting. From a film production perspective, it is a common misconception that ICVFX adheres strictly to the mise-en-scene principle, focusing solely on elements visible to the camera on set. However, the approach is more comprehensive, requiring meticulous refinement not only of the pro-filmic environment but also the creation of the off-camera content displayed for reflection, tailored to fit the dimensions of the LED wall display.

In other words, the concept of mise-en-scene expands relatively with the size of the LED stage in the ICVFX production.

5.4 Project and Market Demand

5.4.1 Typical Projects

EA and SEA ICVFX professionals are actively diversifying their business ventures by extending their services and LED walls to other entertainment industries beyond film production. These include TV dramas, advertisements, variety shows, product presentations, short videos, music videos, fashion videos, “Tokusatsu” and other XR productions.

Specifically, ICVFX is widely used for car-related shooting (Teckwon, Appendix A), driving scenes in TV dramas (Harumi, Appendix A; Teckwon, Appendix A) and avoiding the need to blocking off main urban streets for shooting (Chyi Kei, Appendix A; Sawetprom, Appendix A). In these cases, the LED stage can be maximised to display the background and create realistic reflections.

5.4.2 Hybrid Projects

Hybrid projects require the development and customisation of the ICVFX system to meet specific needs. For example, combining a flying dragon as an AR element with an ICVFX setup for a virtual concert (Sawetprom, Appendix A), combining real-time composited green screen actress and LED stage actors into the same camera feed (Chris Yan, Appendix A), shooting a one-shot video with multiple transitions between two LED stages multiple times while switching corresponding scenes (Yuki, Appendix A), and implementing a synchronised physical and virtual lighting set for a concert where a virtual human performed alongside a live singer with contact shadow (Evelyn Wu, Appendix A).

5.5 Cost of Change

Notably, an LED stage and a high-end computer require a tremendous amount of cost and serve as pivotal components in the ICVFX production process. ICVFX

practitioners have to consider a spectrum of LED stages that range from a planar wall to an L-shaped wall, a cyclorama-like cubicle stage, a curved panoramic stage (also known as a U-shaped stage), and an immersive surrounding type. Insights gleaned from personal interviews with both Chyi Kei and Teckwon emphasise the paramount importance of selecting the appropriate type of LED wall tailored to specific purposes and local market demand. Ancillary factors such as pixel pitch density, screen size, and the size and height of the studio also have to be considered.

The whole setup is not simply plug-and-play; it requires installation, training in-house crew, hiring LED technicians and long-term maintenance. Additionally, research and time must be dedicated to problem-solving.

Furthermore, ICVFX introduces additional electricity-related costs and requires careful management to ensure optimal performance. To address potential overheating issues and ensure the smooth functioning of the ICVFX setup, it is recommended to house the computers and LED stage in an air-controlled environment. This controlled environment helps regulate temperatures, reducing the risk of overheating and ensuring the reliable operation of the equipment (Sawetprom, Appendix A).

5.6 Talent Shortage and Hiring Expectations

ICVFX companies face challenges when it comes to recruiting suitable staff (Marcus, 2021). As emphasised by Bennett et al. (2021) in their industry report, the combination of high technical capabilities in game engines, coupled with creative skills and on-set experience in the art department for ICVFX, presents a formidable hurdle to address. They stated: “[T]he unique mix of high technical capabilities in game engines, mixed with creative skills, plus experience required of working on-set in the art department for VP is a problematic one.” (p.26)

EA and SEA-based production companies also encounter the same challenge. Various interviewees have expressed their expectations and considerations for hiring. Since ICVFX is a multidisciplinary field merging film production, VFX, game development and live events, finding staff who comprehend the complexities and collaborate effectively with creative heads is a difficult task. Instead, there is a prevailing agreement among interviewees to prioritise the recruitment of experienced staff with specialised knowledge, preferably from film production or the VFX industry, rather than opting for generalists new to the industry (Chris Yan, Appendix A; Chyi Kei, Appendix A; Sawetporm, Appendix A; Teckwon, Appendix A). Sawetporm further suggests that hiring three specialised professionals, each from film production, VFX and live event sections and then diving into ICVFX can prove to be more effective.

Beyond professional background, personal characteristics and team spirit also hold

significance in the hiring process. Most of the interviewees emphasise the importance of having a willingness to learn, both for experienced professionals and newcomers. This includes being open-minded and possessing a strong learning ability. These elements are key to fostering a culture of humble learning from one another and the ability to adapt skills from different domains. Communication skills and being a team player are highly preferred (Shinnosuke, Appendix A).

The role of technical artists (TA), originating from the game development industry, is highly sought after. The TA serves as a critical link bridging the gap between art and technology, combining their artistic talents with a deep understanding of programming skills. Their expertise lies in effectively integrating and optimising digital assets with an artistic vision (Bennett, et al., 2021). The TA is responsible for a range of tasks, including creating shaders, developing tools, scripts and plugins, implementing visual effects, and maintaining pipelines and the overall production process. As a result, TA plays a significant role in the ICVFX workflow, helping achieve the desired visual quality and maintaining efficient workflows.

Furthermore, regardless of whether they are fresh graduates or experienced staff, a sense of situational awareness is considered important in the ICVFX environment. Knowing what each team member is working on and being aware of ongoing activities is crucial to maintaining a smooth and collaborative workflow (Nicholas Tan, Appendix A).

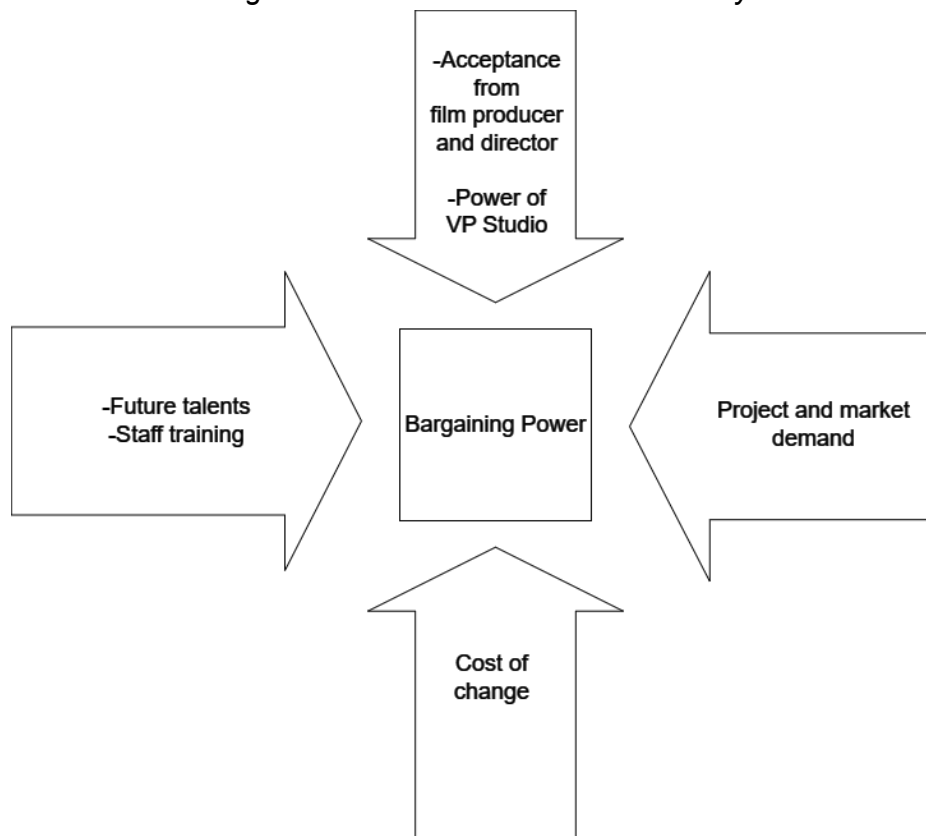
5.7 Chapter Summary and Discussion

To conclude, this chapter focuses on the five common challenges mentioned by ICVFX interviewees from EA and SEA countries. Adapting the theoretical framework from “How Competitive Forces Shape Strategy” (Porter, 1979) in the ICVFX context, four main challenges can be concluded in the following Figure 16 below. Each of the challenges plays a significant role in driving the ICVFX Industry forward. In the short term, acceptance and market demand are the main factors to keep the industry profitable. Talent support and cost of change are important for ensuring its sustainability.

To truly achieve the concept of “what you see is what you get”, hardware and software development are the commonly mentioned factors among interviewees to lower the entry barrier. Their expectations for future LED walls include lower prices and improved display quality. Additionally, they express a desire for more user-friendly game engines that enable the creation of photorealistic assets and achieve real-time compositing at a level of quality comparable to the film industry.

Figure 16

Five Main Challenges in the EA and SEA ICVFX Industry

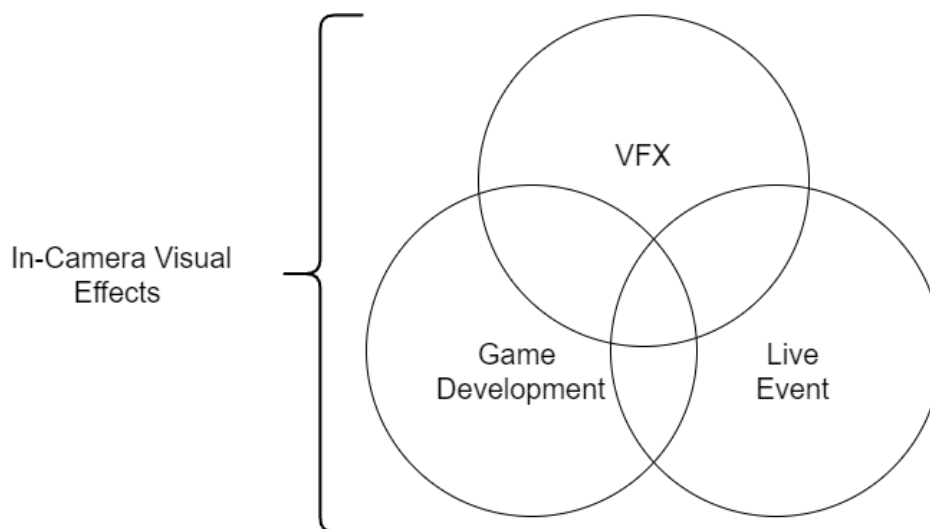


Chapter 6: Findings, Discussion, and Suggestions

ICVFX can be characterised as a conglomeration filmmaking process that intertwines narrative cinematic storytelling and aesthetic elements, with its foundation firmly rooted in cinematic VFX quality and standards. As illustrated in Figure 17 below, it draws inspiration from interactive methodologies employed in game development, fostering an innovative and adaptable mindset in its workflow. A pronounced feature of ICVFX is its “live event-like fixing now” approach, which necessitates agile responses and swift decision-making by the production crew. This dynamic workflow also prompts the expansion of on-set structures, integrating roles and departments such as the VP supervisor, VAD and the “Brain Bar”, leading to heightened collaboration among diverse stakeholders.

Figure 17

The Characteristics of ICVFX



The advent of ICVFX has indeed brought about significant changes in the production culture of filmmaking. One of the common and prominent shifts is the introduction of new roles and departments that have redefined the way VFX artists operate and impacted their required skill sets. In the subsequent discussion, I will explore the findings of the impact of “realtime-lisation” from different perspectives, beginning with the impact on the general role of ICVFX artists, followed by the emergence of new production cultures and suggestions.

6.1 From VFX to ICVFX: The General Role of ICVFX Artists

In addition to changes in occupational titles, artists must undergo skill transfer and adaption to effectively engage with ICVFX. This transition entails encountering numerous challenges, which are listed below:

6.1.1 Work Under Stress: “Live” VFX

Working in real-time is radically different from working in traditional CG rendering. Charmine Chan, a Lead Compositor at ILM who worked as part of the “Brain Bar” crew on *The Mandalorian* Season 1, pointed out the main change of roles between working traditionally and working with ICVFX. Conventionally, as a VFX compositor, she works in front of a computer inside a dark room after the shooting is done. In ICVFX, she can finalise the shot with other crew members collaboratively during the shooting phase (Vox, 2020). This reveals that ICVFX requires VFX artists to work closely with the shooting crew on set. A single shot for traditional compositing may require months to process, whereas ICVFX requires compositors to finish the shot on set as quickly as possible (Kadner, 2021). In other words, regardless of whether artists come from the VAD or “Brain Bar”, working on-set can be perceived as creating VFX in real-time. This working style requires the artists to face tremendous pressure while being able to be operational to create content during production (Geduldick et al., 2022; Sawetprom, Appendix A).

On-set filming endeavours are constantly entangled in a race against time. Typically, the production team must promptly attend to alterations observed by the crew, often within an exceedingly short timeframe, for instance, approximately 10 minutes (ScreenSkills, 2022). Once a change requires more than that, artists need to inform the first AD because the whole crew is left in a state of anticipation or, in the worst scenario, the shooting schedule may be adversely impacted (Rank, 2021). Meanwhile, artists have to find a balance solution between optimising efficiently and expediting their actions. The former is an important procedure aimed at mitigating the risk of the rendering computer experiencing lags and frame drops due to excessive processing demands over time, albeit at the cost of additional time investment. Conversely, a predicament can be resolved through the quickest and simplest means, albeit potentially compromising the computer’s long-term performance. As a result, navigating the challenges of the ICVFX production demands that artists skillfully reconcile this dilemma while fostering a spirit of collaboration amongst themselves. As described by Josh Kerekes (2022):

We'll usually have multiple of these creative engine operators working in concert with each other. We'll have like three of them all working on different elements at the same time up until they call action, and then it's pencils down, holds your breath. Hopefully, the take is successful. And then as soon as they cut, they immediately start going at it again. (21:38 – 21:57)

6.1.2 Versatility

Real-time workflows require artists to have high flexibility rather than being departmentalised. VFX supervisor George Murphy mentioned how versatility is

valued, stating, “For real-time workflows, the more versatile an artist can be, the better. You can be more responsive and flexible in how you come up with answers to move things forward” (as cited in Kadner, 2021). As a result, artists are encouraged to be generalists or “T-shape” individuals to effectively navigate the rapidly evolving ICVFX ecosystem. This entails cultivating proficiency in primary capabilities while being supplemented by relevant secondary knowledge to creatively address the problems (Nicholas Tan, Appendix A). Nicholas Tan further stated that artists in VAD require a comprehensive understanding of both physical props and virtual props. An Unreal developer is required not only to be adept in Unreal Engine but also to extend their skillset to encompass camera tracking and projection software, such as Disguise.

6.1.3 Working Conventions

The most significant impact for real-time workflow is the reliance on the game engine, As a result, VFX artists have to adapt to the game engine-based working conventions. Both environment artists and VFX compositors must be proficient in game engines and 3D skills instead of relying solely on traditional VFX software like Nuke.

Conventional VFX typically involves layer-based composition. As Stephen Prince (2012) notes: “Digital visual effects are composited as layers, but all components of every layer are susceptible to being changed and tweaked, whether they are live-action or a computer-created one” (p. 5). For instance, in green screen VFX production, compositing requires the use of render passes, such as diffuse and Z-depth. These layers provide flexibility for VFX compositors to achieve seamless integration between organic and synthetic elements (Okun & Zwerman, 2021).

However, in the context of ICVFX, the need for render passes is highly reduced due to the game engine’s ability that allow artists to modify individual elements and parameters within the same game world simultaneously (Kerekes, 2022; Orloff, 2022). This real-time capability allows for dynamic adjustments and interactions within the virtual environment, reshaping the approach to VFX production in this context.

With the increasing importance of the game engine in the production process, both the VAD and the “Brain Bar” departments are now equally vital. Nevertheless, the influence of ICVFX extends beyond these two departments. It fosters the emergence of novel production cultures, facilitating collaboration between real-time departments and the shooting crew.

6.2 New Way of Collaboration

ICVFX expands collaboration vertically and horizontally, allowing creative heads to

work together, maximising outcomes, and satisfying both directors and department heads. It requires the integration of live event experts and professionals to construct the necessary infrastructure for real-time image processing and spatial tracking.

ICVFX reduces uncertainty and improves communication by providing real-time collaborative systems, enabling immediate visual adjustments and faster resolution of notes (Rank, 2021). This leads to more precise communication, fewer assumptions, reduced iteration time, and improved production schedules and financial control (Nicholas Tan, Appendix A). The success of production ultimately hinges on the strength of the team. It is through collaborative and communicative efforts among production teams that production can flourish. Emphasising the concept of “Team”, ICVFX recognises the significance of cohesive teamwork with directors and DoP in adapting to this challenge and achieving successful outcomes (Miura, Appendix A; Takanori, Appendix A). Co-founder of Lux Machina Philip Galler (2022), highlighted the elements of being a good team:

It's that having a really good team with a bunch of key skill sets is as important as that team understanding onset hierarchy, the etiquette and [...] the variability of the needed etiquette and soft skills that are required on each of these individuals on sets. So, the hierarchy and the etiquette required for a virtual production stage on a film set are very different than on a broadcast show. (7:02-7:29)

Conflicts and misconceptions may happen when working in an emerging environment. In the following sub-sessions, I will discuss the observed working culture to foster effective teamwork.

6.2.1 The On-Set Etiquette

ICVFX integrates staff from various production backgrounds, and it is necessary to maintain mutual respect as a crucial factor in preventing individuals from experiencing offence. Crew members may feel curious about new departments (ScreenSkills, 2022) or encounter conflicts when collaborating with these individuals (Sawetprom, Appendix A).

Taking what Sawetprom mentioned as an example, VFX workers typically engage in computer and pixel-orientated tasks. It is a norm for them to dress casually and focus on working in a dark room environment. In contrast, the live event crew is more people-orientated and considers dressing properly as a form of presentation and respect. Sawetprom illustrated the culture conflict when integrating diverse production departments in ICVFX:

It is a different tradition. Because my company used to have filmmaking people work[ing] for the event. [...] I have to livestream something and I bring my whole

crew. A man from our crew was wearing short pants with a shirt, walking into a big event hall. And the event people, they asked [me] 'why he dress like that? He must respect the place!' So it is like a different world, a different way of speaking, a different way of life. (Appendix A)

To address this issue, he decided to separate these two teams to avoid unnecessary conflict. This reflects that different cultures, such as wearing appropriate attire, has become one of the important points of etiquette that teams should be aware of.

6.2.2 Communication and Language Barriers in ICVFX

Effective team cohesion relies on communication practices (Shinnosuke, Appendix A). Constructive conversations play a vital role in fostering a comprehensive understanding of each team member's roles and expectations (Geduldick et al., 2022).

In the ICVFX production, jargon from the artistic, programming, and filmmaking worlds can emerge into a single conversation. Green et al. (2014) introduced the concept of a "fluffy scale" to describe the different use of terms between artistic and programming fields: "[An] artist concerned with the aesthetics of an image may describe the process by which it is created quite differently to a programmer concerned with the mathematics of simulating light" (p. 26) In ICVFX, in addition to the VAD and "Brain Bar", which represent two ends of the spectrum, film terminology lies in between. Consequently, artists and technicians must navigate the interweaving of both ends and adapt film production terminology to collaborate effectively within the film production context. Sawetprom provided an example of the terms used for VFX and production team:

[S]ometimes like you're working on the VFX, ... this is because of the colour space, this is part because of the texture, because of the render, But the production side, they have like camera angle, lens, achromatic, aperture. (Appendix A).

Therefore, to facilitate a smooth conversation, it is vital for the department supervisors to be fluent in production languages to understand the director's intention and to communicate the request accurately to the team (Kadner, 2020; Sawetprom, Appendix A), and vice versa (Ramirez, 2023). Conversely, traditional production crew, especially directors and producers, have to acknowledge and understand the terminologies of the game engine and real-time related concepts (Geduldick et al., 2022).

From the director's perspective, they can identify how their creative vision is affected by the possibilities and constraints of the game engine and LED stage. Consequently, a common vision can be shared among the departments involved

(Weta Digital, 2021). Therefore, the establishment of a common language between real-time and film departments is paramount as it ensures constructive conversation and hive-mind-like teamwork for content creation.

6.2.3 Fixing NOW: Collective Responsibility of Creating Final Pixel on Set

In green screen VFX productions, the creative department is limited in its ability to visualise only a small portion of the film on set, as the remainder is presented as a monochromatic green void. Content-related decision-making must be deferred to the post-production phase.

In the context of ICVFX, the deployment of giant LED walls displays the final image, shifting creative decision-making to the pre-production and production stages. The final pixel confirmation is done on set through collaboration between the creative heads to decide on stage color, perspective, and shot composition (Kadner, 2020b; Rank, 2021; Wallman, 2011). As a result, the production gaze has transitioned from the cinematographer's exclusive domain to the entire crew (Miura, Appendix A ; Takanori, Appendix A). The realisation of stage elements requires not only the conventional key creatives to address uncertainty but also involves immediate manipulation and alterations by VAD and "Brain Bar" artists in response to requests. Similarly, "Brain Bar" technicians troubleshoot ad hoc technical artefacts such as moire and flickers (Chris Yan, Appendix A; Sawetporm, Appendix A; Teckwon, Appendix A). This approach diverges from the traditional "Fixing in the post" mindset to the "Fixing now" approach in the ICVFX context (Sawetporm, Appendix A).

6.2.4 Software Research and Development Mindset

In ICVFX, practitioners often have to highly customise the system to create distinctive features, but they frequently encounter situations where the entire ICVFX system becomes intricate and surpasses the capabilities of the original manufacturers to provide solutions (Galler, 2022). Consequently, the ICVFX approach involves cultivating self-reliance within the team and collaboratively resolving the issue without external assistance. Several unexpected factors can arise in the ICVFX production environment, including code-related issues from the game engine, challenges related to LED stages and system adaptability problems with new equipment. The entire system may experience LED blackout during shooting days, even though it worked fine during the testing and rehearsal stages. Failure to promptly address these issues can affect the production schedule. One of the interviewees, Chris Yan, illustrated this troubleshooting process through the analogy of a doctor's diagnostic and remedial techniques:

[B]ecause there are many different hardware that participate in [a] shoot. So, we [are] just like doctor[s], you know, when it comes to the troubleshooting, if the system doesn't behave well, we'll see from the symptom. For example, if the

LED is blacked out, then the possible sickness for this whole system is maybe my feed from Disguise is not going through, or the LED processor will have something wrong or the LED wall itself has some issue. So, when it comes to problems, we'll need to isolate the problem and troubleshoot that. (Appendix A)

In other words, troubleshooting requires the adoption of a software research and development mindset to proficiently pinpoint and resolve the underlying errors. The artists and technicians in the “Brain Bar” must methodically deconstruct a problem into manageable units, enabling them to test each element progressively, starting with individual functions, then integrated components, and finally, the entire system considering performance pressure in an ascending manner. This systematic approach ensures a thorough and effective resolution of issues within the ICVFX context. Therefore, the ICVFX industry, especially the “Brain Bar”, values the transferable technical skills and knowledge from other industry segments rather than fixating solely on specific titles (Galler, 2022). Proficient operators and TDs with a background in computer science possess the capability to approach problem-solving with a software development mindset and consider long-term solutions.

6.3 Suggestions and Recommendations

To address the challenges mentioned in Chapter 5 and unlock the potential of ICVFX, several recommendations can be implemented to enhance industry development, academic education and long-term research in this field.

6.3.1 Industry: Forwardshifting Decision Making

The concept of “Fix-it-in-the-Pre” presents a new approach to decision-making during the pre-production phase, as opposed to traditional post-production. This transformative concept requires a fresh perspective among conventional members of the film crew, including scriptwriters, producers, directors, DoPs, and gaffers.

During the creative development phase, scriptwriters need to understand the advantages and limitations of ICVFX (Chyi Kei, Appendix A; Nicholas Tan, Appendix A). Once the script is finalised, a discussion should include the use of an LED stage, allowing the infrastructure team to commence their construction. Attention should then be directed towards determining the content that will be displayed and/or integrated with the physical set. For example, using ICVFX instead of actual location shooting for car-related scenes can be relatively cost-effective.

Producers should avoid treating ICVFX as a fallback option reserved for challenging shots that cannot be achieved using traditional methods (Evelyn Wu, Appendix A; Nicholas Tan, Appendix A). Similarly, they should not view ICVFX as a complete replacement for green screen techniques. Instead, it should be recognised as a viable solution with its own unique capabilities, comparable to green screen VFX

production. Additionally, producers should acknowledge that ICVFX involves a reallocation of costs and allocate a dedicated timeframe for the director, DoPs, and gaffer to collaborate with the VP team during the pre-production phase.

In contrast to green screen VFX production, where directors have the flexibility to determine the rendered background and content during post-production, ICVFX necessitates a collaborative effort among directors, DoPs, gaffers, and the VP team. This collaboration is crucial during the pre-visualisation stage to confirm camera movements, lighting setups, and assets, rather than making last-minute adjustments on set. It is important to highlight that once these assets and backgrounds are displayed on the LED wall and recorded, making changes in post-production becomes challenging (Evelyn Wu, Appendix A).

6.3.2 Industry: Longer Pre-Production and More Review Processes

To address the issue of the intensive production period, ICVFX should adopt the “dailies” procedure from VFX and implement additional review processes for assets and shots. These processes would facilitate clarification of the creative direction and confirmation of work progress (Sawetprom, Appendix A). Currently, major LED panels are limited to displaying RGB colors, resulting in a restricted color spectrum. As a consequence, the final outcome may appear artificial without sufficient pre-production devoted to addressing this limitation. Ideally, it is recommended to allocate ample time for the entire ICVFX process, including pre-production tests and time to refine asset quality (Evelyn Wu, Appendix A).

To facilitate the review process and enhance collaboration and communication among creative stakeholders, a project tracking platform such as Autodesk ShotGrid (formally Shotgun, Shotgun software, 1995) from VFX production could be established.

6.3.3 Industry: Multiple Cross-Departmental Trainings Are Required

Furthermore, ICVFX requires two-way training to facilitate mutual understanding and appropriate expectations between departments and artists in ICVFX.

The production design department comprises a blend of physical artists and virtual artists, contributing to the multifaceted aspects of the creative process. Physical artists predominantly use tangible materials as their medium for art creation, while virtual artists primarily rely on software to produce art in digital space. Through collaborative two-way cooperation, both parties can gain new insights, and understand the alternative medium in the art creation process. From a production design standpoint, as emphasised by Kramer and Summerer (2022), digital artists must observe and study natural phenomena, such as reflections and physical weight, to effectively reproduce and simulate these elements in the virtual realm, thereby

enhancing visual fidelity. On the other hand, traditional artists can benefit from viewing and experiencing the digital version of their works, gaining an understanding of digital tools and offering valuable input for improvement.

In addition to physical and digital art departments, ICFVFX requires the traditional shooting crew to understand the distinct mindset between traditional production and on-set real-time creation. As mentioned by Dobbs-Beck and Peng (2021):

The Virtual Production group at ILMxLAB is seen as two teams. One is on-set team, and the other is everyone preparing the content to be used on-set. I think those two “mindsets” are quite different. The latter is a little bit more of a traditional workflow, CG asset creation essentially, everything has to be efficient rendering-wise. The on-set mindset, however, is about being adapt at real-time troubleshooting. It’s like working on a live-action shoot essentially. (As cited in Bennett et al., 2021, p. 20)

From a cinematography perspective, DoPs and gaffers can foster mutual understanding and learning by closely collaborating with the VP supervisor and game engine operators. The VP team can strive to create cinematic visuals with refined assets, such as lenses and lighting, within the game engine, allowing them to effectively grasp related terminology. In turn, DoPs and gaffers can discern the differences between physical equipment and virtual equipment, enabling them to identify each other's challenges and limitations (Hogg, 2023; Kadner, 2023b; Evelyn Wu, Appendix A).

These collaborative learning processes are necessary to create a mutual understanding among the newly established and traditional departments, embracing new experiences and cultivating a deeper appreciation for each other's respective mediums and practices in ICFVFX production.

6.3.4 Industry: Maximising Intellectual Property and Creating Long-term Demand

Disney’s selection of *The Mandalorian*, instead of other characters, as a platform for ICFVFX implementation can be attributed to two factors: 1) The *Star Wars* saga possesses a rich and enduring intellectual property that has cultivated a massive and diverse audience, thereby generating significant demand for content creation. 2) The main character's helmet is coated with a reflective material, enabling the optimal utilisation of LED emissive lighting, which enhances the immersive visual experience. Considering these factors, EA and SEA-based production companies aiming to leverage ICFVFX may explore the potential of maximising their established IPs or adapting well-known narratives that can effectively capitalise on the capabilities of LED walls, encompassing various genres, storytelling formats and experience design.

6.3.5 Industry: Global Co-production

ICVFX companies, particularly producers, could consider leveraging their regional geographical advantages and neighbouring countries to conduct co-production projects. Each EA and SEA country possesses its unique production expertise. Beijing has a strong track record in VFX production for live-action films and CG animation, while Shanghai specialises in commercial production, and Shenzhen excels in TV drama production. Not to mention the largest film and TV city in Asia, Hengdian World Studios. Moving beyond China, both Korea and Japan boast vibrant media and entertainment industries, producing cultural content such as K-dramas, J-dramas, Korean films and Japanese films across various mediums and captivating global audiences. Further south, Singapore serves as an excellent platform to tap into the potential of other SEA countries, such as Thailand, renowned for its Thai dramas and creative commercial ideas. Each region has the opportunity to supplement and learn from each other.

6.3.6 Industry-Academic: Local Connection

To address the talent shortage in the ICVFX industry and fill the educational gap at universities, it is crucial to establish collaborative educational programs between industry and academia (Chyi Kei, Appendix A). By forging partnerships with local educational institutions, the industry can offer courses that effectively utilise the LED stage and minimise its underutilisation. Simultaneously, this collaboration provides an opportunity for universities, particularly those with media and art students, to nurture specialised professionals and contribute to the industry's rapid growth.

On the other hand, a close collaborative relationship between academia and the ICVFX industry can offer significant benefits for academic researchers. The utilisation of the LED stage can facilitate cross-disciplinary research studies, allowing scholars from various fields to explore the possibilities and applications of this technology. Such collaboration encourages innovation and knowledge exchange between academia and the industry, fostering a mutually beneficial environment for research and industry advancement.

6.3.7 Academic: Education and Training for the Future Generation

Several areas demand our careful consideration as we advance towards the future. One of these areas is education for the forthcoming generations. In the industry's current landscape, talent scarcity is a prevailing challenge, as indicated by Nicholas Tan. Finding individuals possessing a blend of traditional skills and video game development experience, enabling seamless integration with a real-time game engine, proves to be a difficult task. Education assumes a pivotal role in addressing this concern. Epistemologically, ICVFX represents a fusion of the following fields of

knowledge and techniques:

1. Traditional cinematography. (e.g., cinematic camera operation, lighting)
2. VFX post-production. (e.g., set extensions, live keying, colour grading)
3. Video game development (e.g., game engine rendering, material creation, optimisation)
4. Motion capture technology (e.g., motion capture system, camera tracking technology, tracking calibration)
5. Background content display (e.g., LED).

In 2021, SCAD's School of Entertainment Arts implemented a 50'x20' LED volume for the ICVFX curriculum amid its 10,000 square ft backlot at SCAD Savannah Film Studios. The curriculum was guided by an interactive design and game development program at SCAD (Bartlett & Fu, 2022). The authors pointed out two evident impacts: a) a complete rethink of communication styles between the game engine field and cinematography field is needed and b) students majoring in film, interactive design, game development, and immersive reality overcame the challenging workflows together. The authors concluded the paramount takeaway from this project was:

The technical skills, creative vision, and comprehensive understanding of iterative project management provided by immersive and game development majors were crucial. Equally valuable was the eye for the visual aesthetic and narrative direction provided by film and visual effects majors. (Para. 9)

This shows that the knowledge from both video games and film production is crucial for them to enter the ICVFX industry.

What to teach and how to teach ICVFX become the two main pedagogical questions that require close and collaborative communication between industry and academia. Presently, these areas are often taught in separate courses, streams, or even distinct educational institutions. Given the complexity of ICVFX and its demand for pre-requisite knowledge, learning this field poses challenges. Typically, undergraduate art and media students require a minimum of three years to assimilate the necessary critical thinking and innovative aptitudes. This raises the important question of how to structure the teaching approach. While industry standards and workflows are crucial components of the curriculum, an emphasis on creativity is equally essential. By encouraging students to explore and cultivate their aesthetic expression and problem-solving skills through technology, an ideal balance between creativity and technical knowledge can be attained. To achieve this equilibrium, course planners and professors must engage in a thoughtful investigation. Failing to strike this balance effectively may lead students to be overly focused on technical aspects, resulting in their potential confinement to roles of mere "technical" labour.

The significance of training junior crew members and interns cannot be

underestimated as they contribute to nurturing the future generation in the field. Assigning them to active roles, such as production runners, offers invaluable hands-on learning opportunities through practical and physical engagement (Sawerporm, Appendix A). Active involvement and a willingness to self-motivate are traits highly valued by the industry, enabling junior members to gain experiences and insights that surpass mere passive observation. Additionally, working closely with the crew under tight production schedules allows them to understand the industry culture and technology ecosystem. This immersive experience leads to valuable learning moments as they grapple with various challenges, such as cable connections, equipment setup, and camera tracking. Ultimately, this exposure equips them with industry knowledge, problem-solving skills, and adaptability. As junior members progress in their careers, they may ascend to senior positions, contributing to production from a broader perspective. This upward mobility not only rewards their efforts but also ensures a sustained talent pool for the industry's long term (Geduldick et al., 2022; ScreenSkills, 2022).

6.4 Chapter Summary and Discussion

In conclusion, this chapter discusses the general role change of VFX artists, new ways of collaboration and provides suggestions.

ICVFX has a profound and multi-faceted impact on VFX artists. To effectively engage with these technology-centric techniques, artists must be more versatile and possess additional knowledge and skill sets. Notably, they need secondary skills to participate in on-set activities and contribute to the creation of “live” VFX.

Additionally, real-time workflow influences the working culture and dynamics between real-time and traditional departments, including on-set etiquette, collective responsibility, communication and R&D mindset.

Furthermore, several industry and academic-related suggestions were given to solve the challenges discussed in the previous chapter.

Chapter 7 – Conclusion: It’s a Wrap!

7.1 Result: Summarising the Observation, Analysis and Findings

In 2021, an award program named “Virtual Production: Are You Game?” was held by the Academy’s Science and Technology Council from the Oscar Award (Academy of Motion Picture Arts and Science, 2021) to present up-to-date VP filmmaking practices. This title testifies to how video game technology has been adapted and tremendously influenced traditional film production. VP entwines film and game disciplines and allows them to benefit each other. Game technology not only brings real-time technology to the VFX field but also changes the division of labour. In this research, I proposed a set-actor-camera framework to break down the umbrella concept of VP and illustrate various types of set-extension techniques. ICVFX, a sub-category of VP, is considered the main research objective of this study. The history of the set extensions and Machinima demonstrates how ICVFX was developed. In retrospect, a set extension shot can be achieved in the lab or in-camera. Digitalisation empowers filmmakers to produce VFX with computer technology, thus CG VFX is predominantly produced in post-production. Hence, the green screen technique became renowned with the proliferation of the VFX industry in the digital era. A few limitations, as this dissertation has covered, come with the usage of the conventional green screen, plaguing decision-makers, actors, crew and VFX artists. CG rendering time and waterfall pipeline is some of the headaches that filmmakers encounter with this method. In the history of film, several innovative setups were mentioned and considered as the milestones that paved the phenomenal success of *The Mandalorian*.

To answer how does the new ICVFX paradigm reshape the VFX workflow, this research initiates from a workflow perspective. The agile workflow of ICVFX has been examined and its features discussed to address the question of where the collaboration and iteration happen within the process. Notably, the real-time game engine and LED stage are the two pivotal elements that fundamentally transform the traditional workflow paradigm. Consequently, a game development-inspired agile workflow is formulated, significantly deviating from the linear workflow of traditional VFX processes, where departments like match move and rotoscoping are excluded from ICVFX.

The research further elucidates the iterative production stages in ICVFX, encompassing critical phases like world/assets creation, in-game engine pre-vis, and stage realisation. These stages enable key creatives to thoroughly explore, validate, and enhance the visual components before actual shooting commences. Additionally, a comprehensive evaluation is undertaken to assess the financial considerations, usage, and technical aspects of the LED stage, revealing that ICVFX should not be perceived as a one-size-fits-all solution that supersedes green screen VFX

production. Instead, ICVFX should be regarded as a novel toolkit and its own application scenarios that decision-makers can employ, leveraging its unique capabilities while being mindful of its limitations.

The implementation of the new ICVFX workflow has significant implications for individual roles and responsibilities within the production process. VP supervisor, VAD and “Brain Bar” are the newly established roles and departments. Most significantly, the emergence of real-time technology not only forwarded the post-production workload but also shifted VFX artists to work on set. From a supervisory perspective, VP supervisors are involved in both creative and technical decision-making processes for both pre-production and on-set shooting, enabling them to have more negotiation power. As for VFX artists, in addition to their strong VFX background, they have to learn how to work on set, communicate and be agile. Equally important for “Brain Bar” technicians is to troubleshoot instantly, especially during principal photography phase.

ICVFX has transformed the notion of VFX from a service-based provider into a product-based practice globally, not limited Hollywood, but including SEA and EA production. VFX companies and production houses have invested in, implemented and customised their LED stage to produce ICVFX projects, shifting these companies from a passive position to an active and pivotal role.

Interviewees from EA and SEA-based production companies resonate with most of the aforementioned workflow and division of labour. However, some regional challenges provide a different landscape from the Hollywood industry context. These include the acceptance from film producers and directors, project demand, cost of change and talent shortage. A problem identified is that currently there is a lack of deep understanding of the “Fix-it-in-the-Pre” mindset.

All these factors reflect that ICVFX production, unlike the traditional filmmaking process, is a convergence of various fields: traditional film production, VFX aesthetic, real-time technology, game engine concepts, live event mentality and LED infrastructure. Such convergence leads to a new mode of production culture, not only transitioning VFX artists into versatile artists but also fostering novel collaborations between the production crew and VP crew. In addition, several recommendations were suggested in multiple aspects, ranging from industry training and industry-academic connection to pedagogical planning. These recommendations aim to address the aforementioned challenges involving individual artists, department supervisors, clients and future generations.

7.2 Beyond Filmmaking: Immersive Experiences, AI and the Future of the VP Industry

Since 2019, the VFX industry has experienced a significant boost, largely attributed to the proliferation of streaming platforms like Netflix, Disney+, and HBO Max. This surge in demand is primarily driven by the exponential growth of VFX requirements for episodic series, compelling the industry to elevate the quality and complexity of VFX shots to match cinematic standards within TV shows. Cynthia Kanner, Senior Vice President of Postproduction at HBO, reveals that a single half-hour episode of *Silicon Valley* (2014- 2019) incorporates over 100 VFX shots, exemplifying the increasing complexity and reliance on VFX in television productions. However, television production timelines are typically shorter than films, and budgets are more constrained, posing considerable challenges for VFX studios in delivering high-standard VFX shots effectively within these parameters (Hogg, 2020). Consequently, ICVFX, with its agile pipelines, have gained widespread adoption among VFX studios, enabling efficient and seamless delivery of VFX content.

From an industry perspective, the VP industry itself is experiencing remarkable growth. Forecasts indicate an overall market expansion of over 15% annually, with the Asia Pacific region expected to witness a remarkable 18.6% yearly increase from 2021 to 2028, according to a study by Grand View Research (2021). These trends underscore the growing significance of VP in addressing the surging demand for high-quality VFX in episodic series and the strategic importance of investing in industrial research and development to stay at the forefront of this rapidly evolving sector.

The convergence of ICVFX production with AI technology holds the potential to address the surging demand for high-quality VFX content. Presently, the entertainment industry is experiencing a pervasive transformation driven by the widespread integration of AI with innovative toolsets. The advent of Generative AI has ushered in a revolutionary phase, wherein AI applications are finding utility in nearly every stage of film production. Remarkably, language models are employed to generate scripts and concepts, while images and 3D environment generators aid in visualizing creative ideas. The rise of Deepfake technology is leveraged for diverse purposes, including de-ageing actors, executing face replacements, and even resurrecting deceased performers. Post-production AI tools, such as speech-to-speech, text-to-speech, video-to-video, and text-to-video applications, contribute to the creation of dynamic and imaginative content. Among the AI-driven innovations in the field, Nuke's Copycat function stands as an exemplar of machine learning tools that serve compositors, streamlining the arduous and intricate VFX processes (Kadner, 2023). As AI continues to advance, it has the potential to merge seamlessly with real-time game engines, creating a transformative workflow that presents exciting possibilities beyond traditional VFX creation, allowing for the generation of high-quality VFX shots with real-time rendering capabilities, thus enabling the realization of truly immersive ICVFX.

In traditional VFX production, VFX artists often remain unseen and underappreciated,

regardless of whether the effects they create are visible or invisible in the final product. They often work under exploitative working conditions, facing challenges such as long hours and intense deadlines, while their contributions may go unrecognised, sometimes deliberately excluded from credit lists as part of marketing strategies (Amidi, 2023). However, the ICVFX production presents a potential shift in this dynamic. With VFX artists working on set alongside directors and producers, there is a unique opportunity for these key stakeholders to gain firsthand insight into the complexities and challenges of creating VFX shots. This close collaboration can foster a deeper understanding and appreciation for the immense effort and expertise that goes into bringing these VFXs to life. This appreciation has the potential to lead to improved working conditions for VFX artists, as well as a stronger inclination to credit and acknowledge their creative input appropriately.

This investigation aims to provide a foundational exploration of the influence of ICVFX on workflow, occupational roles and challenges from the viewpoints of several EA and SEA professionals. Due to limitations of scope, this research does not delve extensively into the perspective of other production departments, such as cinematography, lighting and sound recording. Additionally, the colour workflow constitutes another crucial area that warrants in-depth examination in future studies. Similarly, a thorough investigation into the business model of ICVFX emerges as a vital subject of interest for directors and producers alike. These areas present promising avenues for further academic inquiry to comprehensively elucidate the multifaceted impact and implications of ICVFX within the broader landscape of filmmaking and entertainment production.

By shedding light on these aspects, this research seeks to contribute to a broader comprehension of ICVFX and the attendant challenges it presents. Moreover, the appreciation and recognition from directors and producers for the contributions of on-set artists in the ICVFX process hold the potential to foster a more connected and respected working environment. By bridging the gap between creative decision-making on set and the VFX artists' expertise, a collaborative and harmonious production atmosphere can be cultivated. Such an environment would allow for a shared sense of triumph akin to the celebratory exclamation of "It's a wrap!" that reverberates on film productions, signifying successful project completion and the collective accomplishment of creative endeavours.

As ICVFX continues to evolve and integrate further into the filmmaking landscape, it will be crucial for industry stakeholders, researchers, and practitioners to engage in ongoing investigations and collaborative efforts. By addressing the challenges and opportunities presented by ICVFX, the entertainment industry can forge a more equitable and innovative path forward, embracing the potential of this transformative technology to enhance visual storytelling and elevate the art of filmmaking.

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Appendix A: Interview Transcripts

The following interviews were conducted in both face-to-face and online format. In total, 10 East Asia and Southeast Asian-based ICVFX industry professionals responded to the interview, including professionals from China, Singapore, Korea, Japan, and Thailand. The interview was guided by a list of questions regarding their roles and responsibilities, production workflow, as well as their hiring expectations. Some of the questions were improvised based on the answers from the interviewees. The full transcription of the interviews are listed below, sorted by the dates of the interviews.

Interview 1: Sirasit Sawetprom, VP Supervisor from RealBangkok Digital Media, Thailand

Interviewed date: 2023/04/25.

(myself):

Hi, Mr Sirasit Sawetprom. Can you tell me about what is your role and what is your company about in case people don't know about your company?

Sirasit Sawetprom:

Yes, my name is Sirasit, Sirasit Sawetprom. I am a Virtual Production Supervisor. And we are RealBangkok Media in Thailand. We focus on everything that is on Virtual production and AR, XR everything we're working on this kind of thing. So, from this starting point, it's branching into Virtual Production and Virtual Event and Immersive Technology.

Yeah, those are the three main brands that we are working on. But we, the founders, have a strong background from the filming. So, we are more focused on the Virtual Production. But in the other two branches, the Immersive Technology, and the Virtual Event. It's a benefit from our knowledge that we can apply and branch into that area.

(myself):

What I realised is Virtual Production also combines the field of live events from VFX and also from a kind of game development right? But in the end, it's a film-filmmaking process for you?

Sirasit Sawetprom:

For me, Virtual Production is a combination of three things. The first thing is the physical production, the filming production. The second thing is animation, including Visual Effects. The third one is game development. If you draw a circle for Virtual Production. They are 3 circles. For me, the live event, in my perspective, is not one of the circles. It's like a circle that is underneath that three circles. Why do I say that? because when you are working with the live event, you use the same people, the same skillset, same everything. The people working for the live event must know the

camera, equipment, and everything. So, you have some knowledge of filming. you have to know what a texture is, texture size, polygon and everything. so, you must have a knowledge of visual effects because you should think it's a combination. It is a combination between the computer-generated image and plate. The third one is the game engine because your technology relies on real-time rendering. For now, it is the game engine. In the future. who knows, it's another tool. But now it is these three combinations that made Virtual Production. So that's why for me that live event is an apply thing. So yeah, it's branching from it.

So, you have these three fundamentals, and you have one and you add one more thing is the live event. You have live event, and you have everything. That's it. You have an interactive mind; you know how to do interactive things from Virtual Production to Immersive Technology. You do AR, MR, and XR inside immersive technology, right? But you have to know filming because you have to know how to tell a story you have to know how animation and visual effects because you are mixing. You're creating computer-generated images and you have to know the game because you're working in a game engine to make interactive media.

So you understand right? Those three circles are branching like what my company doing.

(myself):

Very interesting insights about how we define the VP. When you're dealing with external directors and clients, how would you introduce virtual Production to them?

Sirasit Sawetprom:

Normally, most of our clients who come to us, have a bit of knowledge. I will separate them into two or three groups that I can think of now. In the 1st year that the world knows virtual production is heaven. There are just two types of clients, the first one is the people who are researching, knowing what it is, how it is and how to use it. And they have to ask it. "I want to use this in my production because I know it's a cost-reduction process". For example, you are one of my clients, you want to shoot a car commercial in the middle of the COVID era, so we have a lot of strict rules. You can't go outside, have a shooting set, that's 5, 10, 11 people. It's impossible. You have like 20-30 people to do a car commercial. If you do Virtual Production, you have one studio, and you have air conditioning. You have a lighting that you can show you can shoot your car with dark or dawn like the whole 5 hours, the whole day. But if you go outside and want the car running in the desert and the background is dawn. You have 30 minutes to shoot one shot. If you miss it. Done, you have to go tomorrow. And if you come tomorrow you have to cost your crew like if you have like 50 people, how? It's like a big budget. So Virtual Production comes to mind, it has upsides and downsides. The upside is they can control everything in their hand. If it is OT (Over Time), they know exactly like "OK, two hours more and be done", right? And we close and go home. But if you go to the physical set. Sometimes you cannot imagine like

when it will end. So, this is the cost selection and cost controlling. And another group of clients that came to us. They know nothing. They just saw a fantastic video of virtual production or version somewhere on the Internet. It's a really big screen with the people walking in the front and it just cool, it just cool and everyone to taste it in my production. So, for the first group that I told you like they already know, it's pretty easy because we have like the experience on that, we just exchange with them like, "OK, what do you think?" If you thought it's true, is it possible in the real world? But the second group of clients, they do not think, they just see the cool thing and come to us. We have to educate them like. OK. You know is reducing your cost. Yes, it's true, but you have to do with the whole movie. So, you imagine you only film 10% of the movie. It will cost you a lot because the building cost of the virtual production studio is very high. If you build it. You just use it for only one day. It's not worth it for you or you use it for a couple of shots, but if you build it once and the second day, or third day the cost is still using because you just reuse the facility and everything here, right? So yeah, so that when we will reduce your cost a lot, like crazy a lot.

(myself):

So, the more you use, the more cost-effective you'll be.

Sirasit Sawetprom:

Yes, it's cost-effective, but it's up to the project. I have two examples; the first example is shooting a movie about a car. For example, maybe a driver 80% 70% of the movie is driving. So instead of crossing the road by police or paying the police for blocking, have it confirmed and everything, you cost a lot and if you miss something. You have to reshoot it again. So, the cost goes rocketly high. On the other hand, you go to virtual production. You set up a studio and when you want to change the location, it's like one click, you go. So instead of four days shot, you just film in three days, two days. It's easier the set and everything. Just like move in, move out. That's it. And another project, for example, it's about a movie that has a car scene. The actor and actress are talking in the car for just 10 minutes in the movie so you pay a lot for the LED screen, the virtual production crew, the Disguise server and everything. Set it up and you just use it in 10 minutes. Compare it with you go out for 10 minutes. So, you understand?

The expectation of the client. We know that their expectation is everything is real which means if they don't understand the limitations of the program, it will affect the final outcome. It's never real.

(myself):

Some people say using an LED wall is like a matte painting. It's like you generate the background.

Sirasit Sawetprom:

Yes, right. You can say that. Because comparing between you have a green screen

on set and you have a final look on set. What is better for you?

And you're working on compositing the first position before right so you will know like Matte painting, you have different kinds of painting, 2D matte painting and 3D matte painting.

(myself):

Yes.

Sirasit Sawetprom:

Yes. Do you still need the same? It's 2D and it can also be 3D, but it's up on the front page what do you use, so in my personal team, because before we have a matte painting that we do on the glass before, right? it's like evolution. That's it. The previous era of Visual Effects is the Green Screen, the current era is Virtual Production, that's it.

(myself):

So, when you talk about there's a car project during the COVID. So, you work remotely with your staff? Or how does this work?

Sirasit Sawetprom:

Remote working is not working in my experience.

(myself):

It's not working.

Sirasit Sawetprom:

It is working in some countries or some use cases. I saw they did it. Yes, but when you do a commercial, I mean on the western side, they may have a lot of time, more time to work on that. but when you're working on a project like that, and you have a smaller budget and you will have a very short time to produce the movie, coming on the set is better. The communication is more efficient. I never do remote shooting. I do that just for live events but never for the filming.

(myself):

So actually, does the leader change the direction? I want to do this, I want to do that.

Sirasit Sawetprom:

It is a different tradition. Because my company used to have filmmaking people work for the event. It was like a live event. I have to livestream something and I bring my whole crew. A man from our crew was wearing short pants with a shirt, walking into a big event hall. And the event people, they asked 'why he dress like that? He must respect the place!' So it is like a different world, a different way of speaking, a different way of life.

(myself):

Etiquette, I would say?

Sirasit Sawetprom:

It is funny, actually when it is pasted, it's fun. But in that moment. It was not fun. Because at that time we had a vendor, our customer was not an event agency. They work with events a lot; they are just "How do you allow your people to dress like this and work with really high-range people like suits and bowties?" And they are confused because the event people wear suits. In the end, I changed my company, so we separated the production team and event team. We separated the area to work with. Yeah, For the data and the control team is fine with the production team. But the people who have to work with people, who have to communicate, we get another set of the team to work on the front line.

(myself):

Ah, so actually there's a bit of behind-the-scenes and also how to talk to the external client. Interesting, I didn't know that.

Sirasit Sawetprom:

Same as Virtual Production, if you're working with the production people, you have one person that communicates. Because if you allow the nerd people from the Virtual Production team to talk with the director, they will fight each other.

The difference is like is if you do something wrong. In live events, it just passes. That's it. Just one time. You don't have will not have any chance to fix it. But if you do miss something in the production, it will come back to you again.

(myself):

It's true because for example, if we use VP to do like cinematic shot, if the director says this is not OK, then we do it again. Sometimes, a live event is like a countdown. We just keep going. Keep going. Keep going. We don't care about any mistakes.

Sirasit Sawetprom:

The show must go on.

(myself):

So what if the client wants to use their own camera equipment and physical set? How would you allow them to adapt to your system?

Sirasit Sawetprom:

Oh yes, we can do that. Sorry, yes. because you were just talking about matte painting, right? We treat the LED wall as a matte painting. It's a one piece of art. What do you want to look through it? Do you want to see it? It's up to you because

we have to adapt to the traditional way of working, but some people like Christopher Nolan, have their set-up lens, and the camera. That's it's already their hand, their eyes, you know. You cannot change. And we stay in the world of art. Everyone has their own tools. So, we understand, and it should be like that, we do everything to support them.

(myself):

So, you need to like to recalibrate or accept their equipment.

Sirasit Sawetprom:

Yeah. The funny thing is, I never calibrate.

(myself):

I've heard a lot of cases they always need to recalibrate. Like so many times.

Sirasit Sawetprom:

I thought the same but in real life. I want that more red. I want that blue. I want that more shadow. I want it brighter. So, everything is messed up already when you like waiting for the LED walls because the director looks at the final picture from the monitor screen and if they like it, they like it, done. So that's why the calibration is not never on my Production, but in fact, it should be calibrated. It should have accuracy because it's up on the pipeline. I am working a lot with the commercial, they want to finish everything on the set, but if you are working on the film production or CG production. You have to bring your plate, like the footage, when you are shooting you will bring your footage into postproduction. Add this, add that, remove this, remove that, and it goes through the whole full postproduction pipeline.

(myself):

So, there's still postproduction in there.

Sirasit Sawetprom:

For me, I'd say it's not necessarily for me to calibrate the background, but for the people who are working on a traditional postproduction. So, they have to have very accurate colour in every pixel. If you ask me, it should be calibrated. Yes, it has to be calibrated. But for my clients, no, they just love what they see on the monitor. That's it.

(myself):

So what kind of reaction the actors will have when they see the virtual production? Will they like very amazing, or do they feel very immersed?

Sirasit Sawetprom:

Immersive for acting? Yes, that's true, but for the first time, they saw the big screen. No, they just like "Ohh it's a big screen. That's nice. It's a big one!" That's it.

(myself):

They think it is a screen, not a set not a set but a big screen.

Sirasit Sawetprom:

But if you ask me, it makes them easier to act because they have real lighting. Instead of the green screen, they see the set, right? It makes the easier to act but Not like an impressive, like "Wow !" It helps them, but not that much. Maybe, if you ask an actor, they will have another opinion, but for me, from my perspective, it's not like "Wow, it's so good. This makes my life easier. I want this! I want to use it to bring this into the next production. " No. they just like "Wow, that's easy."

(myself):

OK. Interesting. Yeah. So, moving on to talking about the control room and the team structures. There's a control room in, you know, every Virtual Production company and can you introduce the department, the component of the control rooms?

Sirasit Sawetprom:

For Me, I do not have a permanent studio, so all of my virtual production is a pop-up production. So the "Brain Bar" or control room as you say. I mean, I design it. For me, the "Brain Bar" is a solution. Virtual Production is a solution for the production team or for a client, because they have some issues and they find the solution, Virtual Production is a solution. So, to decide the "Brain Bar", how the thing will be involved in the "Brain Bar" is a solution. I call it a solution. so, my solution depends on the requirement. What is the question again? Sorry.

(myself):

Can you give some examples of tricky projects that you completed and how will you make up, and build the team that you mentioned?

Sirasit Sawetprom:

Oh, so which question first? The tricky project first or the team?

(myself):

The tricky project first and then we talk about the team and how you solve this tricky project.

Sirasit Sawetprom:

So, I have one of the tricky key projects, but I love that project so much, it's about a virtual concert. Yeah, it's a concert, shooting a concert band with a really big green screen in the background. In the 1st test, we think we just put the graphic into it and done. but why not? We have experience of Virtual Production. We just put the nDisplay thing, Virtual production, ICVFX into that background and the client said can we have an AR on top of that, connecting with the background? I say, For the timeline, I don't think we can do a connection, but we can have AR with the nDisplay

in the background, yes. So this will extend the space out and have an AR flying around and the middle is a concert where you can see the moving head, you can see a model on the screen. You can see the floor of the studio. it feels lively but virtual. You know, In that time I used to work for the only AR, only ICVFX. I never do a combination. How can I do that? So, the solution came out as we do the ICVFX first like the common, very common one, just Unreal Engine, feeding image into the LED wall, so we have camera tracking send the tracking data into the machine. So, we have the ICVFX, done. So, the second part is the AR part. We already have the camera tracking right. This camera tracking system can send the data to any or a lot of machines, even in real-time, right? So, we have a lot of computers that run the AR software, at that time we used Asymmetry and the same camera tracking.

(myself):

At least have the synchronised data for the camera.

Sirasit Sawetprom:

Yeah, it's already synchronised by themselves because the camera tracking is the same thing. So that's it because the camera is shooting on the musician, the background is already ICVFX and we feed that image into the Asymmetry, and put the AR on top of it. Done.

(myself):

OK, so how was the crew for that? You know, ICVFX and AR team.

Sirasit Sawetprom:

Actually, it's the same team because I built a team that time, we called the Technical Team. Yes, Technical Team. Because of the background company, we do a lot of things. This team has to have some knowledge of those 3 benches. Immersive technology, AR, VR, everything, Virtual Production and virtual events so they can do everything by themselves already. So that time we have 4 machines on the desk. Yeah. So, we have a nDisplay. render node, right? And we have the Unreal editor, which uses multi-session to move things around in real-time and we have a pair of machines that run Asymmetry in case of failure.

(myself):

like a backup for that one. So, you also use Disguise?

Sirasit Sawetprom:

Not Disguise. It's just Unreal Engine and Asymmetry, that's all.

(myself):

So basically, there's a group of people who are in charge of Unreal Engine and also Asymmetry. And then how large is the group? like 4, or 5 people?

Sirasit Sawetprom:

6 or 7, if I am not wrong, because we have two people to take care of the camera tracking. we have two people, one is the operator, and the second one is the Runner. And we have two people for the virtual production, for the ICVFX. Yeah, because we shoot all day. So, we can have a swap, If one goes to the toilet and the other one can take care of it. And we have another pair of people taking Aximmetry. Yeah. So, it's about 6-7 people, including me as a supervisor.

(myself):

Yeah. I'm interested in the Runner, what does the Runner job for you? like there is one runner. There's a coordinator? Because you've mentioned there are two people for Aximmetry, two people for unreal, and then you as a VP supervisor and then there and one for the runner. What is his job?

Sirasit Sawetprom:

The runner is like a do everything that we told him to do. A runner is a runner. Run to that, run to doors, checking. Most of them are Junior. So, they are about to be a part of the production technical team, but they are just juniors, they are learning instead of being the team and sitting in front of the monitor. So, we just asked him to do an easier job so they could understand more about the system like plugging this cable, moving the thing, and setting up the camera. Something like that is a physical, physical thing that is easier than the software thing you know, right?

(myself):

Yes.

Sirasit Sawetprom:

Yeah, so they understand when they are done with that job, they understand the whole picture of how to connect each machine. It's not only a power line; there's an SDI wire that carries the video image, right? You also have a power distribution that is a big part, so you have to know how big the power line you can use is. Because if you use too much power, it will get hot and burn. Other than that, there's the network aspect. You have to know how to connect four or five computers into one network, and you have to know about camera tracking. The data income has to have a separate network to send the data because if you use the same network as the internet or another controlling setting, it will cause flooding and lead to data loss and delays. Delay is okay; we can fix that. But data loss causes lagging, and that's not good in production. So, we have to separate it, and they have to know how to set it up, how to separate it, how to fix things, and how to wire things around. That is the runner's job.

(myself):

Is the Genlock also important in all these networking setups?

Sirasit Sawetprom:

Genlock, yes, it's very, very, very important. However, for my production, I have never used Genlock because Genlock is crucial and plays a big role when you have multiple render nodes. I have heard from a friend in production who also works on virtual production. They have a screen that is 20 meters wide, and they use two or three render nodes. If you do not have Genlock, you will not have something like frame sync in Nvidia Sync. Each panel, how should I say it? Each picture of each render node will not be aligned. For example, if you move the camera to the left, people will notice that it's three screens. For us, we are not working on something that big, or if it is that big, we will consider the quality they want. If they want to blur a lot of the background image, we just put the 4K on it. Done. It's just one machine. Another significant role of Genlock is when you are working with the camera and some LED panels, there will be bending. But it's not the bending caused by the frequency when you shoot on the screen. It's a different type of bending, and you cannot fix it if you do not have Genlock. You have to have Genlock to make it work, even if you try to adjust your shutter angles and shutter speed, it's impossible.

(myself):

It's not the camera physical it's the genlock thing.

Sirasit Sawetprom:

I faced that issue once, but fortunately, it just happened on top of the screen if you have like a 6-7 metre height and it is on the top. So, we just shot it half. So OK, I realised that is important. But somehow, I find a way to survive. It's not good. I would say it's not good. You need to have it if you ask me. From today I will have it to save my life instead of shouting at the cameraman, like "Can you try another shuttle angle? No, no, lower lower! "And like "The client really wants to shoot this angle, so I want to have a really high number of the shuttle angle." "But if you do that the screen will flicker and have a banding!" Genlock will come to pay alone.

(myself):

OK. Yes. So, except Genlock. What other elements do you think make the Virtual Production successful?

Sirasit Sawetprom:

Success in which direction?

(myself):

In a cinematic way?

Sirasit Sawetprom:

What does cinematic mean to you? Are you just shooting one perspective? I know being "cinematic" has a brilliant way of explaining. What do you see in your mind now?

(myself):

For me, it's the perfect merging with the physical and the LED wall, And then in terms of colour and style, because sometimes we need to deal with doors and cars, right? And then how to merge them? It's quite critical for me.

Sirasit Sawetprom:

Yeah. So, you mean what is the thing that makes virtual production fool the audience that the backup is real? Right? OK. So you mean how and what makes your virtual production look real? It's the same question that what makes traditional Visual Effects look real.

(myself):

OK. Yeah. Yes.

Sirasit Sawetprom:

It's about the texture, lighting, everything on that. The physical thing is like an LED wall, a camera, it's just like a tool, maybe an LED Wall. Yes, it's sometimes maybe it's too blurry, it is not for the virtual production thing, is for the rental event. So, the colour is not accurate, but maybe yes. But after that, if you fix the physical thing, you fix the equipment. After that, it's like how you build the scene. That's it.

(myself):

You remind me about the pipeline of traditional visual effects because we have lighting, matte painting and at the end, compositing. And that's it. Is it different from the traditional one? Or do you think it's the same?

Sirasit Sawetprom:

For me, it is just another process that comes into production instead of using a green screen, you just use the virtual production and finally, you have to bring everything into postproduction. You cannot avoid postproduction from Virtual Production. Most people do not work closely enough with Virtual Production. Yeah, we have LED wall, we have a camera, we have Brompton, we have Disguise. So, I can do everything. But at the end of the day. You will know that no matter how good you are on production, you still have to bring that to the postproduction, at least color grading, so I say it's just 1% that replaces the green screen. But if you ask me, like the pipeline of the virtual production compared with traditional production, the traditional VFX is still there, because it starts from you bringing your footage into the production and working on that. It's just like that. Same as it's used to before, But the virtual production pipeline workflow. It's just an additional thing that you have to prepare before you shoot.

(myself):

So, we will talk about "Fixing in the Pre".

Sirasit Sawetprom:

“Fixing in the pre” Yes, sometimes you can do that, but most of it, “Fix-in-the-post” is more real. Sorry, I have to draw, it is like this Script, right? Like Script to Screen, Screen is when you release the final thing. This one is the postproduction, VFX. This one is the shooting or production. This one is pre-production, right? So, everything from script to scene is the same, but when you are shooting, work with ICVFX. It has another line like this. You work on the asset, everything blah blah blah. Show on the screen. You should think about everything the asset you work on this, and it just comes to this pipeline anyway. Do you understand me? It just needs to be prepared in advance, but you have to bring this to fix itself after that if you're working on a high-end production.

(myself):

Yes, of course. This is a very interesting angle, and this kind of preparation really like game development or is it the same? Because we are using game engines, right?

Sirasit Sawetprom:

Game Engines only play a role in the optimisation. But other than that, it's like traditional animation, VFX knowledge.

(myself):

Some say that is actually a reallocation from whatever the cost and time in post-production, from the traditional day from the postproduction time and cost, but now you put in the pre-production.

Sirasit Sawetprom:

No, it's not true, like what I draw, everything is the same cost, but you just have another workflow, another production to work for your virtual production. That's it. It's all a lie. Is it possible? yes, it's possible, but. If you want to have a really high-end quality of the content. Production is still a full process, postproduction is the same with the same pipeline, same everything. But it does not have assets. Because the asset is done by the virtual production team, you give that asset to the virtual production team. But if you ask me for the future for the improvement. This thing can be improved in the imagination workflow that you use in your research like the circle. Everything around it is imagination. But finally, you can have that. But that pipeline, for what I draw just is another workflow. If you have done that colour grading and everything, you have to go into the full postproduction. If you want to add some more things that you cannot choose in the set like a fairy tale or something like that, you need to add them in postproduction anyway because even if you use AR, it will be very fake.

(myself):

OK, so let's talk about when we talk about optimization, what kind of things that you think are necessary to optimise the game engine?

Sirasit Sawetprom:

I would say I'm also not good at optimization. I will let my team handle that. I just say it is hard. It's very hard. Even if the game development itself is like a Pandora box or black box. Even in game development, some people only understand game optimization. Yes. So, normally you have to know a basic optimization like if you use a lot of light in Unreal Engine and if that light is not moving, you have to set it into static. If you do that, it will increase your performance a lot, but if you have 1000 lights and you set it into movable.

Yeah, that's the basic thing. Other than that, it's like in engine optimization maybe you have to treat the engine in some way that I do not understand.

(myself):

So you mentioned that you can talk with the cameraman directly on the set? So how would you communicate with each department head?

Sirasit Sawetprom:

In production, the virtual production team, is as same as the Art team, and the Prop team. We are in the same area because when they want to move, I think. In front of the screen, they ask for the art director, but if they want to move a thing in the behind of the LED screen, they ask us. Nothing has changed. That's like one more annoying team sitting there, working with the LED. That's it.

(myself):

So, it's more direct and strict, right? If the director wants to change something, they can directly approach you, and you ask your staff to change this.

Sirasit Sawetprom:

And the challenge of this one is communication because if you never use production language, I will say production language, because the filming production, have their own language, they have their own way of communication. If you do not have that, you will be crying. You lie down on the floor crying, "Why It happens to me?" But if you know how to communicate with them, it makes your life easier.

(myself):

I'm kind of interested in the language. Like, how do you learn? or you need to learn the language of filmmaking, right? So, in the end you need to transfer from VFX or game engine to the filmmaking, the lighting, shutter speed all the things?

Sirasit Sawetprom:

Yeah, it's a skill of the supervisor that you know, like instead of working with the machine, with the software. You have to learn how to work with the people.

(myself):

So, you also need to learn to know the word from your technical side.

Sirasit Sawetprom:

So, sometimes like you're working on the VFX. Oh, this is because of the colour space, this is part because of the texture, because of the render, But the production side, they have like camera angle, lens, achromatic, aperture. Even they watch the picture, and they know which lens you are using to shoot this frame. Yeah. So, something like that is it's another language. So, we have to adapt.

(myself):

I mean, even for the FPS, frame per second, it's different from the camera and the game engine. For me, one of the things I'm thinking because FPS in the game is different like FPS talking about 60, 90, and 120 for the game engine but FPS in the camera is different like 24 or 30. Does this word have different usage? or is it still the same?

Sirasit Sawetprom:

If you do genlock, then everything is the same. They talk in the same language. It's a frame per second, we have a higher frame in the game because it's smooth on our eye. That's it. People love to have a really high frame rate playing games because it's smooth like the physical eye. But for film, it is like. You can do a movie at 60 frames per second, and no one will judge you right, but they just don't do it. Just use 25, and 24 as a standard after all. That's it. For the game engine, it just reduced from 144 to 25, done, talking in the same language, if you have a genlock, you have a signal generator to the camera 24 to the computer you have rendered 24, that's it, it is the same picture, yes.

(myself):

This is the importance of genlock. But, you know, there are other professional terms in the game development and also in the filmmaking. Is it you need to learn them one way only about the film making or is it a two-way learning?

Sirasit Sawetprom:

Yeah, it's 2-way learning. In the pre-COVID situation, we will have an issue with postproduction talking with the production because we talk in a different language, right? But that's OK because you already shoot. We just fix it, done. But for the virtual production. you are shooting and we are fixing at the same time, for example, there was a really funny request, let me think, OK. It is a scene that you can imagine the Arizona stage that has an 88 road in between like the desert in the USA. You can imagine that picture, right? So we built that scene a really long street and have a mountain, like a sand brown mountain in the background. We have cactus and glass, and a bit of the flower. It looks very perfect. and we are shooting for half of a day and the director just sitting and looking at the screen: "Hey, virtual production team, can

we flip the whole scene?" So, I have a question for you, from this example. For the communication side, what will you do? Is it a 2-side learning or 1-side learning from this example? What do you do?

(myself):

I think it is a two-side learning because I need to understand his word so flip for me is reverse short. Right? At the same time, the director also needs to know the consequences of this request.

Sirasit Sawetprom:

That's also true but in fact. He really means flip, like the flip the whole thing. So, you cannot say "NO" in the middle of the production. We have a rule, if you say no, you have to give him why and have a solution for them. So, two-way communication is if they are asking impossible things. You are going to say no, you will need to think about the solution for him and you cannot think of this solution if you don't know why he wants that. So, the first question you would ask him is what do you want? why? and what is that impact on the movie? Something like that. If you understand the way he thinks and understand how he works on the director's terms, it would be easier for you to go along with them. Like, we saw that scene, that thing would be an issue in the future, we remove it, remove that. And in their perspective. They have to understand that it's not possible to flip the entire thing in real-time, it might take time, but the producer sitting around and like "No, no, no, we cannot use one hour or three hours to do that flip, if we flip it, it means you have to need everything new again in a new scene. It's impossible." So you have to understand and find the meaning of everything in that two-way communication. Ohh, one thing I forgot to tell you like the two-way communication kind of one thing is learning the way how the production works. It means from the perspective of the director, they want to change things immediately because they have a new idea in their head. On the postproduction side, the VFX team, and the virtual production team is not possible because everything has to adjust. It's created and generated by the computer. We have to adapt to understand "why" from the example I give you like he wants to change immediately everything. But we have to understand why because they want to do a new shot or a new funny thing on that one. So, we offer another solution and what the best we can do, and he has to understand us like, OK, the system cannot do that. We have to wait.

Oh, one more thing is the texture compiling. In Unreal Engine, you have to compile the texture, sometime. It's like 3 hours, 2 hours, you have that experience before. And sometimes it's happened in the middle of the shooting. This happened to me about 2 or 3 times in the first month of the company. We don't have a fancy 36, 89 core GPU, we just have 16. We have i7, Gen 3, Gen 4, and 16 core, and have to compile 2000 plus texture so it will take two hours. So, you have to think about how you can fix it and fix that, you have to learn everything. They have to learn so that is our limitations, and we have to educate them. Please don't change anything. If you

change anything, you have to spend more than 1, 2 or 3 hours on that because you have to wait for me.

Maybe it's a limitation of the game engine You cannot put a crazy 10,000 billion polygon. Like we used to do in Animation. You know if that frame renders for six weeks for a case like if it might be the deadline. But the virtual production you cannot render. So, it is a price to pay for optimization.

The first is the limitation, the second is the timeline. The timeline is very short. Because you can do animation for the whole year, a whole two years. But Virtual Production is one month. It's not worth working with virtual production for 1 year. 6-months is ok because of the asset building. The longest timeline that we have is 2 months. Most of the project is like 2 or 3 weeks. They, the client would call you "OK, we have a shooting next month", but they do not even have pre-production, so we have to wait for them to tell you what you have to do in the scene in one more week or a week and a half So, in the end. You will have like 1 one-and-a-half week to work on assets and see development and two days of shooting. And a month and a half for the postproduction. Because they don't know how to work with the virtual production. They thought it was CG in real-time, But no. You have to work harder on pre-production, and you will spend more, and you will you spend less on a shooting day. And post-production. But people still use the old mind, the old way, the old school of thought to apply to virtual production.

(myself):

So, does this one cause a lot of stress on the artist or "Brain Bar"?

Sirasit Sawetprom:

Yes, it causes stress for everyone if something is not going in the track.

(myself):

Because, you know, in the traditional one, for example, composers sit in front of a computer, hit render, have coffee time, and then come back. OK, re-render. Everything is under their control, but once it becomes a virtual production, everything is chaotic also at the same time, they need to chase up the schedule, sometimes rendering problems, sometimes checking problems.

Sirasit Sawetprom:

This is why it leads to the topic of why virtual production has to spend more time on the pre-production, fix-in-pre does not mean you fix the thing in pre-production. But that means you have to plan everything before the shooting and in detail, define everything before you go to shoot because if something gets wrong in the middle of the production. No, No, The answer is no.

(myself):

So you have to kind of like briefing day or testing day before the shootings?

Sirasit Sawetprom:

It should be. it should be. Sometimes the production team call me like. "Hey, can we have a shooting with the virtual production next month? How many scenes? 4 scenes?" If you have 4 scenes, you have 4 artists. And you put a day that like, they want to revise, they want to change a thing, they want to review with your work. And they just want a new one. 1 month is OK but not good and not bad. But for me, I prefer 3 months. And the funny thing is if they call you like "We will have shooting next month." They will have a storyboard on the last week before shooting. In the middle of the shooting is like "Bro! You did not tell me you have this shot. How can I build this shot for you now in 10 minutes?" No. So, you ask me, we have a lot. At the beginning of the virtual production years, virtual production still works as a production. If you are working with the really high end of the production like the western, the USA, they have a lot of money to spend on the pre-production. Because they want to save cost from the mistakes in production, right? So, they will ask you everything, plan with you, shoot with angle, how many seconds the camera will run? It's more precise. You can fit everything. You just like put it in the Timeline and click play. But for smaller productions, they don't work on a timeline all the time, they work on the storyboard. It has revisions every day, the client asks to change every day, the commercial thing like that. So, I don't know is this the answer for you? But that's from my experience.

I just don't like when the director says I want to change something. Because when they want to change something, that means my team cannot handle that. Because it's they are all junior sometimes. So, if they want now, it's only me to do that. I tried to train them but it's not enough, it's your experience. So, I have to go back and fix it. Why are you not planning for yesterday, bro?

(myself):

And sometimes cannot blame them because the director adds something new.

Sirasit Sawetprom:

They can, yes, but the traditional way to do that but virtual production way. I don't think there's a benefit. There's no benefit to doing that. And let's also connect to the question of why it's very hard to sell this product or service to the traditional filmmaker.

(myself):

I mean, also this comes the real-time rendering, right, they think it is easy.

Sirasit Sawetprom:

It is not real-time, it is rendered in real-time but have to bake shaders. Yeah, but

sometimes I finish fixing things in a real-time. it's called multi-session, you know it right? In Unreal Engine, we have a multiuser session feature, sometimes I mean it's to use that to fix things now, OK, it's possible.

(myself):

I mean it's also a new perspective to understand.

Sirasit Sawetprom:

It's a new life, I would say. A lot of people think about it like, wow, the virtual production you have a preparation time, blocking shots simulation, camera, anything, No. It happens. But in the last week, more shots appear in the storyboard. Another funny thing is we have a test day before the shooting day like, to test, to perform everything, try a camera angle, check the scene, scene by scene, and the colour is OK. Everything is perfect so I just go to sleep and wait in the next morning and plan to have "Next, next, next, go home." But in that night, the director and the other director don't go to sleep, they just add 20 new shots with the new background and don't tell us like "Ohh I thought it was easy. You just change the light from blue to white. Can I have in five minutes?" Ah... why didn't you tell me yesterday? So our lives are not as beautiful as people think they are working on virtual production.

It's not that fixing in the middle is a Fixing Now. Fix Now.

(myself):

So do they have a lot of tricky short types? like a wide shot?

Sirasit Sawetprom:

No.

(myself):

So basically, it's just on the LED.

Sirasit Sawetprom:

If you calibrate the camera position and everything in the place, you can shoot like you shoot in the traditional version.

Crane shot. The bird's eye view shot wide shot every side of the shot. You can do it.

(myself):

Is there any chance that, for example, maybe there's a case where, the director comes with the story and they understand: "OK LED wall can do this, cannot do that" and they change the shot? Is there any case in your production that they have to change some shots after they realise the limitation of the LED wall?

Sirasit Sawetprom:

Yes, yes, it's normal if they decide to use the wall, if it's a limitation, they have to change, but mostly the ICFX itself can support any kind of shorts. It's really rare to change a shot. I cannot think of an example for that.

(myself):

Well, what would you recommend for a pipeline or for a workflow for virtual production?

Sirasit Sawetprom:

Recommend including the workflow? More review, more review. When you're working on the pipeline, on the workflow. They have 2 main sections. We call it the Review Pipeline for the artist and the Asset Pipeline or asset workflow for the artist. You know the shotgun, right? then you know. it's Shotgun. This one is asset and shot pipeline so when you talk about the pipeline or the workflow, it is separated by this one. Supervisors see your review and clients see your review and keep a note comment. And this one is for the production, so it is the same for the virtual production. We have to concentrate on the review more. Actually, in the same way as you're working with the traditional VFX, you have to spend more time with the review. That's it. I don't think I have anything to recommend it's like. Just a transition from traditional VFX into virtual production applies. It's really similar.

Even the word, we use differently for the word Pipeline. Pipeline for me is the way the data flows in the pipe. If you say submission that is Workflow, not Pipeline. These are 2 different words from the pipeline perspective. Sometimes we describe an issue. It's not a pipeline issue, it is a workflow issue like you decide the flow of the work wrong. So, it made a little mistake and was wrong in some way that is the pipeline. Data input, output. But for the people who work on the producer or the management, the pipeline means the schedule. "Please tell me your pipeline of this project". "OK, We will do this file". "No, no no. I mean when you will do what?"

(myself):

I mean, they also misuse these two terms workflow and pipeline.

Sirasit Sawetprom:

Yeah, it's OK. The pipeline is for technical people but for the artists we don't mind if they use pipeline or workflow because they understand the higher level of the system. For me, this file goes to that one and renders out somewhere from the cloud Yeah, but for me like. we have to support it. We have to take the category of it. Even the tool, we separated the two into two sections, the workflow tool and the pipeline tool. If you are an animator and I give you a tool to.... Do you know the Onion Tool? like we have before and after frames to switch, something like that, not related to file input and output. We call that tool a workflow tool. We write a tool for the lighting team, like finishing the lighting for the whole scene or setting the render parts.

Something like that we call it the workflow tool. But the pipeline tool is like the tool that exports the timeline for the Editorial department into the animation combines the movie from the TD, anything into the comp, or something like that. So, we separate the two.

(myself):

I get the idea like for example, you export an ABC or FBX to the other software. This is a pipeline tool.

Sirasit Sawetprom:

Yeah. And if you are free enough and go to the event area, they have a bunch of new words and a new way to work. People from the production team. They are straightforward. They know what they want, and they say what they want, but not for events. What do you want from us? From us, please tell me. They say I want that they actually want this.

(myself):

OK, so we're moving forward, is there any special knowledge or things that are required in your department?

Sirasit Sawetprom:

Communication, the two-way, communication. Just communicate. If you talk about "Brain Bar". The big thing is the communication. You have to know how you translate technical terms into their technical terms and understand their technical terms to your technical terms. You can do this; you cannot do that. How you convince them how you negotiate with them, how it's about like how you work with people, that's the biggest skill. For the "Brain Bar" team because in the "Brain Bar", everyone knows where everyone can do virtual production, but not everyone can have perfect communication. For me, it is the communication.

(myself):

I think we already mentioned about your daily job, so we will move forward.

Sirasit Sawetprom:

I want to add more to the knowledge and skills requirement. Because there is a position called the virtual production technical director. Yes, so the job description is basically you have to control the "Brain Bar" or the section that you assigned. And other than that, you have to know, or you can give the solution to your client also. So, for the three circles that I mentioned at the beginning of the interview, the filming, VFX animation and the game industry. You have to combine that thing into one person. It is a good thing for a virtual production technical director because when you provide a solution you have to think like this. OK, you provide an expensive solution or not. Can the client afford what you said?

So, you have to think in your head, you have to discuss with your team, your fellow everything and you come up with the final solution and propose to your producer and customers. And one more thing is when you are doing the virtual production mostly and the client will sit behind you.

(myself):

Oh really?

Sirasit Sawetprom:

Because you control the process, you control the whole studio. Normally, we will have the producer sitting next to me. They love to sit with us because the producer wants to change this, change that.

(myself):

Is it very tricky to find?

Sirasit Sawetprom:

Yes, yes. If you go interview someone like that. Maybe that guy comes from one of these circles, they have to expand themselves to other circles. But instead of hiring someone who knows everything in these three circles, you keep them in their specialised area, and they just need to know how to work with the other two sides. Then, you find another two people who have different special areas in the team and your team will be strong. Instead of having a three-person team that knows everything but is not deep, you have three people deep in the different sections and can work together, it is more effective.

(myself):

So this is the technical director.

Sirasit Sawetprom:

Yes, and the technical director, this position means you have to direct, you have to say which way is good for the production, and which way you want to direct it. Yeah, technical director on the technical side, yes.

(myself):

So, you mentioned yourself as a VP supervisor. So how would you work with technical directors?

Sirasit Sawetprom:

It's easy. To become a supervisor, you have a people skill. That's it. People skill, money skill. That's it is because the leadership role is just it's just a managing role, managing people. That's it. If these people can work with the people, they can become a supervisor.

(myself):

So, are there any departments under you? Or are there any departments that you just mentioned, that you need to work with other departments during production?

Sirasit Sawetprom:

Yes, in my company we have two departments working on a Virtual Production project. The 1st is VAD. Virtual art department. But I don't have that team anymore. Because now we use outsourcing more than having in-house, it is easier to find outside. That's it. It's VAD and the technical team.

(myself):

So basically, they have to deliver their unreal scene to you. And then you just use a disguise to optimize the set and then project it to the LED Wall?

Sirasit Sawetprom:

Yes, mostly the VAD team are working on the art design. They will help us with some of the optimization and they send that scene to us. For the technology team or technical team. We set it up and connected with the special actor that we set up for the ICVFX. We make the lighting or the movement of the sun into the control bar or something like that. It's more of a programming thing.

(myself):

So, there's programming involved in your department.

Sirasit Sawetprom:

Yeah, it's yeah. But mostly we work on the Blueprint.

(myself):

As the "Brain Bar" team, you have to synchronise the Unreal vision and also check with all the software. Right? And then somehow does the coding highly involved in your production or just a little bit?

Sirasit Sawetprom:

A bit. Actually, it's not necessary, but for me, because I have my programming skills. So, I built some utility tools to help, for example virtual production dash dashboard. Yeah, because like Unreal has Switchboard already, but that's Switchboard. It does not work easily with the camera performance. So, we built a tool that helps. It's just a tool that on top of that switchboard that synchronises, to perform easier or something like that and works with the camera tracking setting easier, so yeah, it's not like a big whole pipeline but sometimes it is half like if we have a very short period of time to work on some projects and we have to finish in the one week. So sometimes I write a tool to auto separate the shot, mapping with the camera tracking data. Create a camera with the camera tracking in the Maya and export and import automatically in Unreal Engine. Instead of 14, or 18 shots for 2 days, we just finished it in like 10

minutes.

(myself):

It comes in very handy if you know to code and then also other DC tools, right?

Sirasit Sawetprom:

Yeah, but it's not happening on every project, it happens on some projects that require it.

(myself):

Oh, yes, yes. Depends on the scales.

Sirasit Sawetprom:

Because pipelines or designed workflows exist in the world because of the time efficiency. And it is just existing to the world to make the artist focus more on the work and forget about what the technical stuff should be like. How to name the shot, and where to save the file, we just offer them one button. Save, Open and focus more on your work, that's it.

(myself):

But is your job in virtual production different from the traditional one as the pipeline director?

Sirasit Sawetprom:

Yes, it's different. Actually, it's a different role. The cost of production in traditional production is the CG Supervisor. You have to know technical things. You know how to work with people. That is the closest position to the Virtual Production Supervisor.

(myself):

Ah, so the CG Supervisor shifted into the VP supervisor.

Sirasit Sawetprom:

Yes, you just learn more about a new world for virtual production. That's it.

(myself):

Well, because in the traditional one, we have TD for naming a shot, for submitting the shot, for dailies and reviews. And does it also happen in VP? Because there's a pipeline TD in the traditional one, they will write a plugin.

Sirasit Sawetprom:

Mostly Virtual Production TD are TD by themselves. They like very professional soldiers in the field so they can do everything on the set. It's a "Brain Bar". It's like a holy area for them to control everything. If something's wrong in that box, they have to fix it. They have to ability to fix it. And if software is broken, they want something

new, they have to find a solution for you. It's a TD's skill.

(myself):

OK, moving forward, So what do you think about the industry in the future? For example, will the VP fully replace the green screen?

Sirasit Sawetprom:

No. It's not possible. The green screen itself has its own ups and downs. Virtual Production has its own ups and downs, especially the cost efficiency. Some type of shot is still required to work with the green or blue screen. It is really easier. In some productions, you have to bring that shot to the postproduction anyway, so maybe it would be easier. It will go far from more than this a lot if you focus on the ICVFX technology. I just talked with the Brompton guy yesterday, they just announced a new feature for the product, they can render true colour like a very accurate colour for the LED screen. So now the colour that you saw on the LED screen has the same quality as the Sony Bravia in a TV shop. Yeah, and it will go more than this, maybe in the future. You can shoot 1000 frames per second with the LED, who knows? Mostly it will come with more pipelines and the industry will challenge and complete each other by working on the virtual production faster than that. So the time for the pioneer people, like me, I am a pioneer because I start from the beginning of the virtual production, we collect the data, we publish the data. What do you have to learn, what do you have to prepare? We discuss what is what, and what the terms are. and how to work with that. From now people will come and learn from what we do, and even your research will be the pioneer thing for the people in the next generation to come. It's like animation in the 40 years back, like pioneer people come, learn to work on Maya, figure out what is the best pipeline, something like that, So now it's going the same way.

(myself):

Yes, I have a question back to the structure. Is there any title called Real Time Technician in your team?

Sirasit Sawetprom:

We used to use the Real Time Technician because it's just a cool name, but finally, we just changed it to the virtual production technical director because it's worldwide.

(myself):

So it's not only about real-time, it is a bigger picture.

Sirasit Sawetprom:

Yeah, virtual production is a really big one, it's for like the whole industry already.

(myself):

Yes. Because I was just wondering. What does the real-time mean? Does it mean

unreal, or does it mean disguise or other things, right?

Sirasit Sawetprom:

I learned something from my experience that I own my company, you can imagine a funny position in your company. I can say I do that because I used to use Real Time Technician before because it looks grand and looks big for our customers when you have your crew sitting at the desk with the client. Oh, this one, is a Real-Time Technician.

(myself):

OK, I mean the naming title naming is still changing.

Sirasit Sawetprom:

It's just a name. You see like in the traditional Visual effects industry company itself, different position does the same thing in the same company. For example layout and match move. I am confused a lot. Why is the layout working on the camera tracking? and what does the match move team? It's the same team with the same people. OK. So why this company doesn't have a Layout? Oh, they have a match move, OK.... It is the same thing. So Real-time not real-time is the same thing.

(myself):

OK, So what kind of skills you're looking for in new hires in the department?

Sirasit Sawetprom:

From my perspective. When I am hiring a person, I'm not finding the best person. I'm not finding the person who already knows everything there but cannot work with us. So, I only try in this ICFVFX area you cannot work by yourself or just a one-man show or 1 soldier, you have to work with a team. So, communication and not tough. Some people like I know everything. They have a lot of ego. "Why do you teach me?" Like why? I want this but you are not doing it for me So what will it happen? So if you ask me the skill I'm looking for, it is communication, but in the technical term, I just want people who know everything, even a bit is OK, like who can adapt to another branch. If you are good at filming, it can work with you, but you will have to have the ability to learn, learn how to work with VFX and games. If you are good in game development, I will expect you to be able to learn film and everything. So, it's hard to say another position in the industry like "Ohh this is good" No, virtual production is an applied industry, apply techniques, and apply status is based on something already. For example, if you are working on nuclear reaction matching, you cannot expect to have like a nuclear reaction machine physicist to work with you because it's a new thing. You are working on a new thing. You just find people who know from a lot of branches and work together and make a new thing is it better because we are working on an applied area, not a fundamental area.

(myself):

Yes, It's a kind of integrated area. I realise this is also very hard to educate people because, in terms of the people who just graduated, they are from separate areas, right? Maybe they're from only filmmaking or only game engines. And what we mentioned is like they want is they are willing to learn other areas.

Sirasit Sawetprom:

Yes, from my experience, if people have or are willing to learn is easy. But if you force someone to learn. I mean in another way you go to be a chef or a doctor. If you force some people to be it, it's not a good way, right? Then they will not work as a free will. And it's not efficiency. If they come to me, even they know nothing. but they really want to learn virtual production, I will teach you everything. But some people like I thought to be with you is just sitting there. I have 1 student who came to an internship with my company. He just said I don't know where to go to. so, I just go to your company. I give a task to them. They just do it and do it like that. So, I say, you just sit like that? Waiting for the last day and go.

So, what is the point that you waste your energy like that? But it's worth working with the people who are willing and love to work with you. And it is very fun to teach someone that that ready to get you know where.

(myself):

OK, so I think this is the end of our, do you have more to add?

Sirasit Sawetprom:

Yes, I also told you about the people, the clients, the ones who want to be the first to use this technology. Like the image of the brand. We are the first company which use virtual production The new technology from NASA. Yes, but now it is already out. And people know it is pain. Yes, I will say it's a pain to our clients if they're not doing a really good pre-production. It's pain for everyone, paying for us, pain for them, pain for the production team, pain for a doctor who has to listen to you what happened in the production.

Finally, I would tell you that virtual production, the ICVFX Is not hard. But the management world, the budget thing, the economic side of it, it's high. For example, If you want to sell your product. Your product is virtual production, your studio is virtual production. How are you convenient with the traditional filmmakers? And one more downside of it. It is like it's a new thing. Virtual Production is new. If you want to buy an early bird ticket for the experiment, you have to pay more. You will have you want to be the 1st one, you have to pay more. And if you pay more, it doesn't guarantee that will come perfectly.

Like I said. If you want to be a virtual production supervisor. I can teach you in two months, or three months. Six months like to be the best people in Southeast Asia, but

if you want to run a company that sells the virtual production. Even myself, I'm learning it every day, I think it's more, more, harder than employees working. Cinema or filming itself actually is a target. A target is not by itself in the traditional way or anything. Most of the people who work in traditional filming. They also working on the commercial. So, it's the same. The filming is an art. Some people want to do it for art in the traditional way. Use the firm and digitalise, something like that. The commercial is commercial. Just make it done, make a lot of money, done.

For now, I would say live events, I don't know in Singapore, but in Thailand, it's less and less, like 1 out of 10 that you see with virtual production and virtual events nowadays. Because an event is an event, people love to meet each other. So, live event if it's not answered any more.

We did a virtual event 8 months already, like March last year? But it's like almost a year. Even me as a person who does the virtual event. I still don't like it's like sitting in front of a screen cannot interact with, but if you go to the hall. You can use the same amount of money for a big hall but with the amount of money, you have a big screen and nerd sitting in the corner and doing something that you don't understand. You know.

The equipment for virtual production is top-over-the-top quality. You have to have a machine that is faster than the server in the Data centre you know. if you have that machine, that machine has to stay cool. It cannot be exposed to more than 38 degrees. It will slow down like an old-core CPU. Then it will be lagging and everything will be broken. And if you don't put that server in a very cool environment, it will cut off its lifetime.

(myself):

I don't know if it will become better in the future. All the situations will be stable, faster?

Sirasit Sawetprom:

Well, yes, it has to be better. For sure when everyone understands what CG is, what is an asset, what is a VFX. Or what is virtual production but it's quite hard and it takes time.

Interview 2: Chris Yan, VP Technical Lead from Aux Media Group, Singapore

Interviewed date: 2023/05/08.

(myself):

Good morning, Chris. Would you mind introducing yourself and about the company? And what you're doing with your daily job?

Chris Yan::

So hi, I'm Chris. I'm the VP Tech Lead in Aux Media. So what I do is that I will make sure that everything in the studio is good for our VP shoot and then for daily operations and stuff.

(myself):

When we talk about VP, how do you define Virtual Production?

Chris Yan:

So, what I'm thinking is Virtual Production is like an umbrella term for a lot of different ways of filming and different ways of presentation, I would say. So, those items beneath the umbrella are those ICVFX where we use LED to do filming and then extended reality XR. Also, we have green screen compositing, yes and Unreal Renders. But the difference between Animation and Unreal Renders is real-time technologies where traditional animation is everything is prerendered or pre-baked. So basically, in conclusion, Virtual Production means something that couldn't be done physically, and it involves real-time technology. So in that sense, Mocap is also included in Virtual Production.

(myself):

OK. Talking about real-time, can you further expand on the real-time that is in your mind like maybe real-time rendering or real-time update or all of them included in your definition?

Chris Yan:

So real-time changes, real-time data transmission, real-time interactives, all these are considered real-time for me.

(myself):

Yeah. OK. So, what are the main purposes of your team to use VP in Aux media? For example, will you be VP for film productions, live events, and commercials? Or is it a combination of all these purposes?

Chris Yan:

So the application and Virtual Production in Aux here, we do extended reality and

ICVFX for filmmaking as well, but we actually looking beyond Virtual Production. We are looking at like new technologies to be implemented into Virtual Production and also new technology that's going to help us achieve better visual effects. So we actually doing things more than Virtual Production.

(myself):

That is a very interesting point of view to expand the VP. When you introduce VP to your clients and customers. What is their reaction and maybe what kind of misconception they will have in your experience?

Chris Yan:

All right. So when we're talking about Virtual Production, a lot of people would think of green screen first, because that's where the technology is very well known for people that's outside of this industry, yeah. So when we explain the way that we use LED for production most of them will think that so you use LED just to play video, to shoot something? So, then I have to introduce live tracking, camera tracking, and real-time technology then those things confuse them.

(myself):

True. It's a combination of different areas and layers of different technology.

Chris Yan:

Yes, I would say VP is an integrated system which consists of different technology.

(myself):

So what if the case is that the client wants to use their own equipment like a camera or footage? Will you adapt their camera, or you say no, please use ours?

Chris Yan:

I would say everyone around the world is doing VP and is practically learning along the way, so we are learning as well. So we welcome client with their own equipment to come in because that's our learning point as well. So we welcome that but just before the shoot, we would plan for technical rehearsal to make sure things run well and that's more of a workflow of how we plan our work for the project.

(myself):

We'll talk about the workflow in detail later and then is there any feedback or reaction from the actors so far you have experienced? Like when they see that LED wall-like. Wow. So amazing.

Chris Yan:

They will be amazed by we're using LED for production, but most of the amazed come from when they see the final programme feed, the final feed. Yeah. When they see the final of it, that's where the game is.

(myself):

So they can see the final feed on set immediately with the output from the screen.

Chris Yan:

Yes. Yeah. So, they exactly know what's happening in the environment by looking at the final feed and they can see what's happening in the LED walls.

(myself):

That is very good for them. Talking about behind-the-scenes. I know that there's a control room in every VP house. Can you introduce the components of your control room? What are the roles and what they are in charge of for your project?

Chris Yan:

You're talking about the workforce, right? So regarding the workforce, we will have definitely someone who's able to create an Unreal scene and then build it according to the client or client's wants and then there'll be someone technical to be responsible for all the hardware or the tracking trackers for LED processors our render machine, our system, someone who's going to be responsible for that technically. So this guy is a hardware guy and then there will be a Unreal operator and Disguise operator who is actually operating the system on the show day. Yeah. So these are the roles that I would say in our control room.

(myself):

So, there's a technical in charge for the technical side and then for the content creation, Unreal operators and Disguise operators I may wonder if there's any like a VP coordinator or VP runner in the control room?

Chris Yan:

For sure because like as I mentioned those roles, each of them have their own specification, but there needs to be someone who is able to communicate between the control room team and also the director. So, the role is VP supervisor, he has to talk to both sides.

(myself):

Can you talk more about the VP supervisor's roles and responsibilities?

Chris Yan:

For the VP supervisor role, he has to have some certain knowledge of film production in traditional production to talk to the director during the initial stage, the planning stage. And he also needs to have technical knowledge. And the limitation of the whole studio, he needs to advise to director saying, OK, so in the studio which other things that we can do, which are things that we cannot do, which can angle can be achieved. Also he needs to tell the "Brain Bar" who's operating the unreal and Disguise to tell them that, hey, the director wants this change, but then to translate to

the “Brain Bar”, say, “OK, to achieve that change, what should we do?” And also, to manage the “Brain Bar” by saying, for example during the shot, we have this amount of time to change? And then are we able to do it? He needs to gather information from the “Brain Bar”, so that's why he needs to know what the “Brain Bar” is doing. He needs to know a bit of technology from Unreal and Disguise to know whether this is possible, or is not possible.

(myself):

So here comes the importance of communication.

Chris Yan:

Yeah, communication between directors and the “Brain Bar”. And also, he or she needs to know the knowledge of the “Brain Bar”, the knowledge of traditional production, and he needs to know the limitation.

(myself):

That's great. It clearly shows the VP supervisor, and his duty do you think other than the VP supervisor, is there any other element that you think to make the VP successful?

Chris Yan:

To make a successful Virtual Production. As in to make the whole shoot successful. We need to plan it well. Planning is really important. So's where the workflow for everyone who's involved in the Virtual Production there needs to know the workflow they need to know, they need to have knowledge of what's the limitations in the studio, for example, the lighting department, they need to know the limitation, the audio department. They need to know, OK, the props are there. I need to record the sound. How am I gonna do it? Something like that so everyone needs to know the limitation, everyone needs to know the workflow. Because the workflow of Virtual Production is different from our traditional production, it is very different. To make it successful, those who are supposed to be in the planning part, need to get in as early as possible. For example, the visual department the VAD and also the VP sup have to get involved right after the script was formed. So that's where the director will talk to DoP, the production designer and then the VFX team lead and also the VP sup will come together to advise on “OK, so I'm going to achieve this. I'm going to have this short list with this specific camera angles. Is it able to achieve?” and then VP Sup is going to advise on what's the limitation and then for the VFX department. He'll come in to say, OK in the post, I'm going to do like adding some, for example, special effects or colour correction, which colour and which element I need to create in the post-production. That's why it's very important for communication. And then after the planning is the execution. Before the shooting is the Tech rehearsal. We have to make sure that everything works. I mean the camera, then the DoP, director have to be there to see “OK. This is the visual that I want to achieve and then these are the camera shots that can be achieved”. And then during the shoot day, everyone comes

in and participates in the shoot and we already have the tech run day, so everything should run very smoothly. But the director also needs to know that, OK, there will be cases that we want to change the background, or we want to move the props. So, during planning, we have to consider the time to change stuff on shot day.

(myself):

Is there any tricky project that you faced before? And can you talk about what is the project and how did you solve it?

Chris Yan:

There's one interesting project, which is the Star Award that we did. So, it's quite interesting that the client wants to have a real actor, but you know. But she is like in the ghost form, but then there will be another real actor. I mean the actress is in ghost form. The actors are in LED, so they want them to interact. So, we were thinking how are we able to make the actress transparent in the way? So, we were thinking about that then we came up with this solution we can make the actress transparent in a ghost form on the green screen. So, we actually shoot her on a green screen and then we live composite with the camera feed capture from the LED wall so that they can actually see each other live.

(myself):

Yeah, but it's not touching physically, right?

Chris Yan:

They're not touching physically. From the reaction, they are very professional actor and actresses. So you can't really tell whether they are touching each other.

(myself):

That comes to a magic trick, an illusion.

Chris Yan:

Yes, yes, that's what we should do.

(myself):

And you know what their reaction or their feedback is after the experiences?

Chris Yan:

They feel very interesting because they've done green screens before probably, but maybe not in LED and maybe not putting them together.

(myself):

Yes, this is definitely a new way of VP. It's not only LED, but also green screen. OK, so how about the workflow that you just mentioned you talked about like there's an initial day. There's a meeting. There's also a tech rehearsal day, and there's a

shooting day. Is there any more you want to add or how about after the shooting days, what's going on? For example, like a shot, are there any post productions or just like done and then just go out?

Chris Yan:

I would say the whole concept of Virtual Production is to bring the Post forward, including the colour grading and stuff, so there isn't much I would say. From my experience, there isn't much postproduction can add in unless it's some like particle effects in doing an after-effect or some visual effects so but compared to traditional production. Postproduction will have less involvement. But they still need to be in the initial meeting because they need to know what they need to add in for a later stage. And also 1st AD is very important.

(myself):

Can you talk about more about the 1st AD?

Chris Yan:

Yes. Based on my experience in NFTS where I study Virtual Production, so we have to come up with a script. We have to come up with a storyboard, and a shot list, we have to communicate with 1st AD. Our contact point is 1st AD. So we talked to her, and we discussed whether the shots, are they all possible? and which shot we should plan first? Should we change the background? But we don't change the physical prop. We have to plan the shot with the 1st AD and the 1st AD will then arrange with Production Manager who is managing the props on the show day. Consistency is another very important part of production because you have to make sure that OK, after I change my prop after I change my camera angle after I change my background, it's still consistent prospectively and all the items are correct.

(myself):

I may use the term continuity.

Chris Yan:

Continuity, yes.

(myself):

It's very interesting and you bring up the next question about how we deal with tricky shots. I want to do a reverse shot, I want to do a wide shot in a such filmmaking context. Have you faced that problem before?

Chris Yan:

Yes, we had to shoot last year sometime when we worked with a local director. There are a lot of wide angles, and because in Aux, we have a jib, we can use that jib to achieve certain high angles. Then we can use virtual cameras in Disguise to achieve that. So, I would say there's a very interesting shoot. Because we use extended

reality to shoot the short clip instead of using ICVFX. Yeah, because ICVFX, some shoots don't have the floor. So, it's very hard to have a wide shot unless you have a very huge space. But in XR, it's easier to achieve that.

(myself):

Because it's extended right?

Chris Yan:

It is extended. Yes

(myself):

So do these tricky shots affect the pre-production?

Chris Yan:

Yes, because I think last time when we were planning the shot, we planned shots with similar camera angles first, the reason being that like the continuity you mentioned.

(myself):

I want to go back to the "Fix in the pre" mentality. Some people may say that this is reallocation about the cost, money and effort. It was in post, but now it's in the Pre-production or even production onset. What do you think about that?

Chris Yan:

I would say it really varies from project, but everything has to work for a better visual, right? So, bringing postproduction forward, it's actually making sure that the actors will be able to see what's happening in the background. So maybe that will avoid some retakes. They will save some time in the sense. And also, to be able to save money, of course, because they don't need to like the whole crew go out on location shot something like that. So, I think generally, Virtual Production, which is bringing Post forward what we say, will save time. Yeah. Also like the background, we can change the shoot day on the fly.

(myself):

Yes. I mean that also is a huge benefit compared with the traditional green screen production.

Chris Yan:

Yes, I would say it's a huge benefit. I mean for green screen and LED Virtual Production, they are just options for different methods to shoot. It's just which one is more suitable, then we just go for that one. For example, like if we just go downstairs and shoot a park in Singapore, then we don't need to bring the whole park into a studio, right? It doesn't really make sense. We just go shoot on location then. So, it's just different options and how to plan the shoot like whether this section in green

screen, this section in Virtual Production, this section in real on-location shoot these different planning.

(myself):

So, it's a different option for them to choose right so VP is not their only choice.

Chris Yan:

Yeah. And VP will not take over the green screen. I believe so.

(myself):

OK. So, is that the case with projects that involved physical sets before like doors, and cars. How would you deal with that combination?

Chris Yan:

Yes, we have. So how do we do that? You mean how do we manage the props and how do we use them for shoot days? Is that what you want to say?

(myself):

I would ask how would you merge with the LED and the physical set.

Chris Yan:

How to merge with the background, so everything has to work for the final image. So we will confirm the background first, and then the prop team will come in to, "OK. What kind of colour do I want for my prop". Then they'll paint the prop according to whatever the background is, they have to prepare the prop to meet the background. So we have the background first, and then it's the prop team.

(myself):

OK, so background first and then prop, and then check the final image. If it's OK then it's done. If isn't OK, then come back to the loop again.

Chris Yan:

But if we come back to the loop, it's very unlikely we'll go to change the prop. We probably change the background to meet the visual because the background is easier to change.

(myself):

Because it's rendered from the game engine.

Chris Yan:

Yes.

(myself):

How about we talk about the special knowledge or the new knowledge that you gain

from your learning or in your department? Personally, what are the skills that you have learned by transitioning from your original area to VP?

Chris Yan:

I come from a 3D Mo-Graph (Motion Graphic) and Unity gaming background so the knowledge I learned is I would say if I were to classify it would be another game engine, of course, Unreal and Unreal's workflow for Virtual Production. That's the game engine part and also physically, for the hardware, I have to learn how to operate the hardware because it's a learning curve to understand the hardware and to really manage in a way to achieve the vision that we want. Including the LED processor and the camera tracker because we're using the Disguise system, so it's Disguise and also, I learned something about wiring, and how the connection goes.

(myself):

That's interesting. You not only learnt from the software but also the hardware. Also learnt about cables and networking. That is a very critical knowledge in your department.

Chris Yan:

Yes. For the VP Tech department, we need to know how to achieve something that the director wants. So that we have to know how to set up the hardware and what the limitations of the hardware things like. Oh, by the way, the networking I mentioned is about internet networking, network switch networking.

(myself):

Of course. What do you think about it? Is the wi-fi network or it's like a physical computer network?

Chris Yan:

It's network communication is the communication between all the devices because they need to talk. So that's the networking I mentioned about.

(myself):

So what if there's something wrong with the final output like blending, like from frame rate dropping. And then you solve the problem, right? To chase back all the hardware and then solve the problem.

Chris Yan:

Yes, because there are many different hardware that participate in the shoot. So we just like doctors, you know, when it comes to the troubleshooting, If the system doesn't behave well, we'll see from the symptom. For example, if the LED is blacked out, then the possible sickness for this whole system is maybe my feed from Disguise is not going through, or the LED processor will have something wrong or the LED wall itself has some issue. So, when it comes to problems, we'll need to isolate the

problem and troubleshoot that.

(myself):

So this is kind of like problem-solving. Would I say it is the key in your department? and what about it comes to when it happens during a shooting?

Chris Yan:

All right, wow. So, this is a very serious illness. All right, if it happens in a shoot, as I mentioned before, we need to factor in, for example, changing the time on shoot day because it bounced to happen for Virtual Production and then when it comes to certain problems. We will do normal troubleshooting to isolate the problem to fix the problem and then communicate with VP Sup then VP Sup will talk to the assistant director or the director, saying the problem, how long we need to solve and do we need to say shut down the whole LED wall or do something that if the director agrees or the first AD agrees then we'll just go ahead and do it.

(myself):

So you have to fix the problem within like 10 minutes or 5 minutes?

Chris Yan:

Yeah, we need to advise on the timing.

(myself):

Sometimes is it very hard to predict the time? Maybe that 10 minutes at the end it becomes an hour.

Chris Yan:

So usually, we'll double the time to buy more time and to see whether the director agrees on that or not because sometimes if the shoot is really delayed by a lot, maybe we'll just find something that can quickly fix.

(myself):

What if the director wants to change something suddenly on the set?

Chris Yan:

Alright, so if the director wants to add a shot. I mean, he would definitely let DoP know, then DoP will talk to the AD then AD let VP Sup know we are going to change the background or something but so the key point here is the AD because he is running the whole schedule of the shoot so he or she needs to know that. OK, do we have time for one more shot or we don't have it. Is this shot very necessary? If we have time? Sure. Let's try it. Maybe it's a good shot or something. But if it's like technically cannot be achieved, then VP Sup will come in and advise that this is not possible. Because of whatever reason.

(myself):

So it comes again with the communications and negotiation?

Chris Yan:

Yes, negotiation. So when it comes to changes, I mean the relevant party has to be there and during shoot day if there are any changes VP has to be there.

(myself):

So VP Sup has to be involved in the beginning, on the set. And familiar with the whole studio.

Chris Yan:

Yes, the limitation.

(myself):

What if they want to push the boundaries and push the potential of, for example, research and development. Is the VP supervisor involved in such projects?

Chris Yan:

If it's R&D in a different camera shot, I think. Yes, because our VP Sup knows the limitation. For example, this camera shot, we couldn't do it because the LED wall was not tall enough or something. Or like if you want to have different lighting, we cannot do it because the lighting will light up the part of the LED wall which will expose that, and the background is an LED wall or something like that. So if you're R&D in different camera shots, in lighting and all this that has something to do with the production, then yes, VP Sup has to come in, but if it's something like R&D in Unreal Engine itself. Like the different workflow, I would say VP Sup also needs to be involved, but not as much as production. Because this is more of a workflow thing for the unreal part. It's just OK, we can change it faster or we can get better visuals and then VP Sup just need to know that. OK, so this workflow is actually better so that he knows the changes to talk to other departments to understand it.

(myself):

OK. I see. This is also very interesting. How would you connect with different departments? Are there any departments after the VP? Like maybe color grading or editorial. Is there are any departments after that?

Chris Yan:

After that, it will go to the video team. So in Aux, we have a video team, so we go to video team to edit the video and then add the effects that the director wants. Or like the colour grade in the way that the director wants.

(myself):

It largely reduces the time for VFX, for the postproduction. And is it clearer for the

lower steam departments? Like I have this shot and minimum changes are required. I won't say there are no changes. There's something to be changed, or like grading or like fixing something, but it's largely reduced.

Chris Yan:

Yes, this workflow actually lightens the workload for the post-production part.

(myself):

So that's great. Then we will talk about the future. What do you think about the industries developing? How would you envision the future of this industry?

Chris Yan:

So according to my definition of Virtual Production that I mentioned before, Virtual Production mainly has four parts. One is Extended Reality, one is ICVFX and then Green Screen Live Compositing and also Unreal Renders. Among all these, I would mention the ICVFX and the XR. Some people will say that XR is dying or died already, but I disagree with that because XR still has this application. As for variety shows, So XR will have more applications in broadcast. Then for ICVFX, it will be an option for traditional filmmaking.

(myself):

So you mentioned XR, ICVFX, and Green Screen Compositing.

Chris Yan:

Yes. So Green Screen Compositing and XR will be used for broadcasting in the future.

(myself):

Then Unreal Render is part of filmmaking?

Chris Yan:

But this Unreal Render is different from pure Unreal Render, so this Unreal Render may have mocap or maybe live streaming, if we're talking about this one, then it has a lot of applications can do, can be live stream e-commerce or it can be like animation, short film or gaming.

(myself):

So, it's a very large application area that the VP can go into. XR for the show, for broadcast or weather report or something like that. While ICVFX can be used for filmmaking. And these areas can have their own branches, do you think one day they will merge together?

Chris Yan:

I would say they have overlapping features, but they won't merge together because

it's being branched out. So, for example, in a game tournament, they can use the game engine to run, the game is developed by a game engine, then the live streaming is using broadcast by XR. So, it will be different technologies combined together, but they won't merge into one, they have different applications.

(myself):

They also have different workflows behind them and the same as their production culture. And then, I mean it's also very exciting to see how they are involved in their own area and. So, we're going back to focus on the ICVFX. As you mentioned, it won't fully replace the green screen, how do you think about this relationship? Is it like a parallel relationship? or do you think it's with VP that can solve all the special effects shots in the current stage or it is half and half?

Chris Yan:

Green Screen is still an option for a shoot because the Post gets to do however the director has more control than the Post. So in Green Screen, people should have this idea of OK, we can shoot everything then whatever we want, we can add in post. So that's how people would think but for ICVFX. I would say the purpose, different purpose. So, for ICVFX you can shoot like a car driving scene in the studio but you use a green screen to do it. It's very hard to get the realistic reflection and the lighting situation. So that's why I would say. They are parallel.

(myself):

OK. So maybe the last two questions. If being cinematic, is your target, then what are the main obstacles that you are facing currently?

Chris Yan:

The main obstacle. I think for the ICVFX shot to make it cinematic, to make it really look nice, there are a few elements to take into consideration. For example, the lighting, it has to simulate the outer lighting in the studio. For example, the props, the props have to blend with the environment. So these are the obstacles and also the workflow. The people working together. They have to understand. Why do we need to do this? And then, for example, when the background needs to be changed and then the AD says OK everyone holds, we have to wait for 5 to 10 minutes to change the background. And then for example changing the lighting situation, then all the department needs to know. OK, we are changing the background. We need some time. So, like workforce and also the lighting and also the prop. I mean there are many different obstacles. But it's just how we plan and solve it.

(myself):

I would like to ask a deeper question about the people, I know that Aux Media also have some interns and what would you see from them when they come from a different background. They may have different knowledge, they may even have different etiquette, like the style or the traditional culture. What's your experience

observing them adapting the VP? For example, they are from animation, or they may have experience from post-production where they may have different wearing styles, they may have different mindsets. Do you think it is easy or difficult for them to learn this new VP's, workflow and mindset or culture?

Chris Yan:

Yeah, I think. As long as he has some relevant knowledge. And is willing to explore this new area, it's quite easy to let them know the workflow.

(myself):

As you mentioned the willingness. To embrace this new VP.

Chris Yan:

Yes, it's basically the willingness.

(myself):

Are there any other skills or mindsets that you are looking for in the new people?

Chris Yan:

So, I mean definitely, they are the people who can embrace changes. Yeah. So, change and then embrace new technologies. And they are interested in creating better visuals. So, the reason is that there will be a lot of changes in terms of, shot days or like doing planning stage or like hardware, software and troubleshooting all this you need to have a passion for it, otherwise it would be very difficult. So, the passion and willingness. Willingness to change to and to embrace new technology.

(myself):

These are very good positive characters from that, and talking about the relevant knowledge, what kind of background you are expecting them to have?

Chris Yan:

I would say knowledge of traditional production is very important because we're talking about ICVFX, the most relevant industry, is traditional production. And also, VFX. So these two are the most relevant ones. That's why I would say we need skill sets from traditional production, whether it's like hardware or the whole workflow or something and then VFX is they need to know how to change it, how to colour grade, then how to add visual effects and in post-production or and another one is Game Development. So, these three are the most relevant industries, so they need to know the hardware, they need to know how to create the background they need to know how to adjust it.

(myself):

Is it very difficult because in most schools they teach them separately. Film production, VFX and game production are like 3 different streams. But what you've

mentioned is the passion, the willingness to jump into other areas or to learn the difference. It comes to my mind that different areas may have different terms and may have different concepts. The willingness to learn different concepts as well like, frame per second is different even like material from game engine, it's also different. The spotlight is also different in a traditional way. How about the experience so far with the interns in your department?

Chris Yan:

They're doing pretty good because they can embrace new technology and then they are willing, they are willing to get their hands dirty. And I think what you mentioned just now there'll be different terms from different departments, that's for sure. But I would say not everyone has to be the VP sup. VP Sup has to be the bridge for several departments. So he or she needs to have the knowledge for how to talk to traditional production. And how to talk the "Brain Bar" about but while the different departments are by themselves, they can still work within their own knowledge. That's right. It's just that everyone in all the departments needs to be educated in the way that VP is a different workflow. And everyone has to be educated.

(myself):

I mean, yeah, that is very good to summarise and a very important new mindset for the traditional production is "Please involve as early as possible. Please know that we have this workflow and pipeline. Talk to each other" and like the traditional post-production where we have a lot of people from game development, from VFX, from productions. And it comes works as a team. So do you have anything you want to add or want to go back and discuss it?

Chris Yan:

It's just I feel like Virtual Production is really something new and it's definitely it's going to be a popular option for filmmaking. Because it has its own advantages, but it also has its own disadvantages. Only certain shots are good for production, certain shots are not good for production. By the way, in this meeting, I think most of the Virtual Production I talked about is referring to ICVFX. So, for XR is another thing, for Compositing is another thing.

Interview 3: Nicholas Tan, Head of Digital Content and Virtual Production from Aux Media Group, Singapore

Interviewed date: 2023/05/08.

(myself):

So let's get started. So hello, Nick, please introduce yourself. And also, your typical day of work.

Nicholas Tan:

OK. My name is Nicholas. I am the Head the digital content and Virtual Production in Aux Media Group. My typical day is basically looking at what the potential projects are coming up, production schedules, budgeting work as well as the functionality of the "Brain Bar" as well as a studio that we manage.

(myself):

So how do we define virtual production?

Nicholas Tan:

Virtual Production, in my opinion, is very simple as long as I'm not shooting on location, you're considered as Virtual Production.

(myself):

OK, that is a very interesting definition.

Nicholas Tan:

It is. Simply because there is virtual. It is not real. Even if you're talking about shooting a certain plate or certain stills or video assets on an LED wall, that is also considered a Virtual Production simply because we're using technology to mimic it on the location site.

(myself):

So, what are the main purposes of your team to use VP?

Nicholas Tan:

I think the main purpose of using VP obviously is a result of COVID. Having come from a physical event background, we venture into Virtual Production simply for events that are held online. So, from there it actually allowed us to gain knowledge on how to produce productions that are beyond location. So how do we do live streaming? How do we get a virtual environment in more aesthetically, pleasing to our audience? even though they're watching from the screen, they will then be more enticed to continue watching.

(myself):

So, when the clients or director come how would you introduce to them?

Nicholas Tan:

I think generally if we are talking about directors and DoPs, I would walk them through a little bit of the history of how we manage, where we end up in terms of what we do now and also what is the potential in terms of reducing shoot days, making actual shoot days more efficient, as well as reducing the potential of very long postproduction.

(myself):

Hmm, so what kind of reaction they will have normally?

Nicholas Tan:

Every director and every producer will come in and say that if anything they can reduce my budget. Great. You know, I think that's something they're looking at, but unfortunately, a lot of them don't see the nitty-gritty of what that potential could be. While I am very confident that we are able to replica on-location potentials within the studio environment, unfortunately, a lot of the directors have yet to be able to envision that within their scripts or even within their storyboards. So, I guess right now the biggest challenge for us as a VP studio is how do we allow more directors to give it a try?

(myself):

It becomes also part of their creative vision.

Nicholas Tan:

That's right. I think for us we identify the fact that Virtual Production cannot be an afterthought. It has to be something that has to be part of the scriptwriting, it has to be part of the creative development. So that actually allows script writers to know exactly which scene is possible to be done within a VP studio instead of it being an afterthought by the DPs themselves at all, you know, this is a particular scene that I want to do in Virtual Production. So, I guess it's beyond just the directors and the DPs, but we need to move into more of the scriptwriters and the creative development team.

(myself):

It's very interesting. It's not only fixed in the Pre. It's like involved in the Pre already. So that you have the power to affect the script or maybe fine-tune the script.

Nicholas Tan:

Yes, that's right.

(myself):

But what kind of misconception they may have?

Nicholas Tan:

I think a misconception, one of them would be it's on an LED wall, I can fix this very quickly in minutes if I want to change a virtual prop, I want to change a certain location at a certain angle. I think that's a misconception because a lot of them may not understand how Unreal functions and how Unreal is being developed. Tasks to them they are comparing it to an on-location site. For example. I don't like this particular living room, I'm just going to switch and change it into a bedroom. So that's that to them is I'm just moving everything equipment into the necessary environment that I want it to be. That's how they change and of course that also is part of the culture in Asia filmmakers. Namely here in Asia, a lot of directors like to change on the fly, like to change on set, which is something that is not encouraged. Why do I say that? Simply because our trip to Korea also allowed us to understand the proper process that a lot of the directors have locked down their scenes and their angles way before the shooting itself and to change unless the "Brain Bar", who works together with the director to give them time to change. If not or likelihood, the changes are very minimal.

(myself):

So basically, confirm the shortlist with the "Brain Bar". OK. we go back to the client and what other practice when the clients want to use their own equipment or the camera or other things?

Nicholas Tan:

I think generally, we are very open in terms of that simply because as a VP studio, we take care of the "Brain Bar". And if let's say they wanted to use any form of different cameras example, we're using Komodos here and they prefer ARRI. We definitely can do that. Of course. It's all about they're giving us time to calibrate, ensuring that we have enough time to troubleshoot whatever potential they are, and we are good to go.

(myself):

Are there any tricky projects that you faced before?

Nicholas Tan:

I mean every project is tricky. I think every project is tricky because fundamentally we are working with people, and production teams that have no experience whatsoever, whether is it ICVFX or Extended Reality, we have to be mindful that this is their first try. Even though they may have short-lived in different times and space, every studio is different. So we do have to be very mindful and be very flexible, and patient with the production team in order for us to get the best result that we're looking for.

(myself):

So, it comes it becomes a very flexible term I would describe.

Nicholas Tan:

Flexible, yes, but at the same time it has to be effective because there are situations whereby certain things that the production team has requested, can't be done within an hour or so. So how do we work around it? Is it changing at certain camera angles? Is it fixing a certain light? Shifting the environment, a little bit or things like that. It is beyond just changing the environment. There could be other potential.

(myself):

Let's talk about actors, you know, compared to the green screen, we have LED now displaying the contents. And do you see any like reaction from the actors?

Nicholas Tan:

I think talent-wise, a lot of them would have come in on the pretext that it is going to be very similar to how a green screen would have been done. But once they are on set, they actually feel very challenged because this is something that's very brand new to them and they have no idea whatsoever, how it's going to happen. So I guess after maybe 10 minutes, 15 minutes of rehearsal, getting them used to the light things and the LED that's coming out. They kind of get it, but of course, it's also very difficult for the actors themselves to envision how certain things are being done simply because what they see on the monitor as a final output versus what they are looking at LEDs the perspective is totally different. So, a great example will be how a CEO will do a keynote on a green screen whereby he doesn't really have to bother too much about what's going on behind. But in the LED volume. As the camera moves or as it changes a certain angle, a reaction of the LED Wall will then change perspective, then change. So that's something that they have to work with, meaning to say that they really have to be. They have to keep their eye line right. They have to be calm about the fact that whatever is changing. Behind doesn't really matter to them. So that will be one of the things that I think talents have to take note, I mean.

(myself):

It's a very interesting point of view from a talent's point of view. Currently, what are the main obstacles to promoting VP to the directors and any others?

Nicholas Tan:

I think the main obstacle here is that generally, VP has never been at the top of my recall for many of the clients or directors who want to use it as a potential studio for a shoot. I think the reason for that is not just about marketing, marketing the product is not difficult. It's just that adopting is difficult. For example, I could market a BMW pretty simple. Just for spending money putting advertisements, getting people to talk about it. That's fine. It's not difficult. But for anyone who wants to drive a BMW. It's a little bit difficult. It's a little bit different. Money is just one side of things. But how do you handle the machine? How do you look at it and why do you want to buy it and things like that and so on. And marketing point of view, it's really telling the story about why you want to use it. It's not so much about. Yes, it is here we can do this

now, because I think generally around the world that the kind of trending topic about XR or VP or ICVFX that the trend has kind of died down. Everybody is like, getting excited about new technology and that's about it. And obviously from December, during ATF till now. We were passing for two months and that's it. Everything else dies off after the Chinese New Year. This is the market that we're dealing with. Not just about the audience, but also about production houses who are so excited about all we're gonna do VP in Singapore, blah blah blah and it just dies off after Chinese New Year, which is less than a month from ATF. So this is where I see that a lot of the market, while they say they are ready in natural fact they are not.

(myself):

Is it shrinking?

Nicholas Tan:

I wouldn't say that It's shrinking. They're not even trying to attempt.

(myself):

Or is it because the COVID like is gone? So becoming more physical?

Nicholas Tan:

I think this is where a lot of remarks and comments were stating that, oh, you know, XR and VP are probably here because of COVID. After COVID, everybody's just gonna go back to location, on location shot, which I think it's it makes a certain point of sense to a certain point. but contents are being churned out right now. Imagine a K-drama with 20 episodes that could be shot within less than six months. So with that amount of time, the content needs to be out. Going flying to London, flying to wherever just to shoot a certain scene will not be visible in time to come. Like even if you're talking about the MARVEL and the DCs they're taking one year, or two years to get things done and the audiences may not be able to wait for so long. So I guess there will be a market shift in terms of getting movies to be done more efficiently. Quicker, more efficient. I think that that's where the VP plays a huge role in ensuring that our productions are being done quicker and faster and of course better.

(myself):

Do you think the VP will fully replace the green screen in the future?

Nicholas Tan:

No, I don't really think so. Maybe in the next 10, 20 years maybe. But I guess for now. The production teams around the world are still very familiar with Green, and combining both will be likely the next step on how to get them to come up with a more effective treatment of the final film.

(myself):

Let's talk about knowledge and skills. What kind of people do you want to hire in the

department?

Nicholas Tan:

I think in terms of people that I wanted to hire, there are a lot of people that I want to hire. But the fact is, a lot of these talents are non-existent in the market. For example, if you talk about a VAD who's well versed in both Unreal and actual prop creation, such being, it doesn't exist anywhere, even in Hollywood, he doesn't exist. He's either a very specific prop master or a very specific Unreal developer. So to find this individual, it has to come from both ends. This means that the virtual art department actually is held by two individuals who have cross-understanding and knowledge about both departments whether is it a physical prop or whether is it Unreal. So I guess moving forward talent that is coming through within the Aux VP team, must be able to know what they know as primary information. Talent or capabilities need to be supplemented by a secondary. For example, as an Unreal developer, Chris has been hired as an Unreal developer to develop Unreal to really look into it, but he has worked into his secondary role and capabilities such as operating Disguise, being familiar with camera trackers, ability to look at lighting, these are all contributing factors to how a "Brain Bar" Lead eventually is gonna be. You know, he has to understand the different kinds of workflow individually as a system. For example, how does Unreal work in relation to with Disguise, in relation to with the trackers in relation with the LED wall. So, it's not specifically one person who can do all, I pretty much believe that. But at the same time, it is individuals who are willing to come in and take on secondary capabilities, capabilities that he or she may not be familiar with. But is related to what he or she is doing.

(myself):

That is very insightful for the VP because nowadays it's lacking people and it's very hard to find like Unicorn. I would say.

Nicholas Tan:

I didn't even say it's unicorn. It's probably alien. People that I need to hire from other planets. I mean traditional production, it's very departmentalised. The gaffers are the gaffers, the cameramen are cameramen but unfortunately in VP. Everybody needs to know what everybody is doing. Maybe not in-depth, not an expert at that level, but we need to know what the things that happen, namely even as a VP supervisor, what his role is not just about being the bridge but having that knowledge to allow him to communicate better. Because without their knowledge, it's very difficult to portray what are some of the difficulties that the tech team is facing, or even what the "Brain Bar" can or cannot do. And as a gaffer, gaffers' point of view. Somehow it has been made easier. If we have an overhead LED wall, that reflection will then be very much taken care of. But of course, very experienced gaffers would want to have their spots and their wash light spread across.

(myself):

It also depends on the different setups of different studios, right? And also, different structures. Because you may come from a physical production, right?

Nicholas Tan:

I mean, I've produced TVC before from an agency point of view. So with that, it actually allows me to look at things a little bit clearer on what is the difference between the two. For once, I think budget has always been a concern for many production teams and I believe that VP itself will take centre stage simply because of how it affects the budget throughout, obviously right now during the project planning, we get to see a lot of budgeting, how much does the gaffer cost, how much does the DP cost, how much to set aside for Post. But of course, with that. And that is the current way of production. But if we crop out 20% of that fee, that could help to improve the efficiency of the shot. I think that will have a lot of impact on the overall budget. So, I guess a lot of teams right now are trying to figure out what the best way is to try, what is the best way to get this done at a cost that is relevant to the market. And of course. One of the biggest reasons why Korean drama K-pop, they are taking VP as a fundamental way of doing things is two reasons from what I'm seeing is, speed to market and then second, is that a lot of the shot lists are already pre-planned so there is no absolutely no shock, absolutely no changes and our conversation with our foreign partners in there also indicated that the Koreans are not fans of being flexible on set, they are not fans of everything change 180 degrees or 270 degrees during shooting. They're not big fans of that so which is why it makes it very comfortable for them that this is how it goes and that's where I think with that being implemented, a lot of production houses will see that speed to market is actually very critical. With the rise of TikToks, with the rise of webinars, and short videos we can see that the audience attention span is getting smaller and smaller. So a lot of these content-creating companies will need to know that speed to market is really the key here. And if they're able to produce something using VP cutting down their production time from three months to 1.5 months, why not? And that also results in two very specific things. Results in lesser budget and lesser travelling which also resulted in lesser budget and that could potentially be something that they could be looking at.

(myself):

When we talk about budget, do you think it is a reallocation or just a reduction?

Nicholas Tan:

If you think about it, if I need to travel a team of 50 travelling to certain places and so on. That would be a budget that's being reallocated to VP because they no longer need to travel. So a certain portion is about reallocation, and a certain portion is about reduction. For example, over time, now it's more manageable. We know exactly what time you're going to wrap and if anything goes wrong, we might need to do an extension of 1-2 hours max. We don't get crazy overtime hours from the crew.

We don't get crazy hours from the talents themselves. So this once again, I would say reduction, but also there are certain aspects of things that are reallocation. Imagine 50 people flying to Thailand. You know, accommodation, air ticket, food whatever it could be easily \$50,000, \$60,000 just on that and it's just one person \$1000. But for certain talents, they want to stay at a certain hotel, you could go up to \$70,000, \$80,000 and if we allocate that \$70,000, \$80,000 to a VP studio. That will be something that could help to reduce the overall budget of the project itself.

Interview 4: Choong Chyi Kei, CEO of Aux Media Group, Singapore

Interviewed date: 2023/05/08.

(myself):

Hi, CK. Can you introduce yourself and also your company in case people don't know about it?

Choong Chyi Kei:

My name is Choong Kei or CK for short and my company is Aux Media Group. We went into Virtual Productions about three years ago.

(myself):

So how do you define virtual production?

Choong Chyi Kei:

I think Virtual Production encompasses a lot of scope right now. We encompass everything from live CG animation to green screen productions to LED volume to mocap, but it's pretty much very extensive because of the way we look at it.

(myself):

And what are the main purposes for your company to use VP?

Choong Chyi Kei:

For now, we'll be using it for our core business, which is our event industry. Using Extended Reality environments, even for music videos, launches, award ceremonies and such, of course, we are venturing right now into ICVFX and film content creation. That's where we are looking forward. Of course, we still be using it for events, town hall meetings or events if required.

(myself):

It has a wide range of purposes. Ranging from XR, events to ICVFX. So when we talk about clients and external directors. They come to your company and how would you work with them? How would you introduce the concept of Virtual Production to them?

Choong Chyi Kei:

I will introduce them by showing them what the tech evolved from the LED volumes to relating to them to whether they play games, so introducing to them what it's Unreal Engine, Epic Games, and common terms by metaverse that sound so that they can sort of relate to what it is. But no matter what, you still have to bring them to the LED cube itself so when they see it for themselves then they realise, OK, this is the possibility. This is what you've been talking about because a lot of them have seen all the examples on YouTube, online, Disney, Mandalorian and all these kinds of

movies, they know they can relate to it, but really it's only when they go into the LED volume then they realise oh, this is what you're talking about.

(myself):

So they do have some misconceptions?

Choong Chyi Kei:

Most of them have no idea about exactly how it works. I really have some ideas you telling me the green screen is OK yeah. So understand that kind of stuff but really, when it comes to you, then they will sometimes repeat what was told to them beforehand. And like you can really see them rubbing around you, the kind of stuff and the lighting is natural. So that is the main demo that we always do.

(myself):

So it's best when they see or experience the LED wall. So how would you work with clients or external directors when they OK say I want to use the LED volumes I want to use the VP.

Choong Chyi Kei:

I think now it's all a process that we need to bring them through to start from the pre-productions to the actual productions and go through that concept so they can build the environment for them. And then from there onwards, move forward. I'm not too sure whether they have shown you what we have done in Korea. So we have achieved through 5-days course work with an operating partner. So it was very interesting to see how they planned and prepared within six weeks. On the actual shoot day, it was very smooth. So it's just really getting the workflow in and getting the various directors and clients to understand this is how it's done and they can commit the time to do it. So it's not just coming to the actual shot then you talk about VP or XR. It's all the way from the script writing and preparation work. And then how do you go into the production and actually on the shoot. So I think it's so the industry development suffered, but Korea is very well developed and their workflow for Virtual Productions of filmmaking in general is very well established. So when they pivoted into Virtual Production, it was much easier than expected.

(myself):

There is a very interesting point of view compared with the Singapore style.

Choong Chyi Kei:

I am sure Singapore as well as number 1 of the market for the overall industry is not as well developed as Korea itself. So we can see that even though the freelancers are not trained in Virtual Productions, they could adapt by calling me to what the directors want, who were trained in Virtual Productions.

(myself):

So, it also depends on the directors, depending on the market. Also depends on how people adapt to this new technology.

Choong Chyi Kei:

Yeah. Whether they're willing to adapt this technology into the workflow is the most important part.

(myself):

Can you talk about more about that?

Choong Chyi Kei:

I think you see in Korea itself, so many of the productions that you see are actually very common on all the streaming channels, a lot of the content is actually done using LED volume or rather Virtual Productions right now. But it's not a matter. I don't think it's a matter of the fact that Singapore doesn't have the facility which we have. It's just a matter of whether we are willing to give it a try.

(myself):

And I think it also brings some new experience for the actors, right?

Choong Chyi Kei:

Yeah. For example, when we worked with MediaCorp last year for the Star Awards itself, it was very interesting for them even though we had a chat with the two main actors and actress. They were a little bit afraid of it because they were so used to the green screen. Yes, but after half a day of trying out, they were very used to it. They said it's much easier to adapt than they thought was, so you see a lot of them afraid of the technology. They keep asking, "what if? how?" I'm used to the old way of doing things. But you know the green screen has been here for the last how many years already. When the green screen first came out, everybody was there. I was afraid of using it but now it's such a main use in film, TVC and commercials.

(myself):

So, I also heard that their feedback is very positive, and they feel increased their acting.

Choong Chyi Kei:

Right. Yeah. Nowadays for the actors, for the directors, for the lighting guys they can see the immediate effect of their actions, by adjusting the lights, how do they affect the actors and how about adjusting this? By doing this, how the actors will think am I reacting in the right way, so that's the main thing.

(myself):

Moving forward, for you, what are the critical elements to make a virtual production

success?

Choong Chyi Kei:

I think different elements to make VP access is that everybody must give the right time and adapt the right workflow to the various kinds of work that you want to do. From whether it is a trailer, proper concept, TVC to MV. I think what is important that everybody must understand their roles and how and what is it that the current technology can afford in your current workspace itself or your workflow. I think a lot of people, don't understand what this technology is. But first, once you understand it, you can get your hands wet by doing one or two. I think it's very easy for you to adapt to it. It's not as frightening as well, because I don't think can be done this or I hear that this cannot be done, but if you work with our technical team, our "Brain Bar" and our operators themselves. We advise you to say, OK, this is what is required. This is what can be done, this is what cannot be done. Do you want to do this? Let's try it out. And see whether it works or not. This is a very new technology. It's only like 2-3 years. Of course, you can say that it has been around more than that, but actual practical usage is just probably in the last two to three years.

(myself):

After the COVID?

Choong Chyi Kei:

During the COVID period itself. So that is actually I will say there is how things are positive for this Virtual Production element that we're looking at.

(myself):

If I may ask, do you think there is any difference in workflow between like the live event and the Virtual Production? Or like as a whole?

Choong Chyi Kei:

Live event and Virtual Production. Nobody has asked me that question before. As a whole, I will say that there are many elements that are similar. So for example, if you see a lot of live events, recently Coachella itself, a lot of the elements are done using Unreal Engine, which we which we use in Virtual Production itself. So that's cost hybrid and for like Virtual Production, we use tracking in live events right now we can also use tracking to render all the AR elements to it. So I think this is where things are interesting in the aspect that there is a cross of hybrid of technology being used between 2 two different productions, 2 productions and I think the line is beginning to blur in this sense.

(myself):

That's interesting.

Choong Chyi Kei:

Yes, you can see a lot of live events. I think it is very common in America right now.

All the tracking, all the AR elements which the live audience cannot see, but they see on the big screen in the stadium itself. They can see all the elements, and this can be considered Virtual Production as well to me.

(myself):

Definitely. So let's move forward. We just mentioned the different workflows and pipelines. It comes with a new mindset. What kind of challenges or new mindset that your company need to face?

Choong Chyi Kei:

I think the fundamentals for filmmaking, ICVFX are the same as for DOP or the role doesn't change. You still have to decide how you want to determine the scenes. The kind of shots you want to do to achieve to based on what the director wants. So the fundamentals don't change. It doesn't mean that I use a completely new camera with a new lens, but actually no. All those cameras and lenses are from a traditional film industry, the film business itself. So, the fundamental is how you light up that a person, is still fundamental. It doesn't mean that for Virtual Production I use one light I can do the entire production. It's that's not the way to do it. But the workflow for it would be, instead spend as much time on postproduction, you really have the pre-production to plan it out and the interesting thing is that the directors and the actors and everybody can have a vision of how their work will look on the final shoot day itself. Therefore, by the time, you come to the final shoot day, it's more of tweaking and changing some aspects that you might want to change during the shoot itself. The workflow is definitely different because we always say let's fix it in the post, but this is not how it is in the current world and such. So, I will say that while there is a different workflow, and a different mindset itself, the team do really need to learn to combine both together. So, for example, one particular scene itself, one particular movie itself, is it to say that it is virtual? No, it's not. There has to be a mixture of real-life, on-location shoots and then it might be Virtual Production shoot itself. Then with that, as I said, the script writer has to come in right at the beginning, but they all had to come from the beginning itself. When you map out this whole thing, you have to really plan out what is doable. It's not doable itself and then plan it out for at the development phase itself, because it's not a case of whether they come to you and say, oh, Virtual Production cannot make it happen, but do you try to plan it right at the beginning or is it an afterthought? Oh, I can't shoot it in real life, that's why I throw it in Virtual Production, then Virtual Production sucks because it cannot work in this way. But that's not the way. That's what we learned in Korea, so you have to plan and start as part of your normal workflow. I mean, for example, if we all do locations shot, you do assign this location, also shoot this location, all location. It doesn't work. That is what exactly people are trying to adapt or say that Virtual Production doesn't work.

(myself):

It's interesting because the scriptwriter doesn't know what the VP can do, but we cannot do, and then they just like I hate green screen and put it in VP, but they don't

know the VP potential. They say the VP is not working.

Choong Chyi Kei:

Yeah. For example, in VP if they want to do this scene but there is no such content on the market that kind of stuff and therefore the technical crew and Unreal people, didn't have enough time to create the scene that is suitable for that particular scene and stuff. Therefore, do we say that VP doesn't work? No. If you give the VP enough time half a year, one year enough time, I'm sure it can be done right? And you have enough budget. But there are so many elements that you do not know. I would say respect is very important. So you must respect the workflow, respect the timeline. For example, if you know you want to put this particular scene in VP and you only have this particular content that fits within your budget and timeline to do it, that kind of stuff, then, of course, you will definitely work. I mean the entire industry around the world has already proven that LED volume works to a certain extent, but do you always need the biggest LED volume? I was saying not really. It depends on what you need, and what the market can support at this point. It doesn't mean that bigger is better.

(myself):

OK. Interesting. I mean for me it's the bigger they have more camera movement, more content. More people on the set more actors. Is it a critical element? I mean the size of the LED wall.

Choong Chyi Kei:

It depends on how and what story combines it. The LED wall is too big that even the gaming engine cannot support it and they cannot even come to try to rectify that. They realise this is a volume size that we haven't even encountered before, so there's still some limit to technology itself and such. Also, you must think about the business aspect of it. The business model itself is whether we have enough capacity and the people to support the volume that we need, the LED volume the size that we want to do.

(myself):

If I may ask, is there any reason that you chose the current LED setup, the cubicle one?

Choong Chyi Kei:

Oh. There's really a fundamental reason it's really because when we first started, we knew nothing about it and that was the easiest way to set up and do calibrations and such.

(myself):

What would be your ideal LED work set-up in the future?

Choong Chyi Kei:

Ideal LED setup for me. I will think of a 20-metre by 5-metre curved LED wall. That will allow the aspects of most of the shoots that we see in the world market to be supported and I think we will also split between ICVFX and XR, so there should be two studios. It is hard to combine 2 into one. Mainly because of the different ways of workflow that are required for these two different kinds of Virtual Productions.

(myself):

So it also shows that different sizes of the wall may be used for different contents.

Choong Chyi Kei:

Yes. Whether you want to put it at 2.5D play or video footage or you want to use a fully Unreal and any content, all those matters as well.

(myself):

Yes. So, what do you think the industry is developing forward like, what's the future?

Choong Chyi Kei:

If you look at all the development recently, not just in Singapore, but globally itself. Definitely, the industry is developing. In fact, recently at the NAB, I think we'll see a lot of booths showcasing Virtual Production. I feel that the hardware is only at the limit of what it is until the next Brompton of new tech is coming up. Whether is it the media server, software or tracking, or LED panels, I think that we are really quite almost at 90% already. So now it's really about all of us coming together, training the new talents, to be able to grow in this industry and getting them to know how to use the workflow to create the new content for the new generation. I'm sure you agree that how the new generation uses the media and entertainment content is very different from what we used ten years ago.

(myself):

So, I would say in this way one side is the marketing like the director, and the scriptwriter has to know the VP. On the other side you have future generations to support, like VP artists or VP workers to continue to push the VP, right?

Choong Chyi Kei:

Right. So I mean one thing is so, but you can see that for sure VP industry will continue to grow, whether or not just in Singapore or around the region. I'm sure you also analyse this whole environment in terms of the growth rate for the VP industry in Asia and Europe itself and such. So, all these are critical to move forward. I mean that's why we invest in both sides of the point itself. From one side we are trying to push for the commercial and make people aware, the directors of the scriptwriter, the DoP, we'll have to move forward. The next one will be we need a pool of talented young workers who is able to support the industry as we grow.

(myself):

Is it difficult to find like currently for the future generation?

Choong Chyi Kei:

I was saying that it's not difficult to find, but it's hard, because a lot of them went into Unreal Engine because they develop games, but you want to bring them over to what we call the Real-time Immersive Experience. Some of them are a bit... but of course, they are going to, I mean we are supporting the Unreal Engine Virtual Production. So, they mean we saw a lot of applications coming in and then this is what we could do together. I think that is a fantastic move for the industry itself, and I'm quite sure by the end of the year you will see some interesting work that's coming out of that. So I think with this push, we should be able to see more and more adaptation of Virtual Productions in their current work system.

(myself):

If like being as cinematics, filmmaking or even the term ICFX is your target. Then what are the main obstacles that you think you are facing?

Choong Chyi Kei:

I think right now our main target or obstacle is really getting people to be willing to try. Just willing to try. We're not talking about budget or cost or what comes after like that. Because as you know, we have been going to Korea and we have a lot of partnerships with Korean studios, you can see the way they adapt the workflow to their industry is just mind-blowing. I mean recently Netflix just announced they're gonna invest 2.5 billion into the film industry in Korea itself, yeah 2.5 billion for the next three years, which looks up to maybe. About 8 to 900 million per year? I mean so from all these industry developments, you can see that definitely the growth is there and part of it is definitely channelled into Virtual Production. So that is definitely something that is looking forward. You know that this industry is just there to grow and doesn't matter how fast and whether we are going to be catching on the global trends and be able to be part of the growth or are we going to be left behind.

(myself):

Yes, that's the key question. Yes, how to join the whole activities from Singapore's point of view is also very important as not making behind it. It's a big question to actually let the director try you. Do you like it? or you don't like it? You know the potential. You don't know the limitation and then you go back. You change your script, or you ask the scriptwriter to come and then it hopefully will push the VP in the future.

Choong Chyi Kei:

Yep.

(myself):

If I may ask, is there any point that Singapore can do to stand out? or like Aux Media can stand out in terms of Asia competitors?

Choong Chyi Kei:

I think for Aux, we've already made the first step by having all the connections with the MOU, and Korean studios. In due time, we hope that we can also announce some of the collaborations that we are doing within Singapore, Singapore-Korea collaborations content making and more importantly, we have also signed MoUs with three schools at the moment. Republic Poly, Ngee Ann Poly and Singapore Poly. Of course, we hope to sign with the universities such as ADM and of course, SCI, NTU as well. I know that there is a future in Virtual Productions, but they are just worried about the setup cost and the startup cost required which we all know it's not cheap. And of course, a lot of people are worried that becomes a white elephant. A white elephant is something set up and nobody knows how to use it and such. I mean that concern is valid, but I think with our experience or what I've gone through the last three years what you can offer is that for the consultancy what are the holes not to jump into and what are the things that you can move forward expect that the whole process is. I think it's important that we together as a whole, whether is it from the education sector, private sector, or commercial sector all of us have to go hand in hand to make this industry grow faster, because otherwise if you wait and wait, then before you know it, you'll be too late.

(myself):

True. That's definitely true. I mean this is how as a pioneer in Singapore, Aux Media, keeps pushing forward and leading the industry and we will talk about like hiring new people. Are there any specific skills that you're looking forward to for the future generation?

Choong Chyi Kei:

I think because the industry is so new, we are basically more people who are willing to learn. If you have a background in video, film or tech. I think those are the basic fundamentals we're looking for. I mean we are not looking for people who claim that they have tonnes of experience in VFX and Virtual Productions. It's helpful, but it also can be a stumbling block to you, because then you start to compare, the last time it used to be done this way, it can be used done that way. You know that kind of stuff, but I think fundamentals, it's the important part and then having the open mindset to say OK, this is the new workflow, how can I use the knowledge that I have to fit into this workflow because this is the future of how things are going to be done.

(myself):

Maybe the last question is about how you think about the current market? In Singapore because COVID is gone, people may back to physical events? And how would you promote VP, or do you have trust in people who come in the future to try

VP?

Choong Chyi Kei:

Actually, right now Singapore only opened up last May. So, obviously, we know that the revenue of the events will happen as expected. Everybody just rushing to do physical events. So, give us a now time to ask to replan our studios and think about what we want to do and strike our partnership with overseas partners as well. So it will be hopeful for us. Moving forward, I think definitely the market will continue to grow for Virtual Productions. We are really talking to a lot of production houses, and they are willing to come aboard. And I have no doubt that once they get their hands wet behind their ears during the Virtual Productions, they will know I can do this in Virtual Production. So I said, it's not meant to replace everything 100%, but it will become a staple in their workflow to select this part for example, maybe I don't need to do it in real life. Give you a very good example, for example in Singapore, you wanna do a scene, a road closure in Singapore is almost impossible. Almost, I would say not totally 100% impossible, but it's very hard to close the road in Singapore. But what if we have a workflow in Virtual Production that can allow us to shoot everything as though we are on the streets of Singapore itself. That is interesting. So once you want to import that workflow into Singapore, I think a lot of companies and such would be interested in that particular workflow. As such, I think so, in time to come, you give it a year or so, I believe there will be a lot more developments in the Virtual Production scene and for sure next year we will be starting up curriculum in all the polytechnics and such. So, but that one maybe will take a longer time? At least 2-3 years, we see an influx of students who are trained in VP and coming up to do it in that way.

(myself):

I mean the case you mentioned about blocking the road, it opens a lot of imagination. For the filmmakers, like I want to do a lot of VFX, chasing scenes, even like superhero scenes, they can be possible.

Choong Chyi Kei:

It is possible there because we now moving into, I think one thing we haven't touched is the AI aspect. So we're going to test a new system using AI to create an environment. We are going to have another element when we talk about using AR to create the avatars controlled by humans in real-time, because right now everything is done using mocap, on a green screen, that kind of stuff. So right now what we are going to push forward in the next development will be using all these new technology moving forward. So, you can see that the industry is moving very fast. In fact, it's moving too fast for us to really master the latest new technology that's developed, a new technology has opened up already, which Axi are quite good in terms of shortening the workflow, and work process. I think you might know that creating an Unreal environment is very tough. And it's very long in order to make it production ready. But now with this new AI that we are going to try out next week. I think that will

speed up the whole entire what we call the pre-vis process. The directors, everybody will be able to see, OK. Is this environment is what we want? If it is not, OK, let's just try another environment. So, everybody's look-through will therefore be much easier and tighter, and I think the keyword, if you need a takeaway, will be the Real-time Immersive Experience that we're trying to give everybody. But if it is from the director to the scriptwriters to the actors, actresses, even to the "Brain Bar" people to look whether this is feasible or not. Those are critical components for us.

(myself):

Yes, it's actually an experience.

Choong Chyi Kei:

Experience and being able to see exactly what it is. It's no longer having guess. We're taking the guess work out of the whole workflow, you see. Whatever you want, you put it on the screen for everybody to see, to see this is what we want. And then using your own creative ideas and experience, you can make it into something that's production-ready. So that's pretty good.

(myself):

It's like you confirm from the start.

Choong Chyi Kei:

Yeah. What is this gonna be like? But actually, this is basically what is being done in the film industry. It's just that if they actually have a kind of hundreds of million budget. And they can do it. So we are basically bringing down whatever your Hollywood is doing down to the masses and everybody can do it at this level in a faster and more precise environment. So, I mean that all we are developing on.

(myself):

Do you have any more points to add?

Choong Chyi Kei:

AI is something really interesting. I mean, so for instance, we went to Korea for training. So they were saying we're using AI, I am using this AI, they are using this AI as well. So you see, all of us although we're in different countries, different parts of development in the industry, we all seem to be going in the same direction. So I think that's very good for you to think forward.

(myself):

AI is a great potential in the future.

Choong Chyi Kei:

Yes, yes.

(myself):

I mean, are they AI can generate a 360 like a dome automatically when you import into Unreal then maybe something can be updated in real time or with the prompt writing with the ChatGPT then it is another boost.

Choong Chyi Kei:

Yes. So I'm not saying that it will take over everything but at least the initial process of creating the vision that we want, and we test the true vision then we can take that further in in the further development of the actual assets and such.

(myself):

Yes, a very good industry insight.

Choong Chyi Kei:

I mean we are hoping also to bring our current partners expertise to Singapore and the region and do some master classes and courses. So everybody will grow and faster together.

Interview 5: Piao Teckwon, VP Supervisor, Korea

Interviewed date: 2023/07/09.

As requested by Teckwon, the name of the VP studio is hidden.

(myself):

Hi Teckwon, would you mind introduce yourself?

PIAO Teckwon:

I am Teckwon Piao. I am Korean Chinese, and I am working at the Virtual Production Studio in South Korea. We have two studios in South Korea, one for Virtual Production, ICVFX and the other one is XR stage.

The difference between the two studios is the ICVFX studio we have the wall LED and the ceiling LED without the floor LED, but XR stage we have the wall LED and floor LED, without ceiling.

(myself):

So you have two different setups for two different studios for two different purposes?

PIAO Teckwon:

Yep.

Firstly, I have to introduce myself. I was the director of photography for commercials, films and music video scenes in Korea. Now I am a Virtual Production Supervisor in Korea

(myself):

How would you define Virtual Production?

PIAO Teckwon:

Because our Virtual Production... I don't know how to say in English. He is the one under CEO and a professor from my university. Back then I was the DoP in Korea, he came to contact me and ask if I am interested in Virtual Production and want to work under him. I said OK. And then, I became Technical Artist to learn the technical part when I join this studio. I did not what Virtual Production is at that time. So I learn the technical part, Disguise, ICVFX and XR And then for around seven months, I got promoted to Supervisor. My professor is also a supervisor, so I am in his team. Simply say, in Korea, Supervisor have to discuss how to shoot VP shots with director, DP and gaffer. Director gives us direction and then I will tell our technical part such as Disguise Operator, Unreal Engine Operator. Supervisor mainly in charge of technical communication between the production and our VP Production.

(myself):

So basically, a supervisor is mainly responsible for technical parts and communication?

PIAO Teckwon:

Yes, the main role for supervisor is supporting the production and inform them how to use our studio to achieve what they want. And to inform and give direction to technical department, how to shoot this angle? Do we have this effect? I want to shoot like this, so you have to adjust the image or Unreal assets. The most important role for supervisor is to communicate both side and tell staff in VP part what to do precisely.

(myself):

Ok, does VAD exist in your VP team or just an entire department?

PIAO Teckwon:

Virtual art department team is responsible for Unreal part, in order words is for ICVFX. And then technical part is responsible for Disguise operating.

(myself):

Maybe I will describe the technical part as the "Brain Bar", and they focus on Disguise?

PIAO Teckwon:

Yes.

(myself):

What is the main purpose for you to use VP?

PIAO Teckwon:

The driving scene for drama and movies in 2D plate. 2D driving Comp. These are the main purposes. But VAD are not involved in these shots.

(myself):

Because the background is pre-produced?

PIAO Teckwon:

Yes. We are responsible for street view shooting and its post-production.

(myself):

So, there is a post-production department?

PIAO Teckwon:

Not exactly post-production. Because we have to shoot street footage, we use 5 RED

KOMODO cameras to shoot the street and 1 camera for sky view. So we have 6 cameras. And we also developed a shooting car. We attached rig and camera on a convertible for a BMW. We have produced 200 – 300 footages for most Korea-base production.

(myself):

OK.

PIAO Teckwon:

We have to stitch it after shooting, because we have to combine them. We also have HDR Processor for Netflix. Netflix wants HDR. So our recent footages are HDR.

(myself):

So this 360 video shoot belong to the VP Supervisor or other departments?

PIAO Teckwon:

For us, it belongs to the supervisor. Technical department will do the stitching work after we obtain these footages. I was Technical Artist before, so stitching was part of my job.

(myself):

I want to go back and ask something about Technical Artist. Is it part of their job to learn Disguise, Unreal and XR stuff?

PIAO Teckwon:

More tilted to XR and Disguise. For Unreal, because we have VAD, so they will handle 3D assets. For me, I need to understand what kind of function and result Unreal can create. But I won't use Unreal to create asset practically.

(myself):

I see.

PIAO Teckwon:

So, it is more about Disguise.

(myself):

Is the VFX supervisor involved in your workflow?

PIAO Teckwon:

Do you mean the CGI in postproduction? No, we don't have.

Our VAD director has 20 years working experience in VFX field. But I do not have much interaction with VFX.

(myself):

So, can I understand that VAD build up the virtual scene and send it to you for shooting?

PIAO Teckwon:

Close, but we keep communicating when they are working on the virtual scene.

(myself):

Ok. Will the VAD director be on set during the shooting?

PIAO Teckwon:

Yes, he has to be there.

(myself):

How would you introduce the VP to the client or external client?

PIAO Teckwon:

If that is done by my professor, he will introduce VP with his documents and material during a meeting. Or it will be done by our CEO. They will introduce it together.

(myself):

What is their reaction?

PIAO Teckwon:

Most of them feel amazed. Because they have an idea what VP is before they come. So they can understand VP a lot easier.

(myself):

Is there any misconception they may have?

PIAO Teckwon:

For ICVFX.... not that much. Client will ask for what they want, and we will tell them what can be done, what cannot be done and how to achieve better.

So Supervisor needs to clearly understand what can be achieved, what cannot be done in a VP studio and what needs to be done in post-production.

(myself):

I see. What if they want to use their own equipment, will you adapt their camera into your system?

PIAO Teckwon:

For example, if it is a 2D shooting, like driving comp. They can use their own camera, because no tracker is needed. So, it doesn't matter. But we will tell them to use

Genlock. This is the most important thing shooting at the studio. So, we need to explain what Genlock is and ask if their camera has this. They need to change one with Genlock if they don't have.

(myself):

So Genlock is a must.

PIAO Teckwon:

Yes.

(myself):

Ok, how would you introduce VP to actors?

PIAO Teckwon:

To be honest, we don't have a lot of interaction with actors. Because after we set up everything, they just stand in and performance according to director's guidance.

Oh, back to the equipment. When we are shooting ICVFX and XR, we will suggest use our studio-ready equipment because it needs a lot of preparation. If they really want to use their camera. OK. They need to plan extra 3 -4 days for us to calibrate their camera and lens into our system. But in Korea, they have to rent camera and lens. It doesn't make sense for them to pay these extra rental fees. So, most of the case, we will use our studio camera.

(myself):

I see. How much time do you have for a production?

PIAO Teckwon:

For 2D driving comp, we don't have much time. They (Client) have to confirm what kind of footage, duration checking and what they want with us. We don't have much time and less workload is needed for 2D. Just inform us what footage you need to use and come to shoot. But for ICVFX, it takes around.... We will tell them we have assets from Unreal Market and let them choose. Once they confirm the asset, we will buy, modify and optimise them. We will also test with the scene. If everything is ok, then we can have shooting. It takes around 2 weeks.

(myself):

So, it takes around 2 weeks for preparation.

PIAO Teckwon:

Yea, around 2 weeks. We also experienced within 1 week. But we suggest 2 weeks.

(myself):

How is the hierarchy in your team?

PIAO Teckwon:

We have a technical team, which includes Disguise-related operations. We have a VAD department and hardware/solution team for solving LED and hardware-related problems, so they have to be on-set. And we have a Production team. And we have a Supervisor team.

(myself):

So the Supervisor team have to oversee all these four departments?

PIAO Teckwon:

Yes, correct.

(myself):

For you, what are the elements to make a VP successful?

PIAO Teckwon:

Color and assets are important.

(myself):

So, there is a colourist in your workflow?

PIAO Teckwon:

Yes, one of the technical team staff is a colourist.

(myself):

Does this mean that you will send the shot to the colourist?

PIAO Teckwon:

But we don't have post-production color grading. We do this on pre-production. The DI from the production team or VFX part will handle that. We focus on our material and 3D assets; we don't have post-production, because we are too busy.

(myself):

I see. So basically, you are part of pre-production and shooting.

PIAO Teckwon:

Yep.

(myself):

What are the challenges for the team to adapt to Virtual Production?

PIAO Teckwon:

There are cases when people come and realise there are so many limitations. This cannot be done, that is impossible. And we also have to inform them. So some of

them think it is better to use green screen. It is understandable.

But the main tendency is to use LED. This can provide a better sense of immersive for actor and director.

(myself):

Would you mind sharing a tricky project and the way it was solved?

PIAO Teckwon:

A tricky project.... To be honest, I think most projects are similar. I think the biggest challenges for shooting in a VP Studio are the hardware or software's bug and error that occurs during the shooting. So we have to solve it in a flexible way on the spot. These are tricky points. For example, a LED line of light suddenly goes off during shooting. It is possible for electronic devices. So the hardware team will fix it as soon as possible. And for Disguise. It is much stable now. But it had so many bugs and problems when I just joined this studio as Disguise Operator. For example, back then we had a driving comp. I placed 6 video footage on the timeline, it becomes laggy all of a sudden and failed to do its job. But these problems are gone now. I can put more than 10 footages on the timeline and it still works fine.

(myself):

I think the industry develops with the software.

PIAO Teckwon:

There were much more problems back then.

(myself):

Yea, same as the steps for color calibration.

PIAO Teckwon:

Yes, it is much faster now.

(myself):

What is your typical workflow for a project? Does the script included or excluded?

PIAO Teckwon:

Basically, it is excluded. It belongs to the production crew, but we will adjust it according to our studio capability and situation. If you are asking a more detail workflow, I think it is not that complicated. You are talking about ICVFX right?

(myself):

Yes.

PIAO Teckwon:

For ICVFX.... Actually, we did not involve ICVFX projects that much. Really not that much. We did 2 with Korean Film Association after Aux Media visited Korea. We worked for those selected top Korean directors, producers and DPs who want to experience Virtual Production. We did 2 shorts for them. At that time, we had better control. But we only produced 5-6 ICVFX projects until now, less than ten, I remember.

The most important part for ICVFX is VAD. We use nDisplay instead of Disguise for ICVFX.

(myself):

So nDisplay instead of Disguise.

PIAO Teckwon:

Yes.

(myself):

But why?

PIAO Teckwon:

Because Disguise is just for playing high-quality 2D footage. This is its advantages. It also can produce XR content with Unreal. But we won't use Disguise for ICVFX, because it is not efficient. Because nDisplay is native to Unreal. It can connect n computers and render the content to LED wall in real-time. So it has less limitation compare with Disguise. For example, if we are doing XR, we will use Disguise to extend the content in real time. But the content pass through Disguise and RenderStream and render on the LED wall. Disguise will provide some limitation. The quality is lower than nDisplay because the content goes through Disguise.

(myself):

So you mean the content passes through one more layer?

PIAO Teckwon:

Yes, it passes through one more layer.

(myself):

But does it pass through Brompton?

PIAO Teckwon:

Of course. Brompton is the LED processor. You need Brompton to display the content on LED. You can understand LED and Brompton as one thing.

(myself):

So you are using 5.1 or 5.2 for Unreal?

PIAO Teckwon:

We are using 5.2. 5.2 improved a lot for the color part.

(myself):

I used nDisplay on 4.26 before. It was named switchboard, and it was hard to use.

PIAO Teckwon:

Yes, now we are using 5.2. But for Pre-vis, we haven't built up a system for pre-vis. But we are developing software for pre-vis. Back then, when director and his people came to discuss with us how to shoot, we make the change instantly. We didn't go through a very detail pre-vis process. But we are developing this part now.

(myself):

So you mean you will use other software than Unreal?

PIAO Teckwon:

It is based on Unreal and inside Unreal. In our VAD team, we have a developer focus on coding and stuff like that. I am not familiar with that part.

(myself):

How would you deal with different shot types? Like wide shot and extreme camera movement?

PIAO Teckwon:

Wide shot, yes. But DP will adjust based on the situation. For example, if he uses extreme wide shot, the floor will be seen. So, he is not going to shot like that. We will talk to him, if you want to use wide angle, you will see the floor, so the virtual set will look on a LED. So, he won't shot like that.

(myself):

They have to adapt to the limitations.

PIAO Teckwon:

Yea, otherwise, they cannot shoot. But there is a small tip for ICVFX: If your VAD is not decorating the LED floor. You can place a wooden plane or something like that to higher actor's level. In that way, you can have full body shot.

(myself):

How did you solve the contact shadow?

PIAO Teckwon:

We will talk to gaffer. They will know how to set up the light behind the LED, keylight or something. This is his role. We will tell him how to make the shadow more realistic. gaffer will adjust his lighting accordingly.

(myself):

So the physical lighting department is still there.

PIAO Teckwon:

Yes.

(myself):

I think it is a multi-departmental communication and negotiation.

PIAO Teckwon:

Yes, communication is the most important. So Supervisor has to communicate well.

(myself):

What are the challenges to communicate well?

PIAO Teckwon:

The challenges depend on personal character, I think. How he treats people, how he talks with people. How he can convince director if the director request something impossible for VP. Also, he has to understand all technical part in VP, including those problem, advantages and disadvantages. You cannot convince them without this knowledge. So it is important to fully understand and master the knowledge in VP. To be honest, I wouldn't say I am fully understood, because I was not in Unreal. I was DP and focused on shooting. Chris may know much more about Unreal. He knows much more than me.

(myself):

What do you mean by the terminology?

PIAO Teckwon:

The way you communicate is more important. I think.

(myself):

Where do you think is the industry developing forward?

PIAO Teckwon:

To be honest, the VP industry, no matter in China or Korea, it is not very demanding. It is mainly used for Live Shows because they use XR. There isn't that demanding for ICVFX in Korea. I think. ICVFX is very little demanded. But everyone will only think about ICVFX when we mention Virtual Production.

(myself):
Interesting.

PIAO Teckwon:

But ICVFX is the least usage. The most demanding situation is car driving scene. 2D driving Comp. This is the most and it is really cost-effective. From Production's perspective, it can really save a lot of money. You can shoot 20 scenes in 1 day. In our record, the highest record is 23 scenes with 12 cars. Yes, for the car scene in drama and film. Actors can focus on their performance in VP studio. But they were in real street before, right? That was not efficient and came with a lot of limitations. So, it is much more efficient in VP Studio. So this is the highest demand.

(myself):

True, it is more convenient to use 2D.

PIAO Teckwon:

Yes, others like fashion shooting and commercial are also demanding. They will have their motion graphics done and we just display it on the LED. We mainly use LED stage for car commercial. Almost all new car commercials in Korea are filmed in our studio, like Hyundai. LED is the best for car, because we can have real reflection from LED. So for here, we filmed a lot of cars, no matter it is commercial, drama or film. For XR stage, we mainly use it for TV variety show. We have a fixed schedule every week. Normally, XR will merge with 2D footage. And then should be fashion and clothing shooting.

(myself):

MV as well?

PIAO Teckwon:

MV yes, sometimes.

(myself):

So will you foresee a demanding trend in these fields?

PIAO Teckwon:

For the future... I think there is still potential for it. But personally, I don't want to only focus on VP.

(myself):

Why do you say so?

PIAO Teckwon:

Because I want to be a director who can maximise the potential of VP instead of a technical staff in a VP studio. Because the role of VP studio is always supporting

external production. It doesn't feel you are doing for your own work. I am not sure if you can understand me. I have spent almost 2 years in VP. It is good to learn so many things, but I was DP before, and I am trying to be a director. I have done a lot of fashion related shooting, so I wish I can be the one who can maximise every single advantage of this VP studio instead of a supporting character. This is my personal through. But for its future, I think there is still a lot of potential for it. For the people who know this for the first time, they feel amazing. Once you stay here for a while, you will realise there are a lot of limitation.

(myself):

So you mean it is highly reliant on the technical part?

PIAO Teckwon:

Yes. If I have a project and I want a high-quality outcome. I still prefer a green screen, because you can have a more realistic and higher quality VFX in post-production. Let's say a big project from Hollywood, like The Mandalorian and Batman. They did not use VP for every single shot.

(myself):

Yes.

PIAO Teckwon:

Maybe only a few scenes.

(myself):

For my own, I come from a VFX background. The role for VFX is support and it is very passive. So I was wondering if VP can bring a stronger bargaining power for artists. But it seems not that much.

PIAO Teckwon:

Yes, unless that is a studio-initiated production. But to be honest, VP studio is a supporting role because production side only come to us when they have a demand. Right? So we still have to work for them and try our best to support this work. But from a supporter point of view, you can see if this match with your character. If that matches, you can keep working in VP studio, like Unreal part or even Supervisor. But personally, I want to use VP studio for my own work. Because even external production come here to shoot, they may not have a high level of understanding about this VP compare with us who have worked here for 2 years. So it depends on what you want.

(myself):

Yes. I visited TEAM Studio last December. I met one of your staff when I was in SIGGRAPH Daegu and he invited me to visit there. I was amazed by the size.

PIAO Teckwon:

Oh, our main studio is two times larger than TEAM Studio.

(myself):

So as you mentioned, different studios use different purposes, right?

PIAO Teckwon:

Yes, XR content is in TEAM Studio.

(myself):

So ICFVFX is in the main Studio.

PIAO Teckwon:

We wish we could have more ICFVFX. But it is always R&D.

(myself):

I saw there was an event for XON, Dexter Studio and Vive studio few days before. I am curious about what that event was about.

PIAO Teckwon:

That is a promotion event to promote the VR industry. We had someone from Epic Games and it was a good experience overall.

(myself):

I heard that there are 10 studios in Seoul.

PIAO Teckwon:

Yea, that is too much for a small country like Korea. It takes 10 years to recoup. Because it needs to invest a lot of money. You have to keep updating hardware, software and licences. It is not cheap to buy all these equipment.

(myself):

Do you have any internal training?

PIAO Teckwon:

So far, we don't have internal training. But we have training from a country level, and this is for the industry professionals. I think it is normal for VR studios not to share their technology. But our studio is ok. We shared a lot when Aux Media came to us. I somehow feel other places are a bit unwilling to share. Even we had technical exchange with Dexter and Vive last time, it was not in-depth.

(myself):

I understand that the core part is always top secret. But do you think this industry needs more sharing?

PIAO Teckwon:

Of course, it will be good to have more sharing. But that is not the reality. For here, we are good at shooting 2D driving comp.

(myself):

But Dexter and Vive have their own skills and fields, right?

PIAO Teckwon:

But they don't have as many projects as us.

(myself):

So Netflix doesn't create a huge impact or demand in Korea?

PIAO Teckwon:

Netflix came here a few times. But they work with another VP company called Westworld. They built a temporary VP studio, but they have removed it after shooting.

So the highest demand are fashion, drama, TV show and commercial. Film is dying in Korea. There is not that much for film.

(myself):

Oh, I thought that was the opposite situation.

PIAO Teckwon:

There are a lot for Netflix Drama. But Film is really shrinking to ... around 1/10. Hundreds of films can be done before, but now only can produce ten to twelve.

Sorry I have to go.

(myself):

Ok, one last question. What kind of skills are you looking for in new hires?

PIAO Teckwon:

To be honest, we prefer someone with experience. For example, if you are colourist, you concern colour, so it should be ok. And you have to have a heart to learn new thing, so we prefer younger staff. For our company, each of our staff has own background and experience. For example, I was DP, the new staff is coding, software developing. It also depends on if the new staff is a fast learner.

(myself):

Ok. Thank you.

Interview 6-9: Hibino VFX Studio, Tokyo, Japan

Interviewed date: 2023/09/12.

Hibino VFX Studio staff (in speaking order):

Harumi Miura - VFX technical director

Higashida Takanori - VFX producer

Narita Yuki – VFX technical director

Watanabe Shinnosuke – VFX Manager

As requested by Hibino VFX Studio staff, the mentioned project titles and external company names are hidden.

(myself):

Do you mind introducing yourself and your background?

Harumi Miura:

Mr. Higashida, he is a VFX producer. And Narita Yuki is a technical director. And I am also a VFX technical director.

Higashida Takanori:

Hibino VFX Studio is a visual division under Hibino. It is located at a place called Hinode, it has a studio with around 190 square meters. Hibino VFX Studio has a LED wall equipment system and can be implemented outside the studio. Hibino Staff are able to transport and build up the LED wall system. Currently, we have a setup in one of the Japan TV companies. The system can be built according to the project. Currently we have managed 4 studios.

(myself)::

As you mentioned, you have 4 studios, right? There is Hibino VFX studio at Hinode, a studio in the Japanese TV company, a studio owned by another Japanese TV company, and one more studio (Metaverse production).

Harumi Miura:

Yes, we can anywhere to install the system. Currently we have 2 studios running in TV production studios.

(myself):

I saw there is a Metaverse Production from your website. Is it also part of your company?

Higashida Takanori:

For the Metaverse Production, we work with 4 other external companies, 5 in total to produce projects. We work collaboratively.

(myself):

I see, I see. It is a collaboration with 5 companies.

Harumi Miura:

Yes.

(myself):

It is a large scale.

Harumi Miura:

Yes, collaborative companies get together. We try to use group work to make better quality and spread this virtual production network.

(myself):

How would you define Virtual Production? So we are going to question three. Because sometimes, you know, we would use LED walls. Sometimes we use Avatar. So how would you define this term?

Higashida Takanori:

For us, it is the LED. We use LED walls for Virtual Production.

(myself):

So it is only the LED wall and to replace the green screen?

Harumi Miura:

Yes.

(myself):

It is a very good definition of virtual production.

Harumi Miura:

Because we have LED walls, devices and experienced technicians. So, this is our good point to use LED walls.

(myself):

It is very interesting that Hibino VFX Studio is located at the centre of the Tokyo. But normally LED wall requires a big area. Can I know why you want to locate your company in the centre of Tokyo instead of other places?

Higashida Takanori:

It is because here is close to our main company. So the company was established another company building here.

Harumi Miura:

Our headquarters is at Shinagawa, which is very close to this building. The company decided to set up a VFX studio after the pandemic. So you know, after we visual division moved here, we decided to make a studio in this building. We secured the space after moving here.

(myself):

Yes. I think it's very good plan. I think because it's located in the centre of Tokyo. So, you can have different projects easily, like CM, drama. And what is the main purpose for your team to use virtual production?

Harumi Miura:

This VFX studio, is not so big, but it is good enough to shoot commercials. Sometimes we do TV drama shooting here, but only some scene. Not entire TV drama shooting.

(myself):

Interesting! I also saw there are a few projects like live events and Tokusatsu. It's not only CM and drama but there are also some Japanese unique productions.

Harumi Miura:

So far, we have been doing different kinds of projects.

(myself):

I am very interested in these productions, what is your daily job in dealing with these different kinds of productions? can you share your typical day of work?

Harumi Miura:

For example, I will describe a day at the Midoriyama Studio. We are shooting TV drama there. My coworker and I, only 2 people are in charge of operating and maintaining the systems and the LED wall there. We start to work 1 hour before the shooting starts. Midoriyama is a little far from Tokyo. We get there in the morning and switch on every device and checking errors. If we find something wrong, we have to fix quickly. And we try to create the nice background on the LED display behind the studio set until the end of the shoot. The shooting takes very long hours.

(myself):

Yes, and I think it's not only the production and the shooting days. I think there's also pre-production. For example, from what I know, for CM, it's a very short production period. and just shoot 1 day or 2 days then it's finished. But I'm interested in how other productions like TV Drama. How would you compare with CM production?

Higashida Takanori:

For Tokusatsu, sometimes 1 day for preparation, 1 day for rehearsal and the actual

shooting. 1 day for preparation and inquiry, then the actual shooting 1 day. So, it usually ends in two to three days.

Harumi Miura:

About the Tokusatsu project, the shooting is about one day. And before the shooting, we do an Angle Check. You know, technical staff get together at the studio and the cameraman actually check the angle for each scene. Before Angle Check, the art staff come to the studio to set up the scene and studio set.

(myself):

Yes, it is very interesting for me, because I didn't have done any similar project before. So that's why I like to want to know more about that one. Thank you for the answer and we can talk about the workflow later. So maybe we can move on to the next question. You mentioned you are from live events or from music video productions. But now is going into LED wall productions. So, what you have learned or expanded from your area into VP?

Harumi Miura:

okay, for me, I gained a lot of knowledge about LED setup. Also, at the shooting studio, I learnt a lot about colour management. Yeah, this is very important. And it is not easy to understand everything about color management. I am still learning. And also lighting.

(myself):

How about producer?

Higashida Takanori:

Up until now, I had been working on concerts and events, so I wasn't in video production itself. Although I was involved in video-related production, I wasn't in the field of video production. I've been doing a lot of things that I've come to understand. Up until now, when I've done concerts and events, I've only done work where the audience is excited by the visual expression, direction and operations for the real audience. When a show starts, it keeps going, the audience gets excited and after two or three hours, everyone is satisfied and goes home. Our job is done. We have done a lot of this kind of work. But in video production, take CM as an example, you have to concentrate on a 1-second or 0.5-second cut. 10-20 people gather together around the monitor and discuss how to do this, and how to do that. Also, when someone says "OK", we finish that work without knowing the reaction of the audience, but up until now we've all been looking for a real reaction, so it's completely different. I don't know audience's reaction. There are so many differences between making a project, having it finished, and later seeing it and enjoying it. It is very new for me.

I think it's great that the work I've created is still there and I can see it over and over

again as a work of art, have people see it over and over again and enjoy it. I think that's great. I think that's a great job. In the past, I would do a 2- or 3-hour show and that would be the end of it, but now I'm doing this kind of film production work, so I think it's a great job.

(myself):

I believe it's a very good answer. Because you compare with live events. You also mention a lot of people stay in front of the monitor, and watch the shot. But live event is like 3 hours continues and at the end, OK, finish and let's go home! That is a very good, excellent answer. Let's move on. Narita? Do you want to say something, or I can move on?

Narita Yuki:

It's been about 4 years since I joined the company, and I haven't done many live events during the pandemic. So, I don't really have a deep understanding of what has changed. The required knowledge is completely different, so even I use the same LED, if it looks beautiful for that moment, that's fine. But in CM, I need to know about the relationship between a color pixel and a camera, or something like that. Even with the same LED, totally different knowledge is required, so there are new things to meet new knowledge. I wonder if I encountered new knowledge.

(myself):

It is very interesting because an LED wall can be used for concerts and live events. But when it comes to productions like CM and drama, it needs another knowledge. And it is an interesting answer from Narita. So I will move on to the next question. When you are dealing with external clients or an external director. how will you introduce ICVFX to them?

Higashida Takanori:

For ICVFX, we often invite people to come to the studio and see it, run the 3DCG in the studio, and give detailed explanations. I think it's best to see it because it's not clear just by explaining it.

(myself):

So you will invite them to the studio and have an experience of the LED stage?

Higashida Takanori:

Yes.

(myself):

What are their reactions? Would they feel surprised? like Wow, amazing!

Harumi Miura:

Most of them look very happy to see ICVFX. They show us a nice reaction.

Higashida Takanori:

Recently, ICVFX became famous. More and more people become familiar with it, so for them, it is not as amazing as before.

(myself):

Yes, now more and more people know ICVFX. I think starting from the Mandalorian, which was produced by Disney. You know, it's more people who know more about LED walls.

Harumi Miura:

Yes.

(myself):

We can move on to the next question. Sometimes when you work with them, they may have some misconceptions. Do you have any case like this?

Higashida Takanori:

ICVFX is an absolute requirement for 3DCG, but this is not well understood, and many people think that backgrounds shot in normal 2D can be linked to the camera. It is often that I need to explain to them, if they shoot on location in 2D, in a normal way, the background scene cannot be expressed three-dimensionally, nor can they be linked to camera tracking.

(myself):

Yes, because for a normal LED wall, people just think an LED wall is a 2D display but they don't know that it's a 3D, it is camera checking. Sometimes people just think that is just a projection. In fact, that is different.

So maybe we can go to question 4? What if they want to use their own camera equipment? because, you know, every studio has its own equipment but sometimes clients and directors that want to use their own equipment, then how would you suggest?

Harumi Miura:

For us, it is not a problem. We accept any request about the devices. We can prepare for the camera if they request. ARRI or other cameras. We have to care about the model. What model do they use, and the lens. We have to do the lens calibration for the tracking. We need to know how they would use the tracking camera and how to attach it to the camera. We have to make sure of some things.

(myself):

So even they have different models, different lenses. As long as they tell you, then you can calibrate with that?

Harumi Miura:

Yes.

(myself):

Okay, so even the camera tracking?

Harumi Miura:

No problem. If we can have time for the lens calibration and some adjustments.

(myself):

Why do you need to know the models? Is it because there is something very important for the calibrations? Or they can use any models?

Narita Yuki:

According to my knowledge, the flicker? the noise? Those black lines appear on the LED wall or not depending on the performance of the camera. If we are using a good camera, we won't face such trouble.

Harumi Miura:

Yes, about the camera, it is up to the camera. You know, it affects the chance of the artefact flickering. Some cameras don't accept the Genlock signal. Something like that. We want to use the Genlock, but some cameras don't have a connection.

(myself):

So, the Genlock is also very important.

Harumi Miura:

Yes. But even if they don't have a Genlock connection, we still use those cameras. In case of that, we will check the artefact on the LED screen more carefully and try to remove the artefact by adjusting the LED processors.

(myself):

Oh! So you adjust the Brompton instead of the camera?

Harumi Miura:

Yes, we do.

(myself):

I see.

Harumi Miura:

We can accept any request if they want to use their cameras. We are ok.

(myself):

Okay, moving on. How will you introduce ICVFX to actors?

Harumi Miura:

I've never talked to actors.

Higashida Takanori:

For actors, the director will explain things properly, move like this and that, and then we'll go along with him.

(myself):

The director can talk to the actor directly.

Harumi Miura:

Yes, in most cases, the director will speak to the actors.

(myself):

What is their feedback and reaction after they use ICVFX?

Harumi Miura:

I have never talked to actors, but I know they are happy to act in front of the LED walls. Sometimes they come over to the system area to see what's going on, wondering what this is. They become more curious.

(myself):

You introduce the next question, sometimes they are curious about the team like, what are you doing? Some of the VP studios, have virtual art departments and also Brainbar. Do you have similar team structures in Hibino VFX studio?

Harumi Miura:

I'm sorry. We're not familiar with the words VAD and Brainbar, I tried to check the word, but I couldn't find the meaning.

Tsuyoshi Mitera:

So, I think VAD, what you mean is somebody who makes the content for the virtual background, right?

(myself):

Yes, like Unreal Engine staff.

Tsuyoshi Mitera:

Brainbar? I have never heard of Brainbar. What do you mean by that?

(myself):

So basically, these 2 terms are from The Mandalorian, Disney. They use the VAD virtual art department for content, like Unreal Engine, and virtual art. The brainbar is for the LED wall, system input and output, and the technical side. But depends on the company, sometimes there is only one big department to handle everything. Sometimes they have different teams. So, some of the companies, don't really follow these 2 terms. But for me, virtual art is for art. Brainbar is for technical.

Tsuyoshi Mitera:

Technical means hardware-wise? Do you mean people and probably hardware?

(myself):

The technical side means LED wall, Disguise, Brompton. In their definition, these belong to Brainbar.

Tsuyoshi Mitera:

In that sense, Brainbar is Hibino themselves.

Harumi Miura:

We don't have VAD. I don't know if I can say we have Brainbar. But we do technical things.

(myself):

I think maybe there is a whole team to handle everything.

Harumi Miura:

Yes, everything.

(myself):

Some companies don't have these 2 terms and some of them have different definitions. So is okay. But I just want to know and am curious how will you define different departments. Yes, it is totally fine. It's totally okay.

Harumi Miura:

Yeah. Our studio members can handle everything. We do LED wall installation, adjusting the processors and using Disguise, media server, programming, operating, everything.

(myself):

It is a very powerful team!

Tsuyoshi Mitera:

Because Hibino themselves is a rental company who serve in various kind of events and concerts etc. So, they already own equipment. They have them in their inventory.

And then the operators who can operate the equipment also, setting up this equipment is their job, the main job. So they have no problem doing anything with the equipment from their inventory, of course. And then what they don't have is the virtual art department . So normally they team up with the content studio outside of the organization, or there's sometimes a freelancer. So, it is a team of people. And then the virtual art content studio and then the production, that's like the usual setup for their production.

(myself):

Yeah, it is interesting, because your staff can do both operation and set up. These two abilities can be found in the same person, right? May I know how large your team, like? How many people are in there roughly?

Harumi Miura:

Not many. About 20 people, including management people. All together about 20.

(myself):

It is a quite big team.

Harumi Miura:

Yeah, when we need to set up a large LED wall, we ask freelancers and other companies people to join us. You know, but currently, we have 4 studios in operation, since we usually don't work together, I don't feel we are a big team.

(myself):

It is very interesting. Some companies may have a small team and they will handle everything. Of course, for the installation, they also outsource to ask people to install, and then the studio stuff, they will operate for the production. I think Hibino is a large-scale company, so you have different staff from different studios. Maybe we can move on to the next question, what are the differences between working with LED wall versus green screen production?

Harumi Miura:

We don't know very much about green screen production actually. But I know if we use LED walls, we can use the advantage of reflection for the shooting. This is really effective.

Higashida Takanori:

The great thing about being able to shoot while watching the visual on the LED is that everyone in each section can create things while watching the final image on the monitor. After all, it is different from creating a painting. Everyone, like the supervisor, director, cameraman, lighting and us, can change the final image, like the lighting and camera angle while looking at the composed result. I think it is the biggest difference from green screen production. Also, the actors, can watch the LED and follow the

timing for acting. I think that is the biggest the difference between green screens.

(myself):

Yes.

Higashida Takanori:

Until now, green screen production requires imagination from everyone during shooting and relies on editing. But LED wall virtual production is different, we receive everyone's input.

Harumi Miura:

I can say that this is very important to share there. All staff in the studio set can share the ideal picture.

(myself):

Yes, it's very important to have an ideal picture and visual content for the whole crew and actors to act and react. As the producer just mentioned, there are lots of people on the set, like the cameraman, supervisor, lighting and even Hibino staff at there to watch the final picture.

If you use LED wall virtual production and compare it with the green screen, it may change in terms of the workflow, the next question is Are there any challenges for you to adapt? How will you adapt this kind of new production workflow?

For example, as the producer mentioned. You come from like a live event background, which is like 2-3 hours of keep going. But now it's like shot base production and sometimes like a loop. No good? again, no good? again. So is it very challenging for you to learn? or is it still okay?

Harumi Miura:

I just tried to get used to it since we are very new to this filming industry. In the beginning, I joined the shooting and tried to know the procedure, I learned there is a time for "Dry(DR)". The actors and cameraman get together like a rehearsal before the shooting. I didn't know about that time. After this Dry, they have a camera check, then they start shooting. Through watching their work, I tried to get used to their workflow.

(myself):

so, I think the rehearsal is very important and let you know what is going on. What things do you need to address and adapt?

Harumi Miura:

Yes. Because the camera rehearsal is the last chance for us to adjust the LED settings. We need a camera line to adjust anyway. It is a very short time in camera

rehearsal but we have to check the camera line quickly adjust the LED and make sure the color or artefact. We try to solve anything wrong. Also the position of the image.

(myself):

Okay, so I will go to the next question. From these 40 projects that you have done, like CM, and drama. Do you mind sharing any tricky projects? And how did you solve it?

Narita Yuki:

The most challenging one is the one-cut promotion video. We kept changing the 3D scene during the shooting. That was a one-shot shooting. I had to keep changing the background CG for around 5-6 scenes while the camera was shooting from one LED wall to another wall back and forth. Technically, that was the most challenging project.

(myself):

And I think that will be very important to have rehearsal again and again. I also see also from the website. There are some projects about like timelapse and combing the physical set. Are these projects also difficult for you, or easy?

For example, the web movie shooting Project A and also Project B. You have some physical set for those projects. The official website mentions that you used physical sets and art with the LED wall.

Harumi Miura:

Do you want to know if it is difficult to shoot?

(myself):

What is it difficult for you to merge like color or visual merge with the physical set and the LED wall?

Higashida Takanori:

It was difficult, but it was something we usually do, so it's not as hard as you think. We had physical art, and once the lighting was decided, the only thing left to do was change the lighting in the CG to make it convincing. I think it's okay as long as you don't mistake the workflow.

(myself):

Okay. So, there's a physical set and lighting and then you will confirm the final image, as long as it's okay, then it's good to go.

Harumi Miura:

After lighting adjustment, we will try to match the color between the physical set and

the LED image. We also adjusted the LED processes a little bit to match the color.

(myself):

Indeed, I believe the color adjustment is very tricky. We can go to question three. So, the overall workflow is like you create all the shots in pre-production and there's no more post-production? What does "Fix-in-the-Pre" mean to you?

Harumi Miura:

Sorry. Again, we don't know the word "Fix-in-the-Pre".

(myself):

Oh, normally, we will have Fix-in-the-Post like the producer mentioned. But for now, there is no more post-production, but create the shot in pre-production or during the production. So, I changed the terms from "Fix-in-the-Post" to "Fix-in-the-Pre".

Harumi Miura:

We have never talked with the person who is in charge of post-production. So, we don't know how they change the color or light after the shooting.

(myself):

It's okay. No worries, no problems. But I want to ask when you are done with the shot, do you also do the editing, or do you pass to the client?

Harumi Miura:

No, we don't do anything after that.

(myself):

So just like, shoot, done and finish.

Harumi Miura:

Yes.

(myself):

Interesting. I think we can go to question 4. How would you deal with different shot types? What if the client wants to use a wide shot or and they want to use a very extreme camera movement? Is there any experience for you and your team?

Higashida Takanori:

Well, as I said, it's often a problem. When it comes to wide shots, there is a limit to the size of the LED wall. What to do about something bigger than that? It is a problem that often arises. Of course, we can do as wide as possible, but for us, when it reaches our limitations, we will explain that "this is our limit." Also, we also need to deal with the delay because of the fast-moving camera movement. That's a problem that occurs from time to time.

Harumi Miura:

Maybe I can tell. I have handling movable LED walls at the current project. In the studio, there are 2 sets and depending on the scene, we have to move the LED walls in front of the selected set. This is very difficult because we have 5 walls. And sometimes we use 3 and the maximum is 5 LEDs. And I have to adjust carefully the surface, especially the joint parts.

(myself):

Oh, I mean, it's a very interesting answer, because you have a moveable LED wall, and it is very flexible. That's why you can move your LED wall outside the company. I would like to ask some projects that you have done before. For example, if you have done a MV shooting with Artist A, there is a virtual character at the back.

Harumi Miura:

It was a long time ago, last year. I remember that.

(myself):

Because there is a virtual character at the back. And did you use motion captures for that?

Harumi Miura:

No, that was a very simple screen process shooting. I remember that they shot it very simply and not long hours. They started in the morning and finished in the evening. What would you like to know about that project?

(myself):

Because I assume they used real-time motion capture for the virtual character. And I don't know if that's difficult or it's like easy.

Narita Yuki:

We only shot the scene where the artist was singing while playing a movie at the back. So, we didn't use real-time motion capture.

(myself):

So, it's like a movie at the back. Interesting, because I thought that was a real-time motion capture. Another project that I want to ask about is the AR elements, like. For example, with the TV station, there's one project with AR elements. Also is another one called Demo with the XR elements. I am just curious, is it difficult or easy?

Higashida Takanori:

That is not difficult. The artist came to the stage and used AR to visualise data. That's for the program.

(myself):

We'll talk about the next one. For you, what are the elements that can help ICVFX project success?

Higashida Takanori:

For ICVFX, it is important everyone has the passion to do ICVFX. Each session, like lighting, and camera, have the passion and work together. If there is even one person in the team who thinks that ICVFX is no good. I think the teamwork will instantly collapse and there will be no success at all. ICVFX is a 3D CG virtual production. There is a need for understanding. If there are negative comments within the team, then the ICVFX will not be succeeded.

Harumi Miura:

We need a camera line to adjust the LED or the Unreal Engine during the shooting. So, if the camera team understand the group work about the ICVFX, then it will be great to co-working. Technically, we have to gain and keep the good fps. The maximum FPS is the best. We try to reach a high FPS, also we need to creators to understand that.

(myself):

I want to ask more about the creators like sometimes, if he wants to use the wide shot, but as the producer mentioned, there's a limitation. Then how will you tell the creators like, oh, cannot do something like this, or how will you deal with it if the creators want to create something special?

Harumi Miura:

The creators mean...?

(myself):

The client and director. For example, as you mentioned, there's a creator, and they need to understand the LED, and good FPS and also require good teamwork. But sometimes creators, may not understand, like I just want to shoot and bye, bye, I don't care! As you say, it's also very important to let the creators understand some limitations and we have to work together to make it a success.

Harumi Miura:

I don't know how much we can do for that. We need a time to talk about that. We should do that before the project starts. Once it starts, it's very difficult to find time to talk about the virtual system and camera system with the technical staff.

(myself):

You mentioned the meeting before the project, is that important?

Harumi Miura:

Yeah, I think so. Although I don't know how much we can have time to let them know this new method ICVFX is for them.

(myself):

Thank you. It's a very excellent answer. And I think if we have a meeting before the project. Sometimes it may also change the script as well, I guess. And also, can make your life easier.

So maybe we can move on to the next questions about the future. So, what do you think about the future of this industry?

Higashida Takanori:

Japan is a bit behind compared to the rest of the world, so I think it will continue to develop. The performance of Unreal Engine will continue to improve, so I think this industry will continue to develop.

(myself):

I think this is also a very important element for virtual productions. Because it's new and we need more knowledge and skills for that. Do you think ICVFX will fully replace the green screen in the future?

Higashida Takanori:

I don't think that will fully replace it. ICVFX and the green screen will be two different approaches. If the LED is 10 times cheaper than now, and 3DCG is 10 times easier to create than now and is more photorealistic, then the green screen will maybe disappear. But for now, the industry will use 50% green screen and 50% ICVFX at the same time.

(myself):

How do you see the market in your countries? Because Japan has internal production, like CM, drama, and even in the future we have Streaming services like Netflix.

Higashida Takanori:

In the world of commercials, I don't think the number of jobs in commercials will increase dramatically, but if you look at dramas and movies, I think the number of jobs will increase more.

Harumi Miura:

I don't know the market in Japan exactly. I think if compared with other countries, maybe we don't have many studios where is able to shoot ICVFX in Japan. So probably the number of studios may increase, I hope so, although it must be hard. because think about the cost of setting up an ICVFX studio.

(myself):

For now, it is expensive to set up an LED wall.

Harumi Miura:

Yeah, not only for devices, but also the staff, and technical people to operate all the devices for the studio.

(myself):

So when you talk about technical people and future people, what kind of people or skills you are looking for?

Watanabe Shinnosuke:

For us, instead of 3DCG, we hope to find a person who can communicate with different sessions smoothly. The technical skill comes after that. Especially, for us, in virtual production, we have to handle direct requests from camera sessions, content sessions and supervisors.

(myself):

So it's like a direct communication.

Watanabe Shinnosuke:

Yes, it is communication.

(myself):

Thank you.

Interview 10: Evelyn Wu, Shenzhen, China

Interviewed date: 2024/01/24.

As requested by Evelyn Wu, personal job titles, mentioned project titles and external company names are hidden.

(myself):

OK, let's get started. Hello, can you briefly introduce your background and current job to readers?

Evelyn Wu:

I am in charge of the virtual production technology section within a large company in Shenzhen. Kind of like a product manager.

(myself):

Can you describe your daily work?

Evelyn Wu:

My daily work is divided into several parts. In the first part, there is a VP studio operating somewhere in Shenzhen. And then daily testing, meetings and related shooting.

Related to shooting, in pre-production, I will do technology consulting and execution. The second part is our own research and development products. For example. Because we are very optimistic about VP Ndisplay in this area, we have a complete set of self-developed products for the entire VP process. R&D is also part of my job. Another part is that we will do virtual studios for other needs. Such as government, and school departments to provide some solutions. Helping them to execute their project, that's another part of my job.

(myself):

How would you define virtual production?

Evelyn Wu:

Virtual production. I think it is not only limited to LED. It is actually a kind of filming technique through real-time and visualisation. By game engine, the previously post-production environment can now be rendered in real-time. This approach, which I personally define as virtual production. In a green screen production, through the superposition of elements in a game engine, the result presents an environment that seems to be in a virtual world. Or motion capture can be used to generate a visual in real-time.

Another aspect is that, in a conventional sense, we are all very familiar with the

concept of an LED wall, where real-time rendering is applied on top of it, allowing for real-time superimposition. This is also a form of virtual production. Therefore, virtual production is not limited to just LED virtual shooting. I believe that its definition is diverse and can be adjusted based on the specific requirements of each project, allowing for a combination of different shooting techniques.

(myself):

Whether it's a green screen or an LED wall, both rely on real-time technology.

Evelyn Wu:

Yes.

(myself):

What projects have you done with virtual production before?

Evelyn Wu:

In the past, while in Korea, I was involved in providing services for film and television drama productions. However, after returning to China, at my current company, my main focus has shifted towards live broadcasting events such as press conferences and advertisements, which tend to be more frequent.

(myself):

So what field did you come from and what new knowledge did you learn through virtual production?

Evelyn Wu:

I actually used to work at a television production company in Korea, mainly in production and business-related roles. However, through my involvement in virtual production, I have gained a lot of knowledge in game engine technology, hardware, and transmission protocols. My focus has shifted towards deeper into the core aspects of virtual production, which is quite different from what I had previously learned.

(myself):

Does it need a lot of programming and development knowledge?

Evelyn Wu:

Yes, it requires a lot of programming and development. However, it is difficult for me to learn programming and development because my undergraduate and graduate studies were not focused on that. Instead, I would prefer to learn the overall logic of virtual production and how it is implemented. I am more interested in understanding which parts are more important in practical applications. I would like to approach development and programming with a logical mindset similar to product development, focusing on implementing various functionalities.

(myself):

That's why you have implemented different plug-ins that simplify some of the cumbersome steps.

Evelyn Wu:

Yes, to make shooting easier and better.

(myself):

Then let's move on to the second part. How do you generally introduce virtual production to external clients and directors?

Evelyn Wu:

Since we have a studio in Shenzhen, we can invite them to our studio for demonstrations. Our studio is divided into three parts. The first part is motion capture. In the motion capture area, I can have someone wear a motion capture suit to drive my virtual character in real-time, allowing him to see the composited effect in real-time. This will demonstrate how we can quickly animate the character using the motion capture data, instead of traditional hand-keyed animation methods.

The second part is virtual production with the LED wall. For the LED wall, I will explain it in two parts. The first part is the conventional approach, which is our Unreal team-defined workflow called Virtual Production NDisplay. In this approach, the filming is done directly on the LED wall. Like *The Mandalorian* and *Batman*, where they utilise UE's NDisplay to film within the LED screen environment. The video output from this process is in the RAW format. Then you have the flexibility to have colour grading and post-production with this RAW footage.

Another aspect is XR (Extended Reality). Initially, XR was widely known for its applications in offline events and concerts. However, since our studio caters to the gaming industry, we require a sense of spectacle and visually stunning imagery. Therefore, I have also introduced XR solutions to meet these demands. We can seamlessly transition from virtual production (VP) to XR in real-time, allowing us to showcase the capabilities of XR technology.

When presenting the options to clients, I explain that if they have large-scale scenes where the overall quality and post-production color adjustments are not really important, they can opt for the XR solution. This enables us to create immersive experiences with dazzling visuals. By incorporating XR into our studio, we can cater to a wide range of needs, including motion capture, conventional LED-based XR, and various aspects of virtual production.

(myself):

How do they usually react?

Evelyn Wu:

Their reactions are actually quite good. Like some external customers, if they don't know a lot about this thing, they will find it very magical. He could directly see a virtual object as if the metaverse was really right in front of them. As for the director, they want to know "How I use this thing". "What kind of problems will happen?" They would ask me for some clarification.

(myself):

You just mentioned that the director will ask some questions. Do they have any misunderstandings about virtual production?

Evelyn Wu:

Instead of misconception, most of them haven't used it. Some people think LED walls can solve all shooting problems. But actually, it's not, because an LED wall is something that has physical space. Physical problems are very difficult to overcome, for example, reflection. It may cause the color is not be real enough, then how to match your virtual environment and real environment? There are also some spatial constraints. It doesn't solve everything that the green screen cannot solve.

I can do whatever I want after green screen shooting. But for virtual production, you need to do a lot of preparation and debugging work in pre-production. When you are on shooting, you need to make some modifications on the spot. It is impossible for you to make large-scale modifications to the background afterwards, so it is not a shooting method to solve all problems. It is a very good means in certain cases. Such as somewhere which is difficult to reach, or you have high requirements for lighting, such as you need to shoot sunset for the entire day, but outdoors is windy and rainy, so it is still a relatively good choice. It's just a means for filming.

(myself):

And generally, how do you work with them?

Evelyn Wu:

There are actually many ways to cooperate. It depends on what you say. Do you mean directors?

(myself):

Yes.

Evelyn Wu:

For the director, we'll provide technical solutions. For example, if he wants to shoot a car scene from the main character's first perspective. My camera can't be carried by a human or simulated in a conventional way. Then, my main character has to wear a camera helmet on his head, but that affects my camera tracking. So, how to meet the

director's requirements? How to provide technical solutions? How to run tests to make sure he gets what he wants? We work out the overall technical solution.

(myself):

We just mentioned car scene shooting, what if the director wants to use his own equipment, such as all his own cameras or lights, how will you and your team handle that?

Evelyn Wu:

We do not provide the corresponding equipment, they have to bring their own equipment, but I will clearly tell him what kind of camera and technical standards I need. Because Genlock is very important in virtual production, the camera needs to have this function. Most of the camera nowadays has such function, so it is not so difficult to find. Our overall requirements for equipment are not high. Whatever equipment he brings over, we can have a calibration and adjustment for him. So, he could use his own equipment.

(myself):

As long as his camera has Genlock.

Evelyn Wu:

Yes.

(myself):

Ok. Let's move on. How many people are there in your department team? How is the division of labour?

Evelyn Wu:

Are you asking about our department? Or our team?

(myself):

Let's say department.

Evelyn Wu:

For department, it actually divided into business, production and technical teams. The business handles clients and projects. The production team is responsible for overall project coordination. The technical team is responsible for technical support.

(myself):

Can you tell me more about the technical team?

Evelyn Wu:

In the technical team, I primarily focus on product development. The production team consists of R&D, on-site engineers, and hardware engineers. This is how the team is structured to meet the requirements of various projects.

(myself):

The next two questions are about the role of a VFX supervisor, but I think you can answer them because of your extensive experience. In your opinion, what are the key differences between green screen shooting and ICVFX shooting?

Evelyn Wu:

The biggest difference, in my opinion, is the influence of light. The green screen is a widely used element in traditional film and television production. I can add a lot of effects during post-production and enhance the overall visual appeal of the footage. However, it comes with the challenge of extensive post-processing work since the entire studio is covered in green. Keying is required, which can be costly. The labour cost for green screen shooting is relatively low, with an average cost of a few hundred dollars (RMB/Chinese Yuan) per minute, but the process can be quite tedious and labour-intensive.

The major advantage of an LED stage is its ability to solve real-time on-set lighting. It can provide the desired lighting environment directly on the set. The adjustability of LED lighting is also great. But, LED cannot solve all problems; it can only solve specific aspects. Also, there is a concept of " Forward shifting post-production ". With LED, all assets, camera shots, and even the planned routes and movements need to be prepared in advance. Once filming is done, it is difficult to make changes. With green screens, you can change whatever you want during post-production.

(myself):

Indeed. What are the role differences between a VFX supervisor and a VP supervisor in a Virtual Production context?

Evelyn Wu:

I think they are all people who provide solutions, but their ways of thinking and providing solutions may be different. The VFX director has to think about how to set up my green screen, where should I put the tracker, and then how many people I need in Post? How many shots? how many scenes need to comp? How many matte paintings do I need? etc. to form a team, and then to comp each shot layer by layer. VFX supervisor plan and coordinate the entire post-production and that is to establish a bridge between the post-production and the director. To tell the director that the green screen has to be set up like this. To tell actors where to walk, and then what kind of tracker should be pasted on the body to ensure that we can identify.

Same for the VP supervisor, what kind of scene should I create? What is the perspective of my asset? and then how to project it to the LED screen? How to make these scenes work match with my virtual production environment? and then how to communicate with other departments such as gaffers? I think how they work is the same but with different ways of thinking and the “Forward shifting post-production”. He has to finish what should be done later in Pre.

(myself):

I want to follow up on that. You mentioned " Forward shifting post-production " where once certain elements are fixed or confirmed in pre-production, they cannot be changed anymore, right? However, there are situations where directors may want to make changes on set. Could you please provide more information about such cases?

Evelyn Wu:

Making changes on set is not a problem, like adjusting simple lighting, adding a tree, or including minor elements. These changes are relatively easy to do. However, if you want to transform a scene from a massive forest to a desert, it would be very costly. But for the green screen, you can change whatever you want because that is a green screen. So, in “Forward shifting post-production”, assets are customized and prepared in advance. If you need a conventional asset like a desert, I can easily adjust it using virtual assets available in LED setups. However, if you need a highly customised scene and then with a huge change, it is hard to achieve.

(myself):

As we mentioned “Forward shifting post-production”, VP merges with filmmaking and game development. What do you think are the challenges of collaborating with film directors?

Evelyn Wu:

Changing their mindset.

The main challenge is that traditional film industry practitioners have their pride and proud of what they have done. If you need to break their conventional mindset and make them accept something new, there are a few key points. First, you need to present them with successful case studies that show the improvement in cost efficiency or effectiveness. It's important to provide strong and compelling evidence to convince them. If this new approach is not efficient, lacks good results, or is costly, they will have no reason to use it. Therefore, for us, we are making the new tool efficient, cost-effective, and capable of delivering high-quality results in pre-production. This will make professionals in the traditional film industry more willing to accept and use this new approach.

(myself):

Indeed. This is a point that requires mutual understanding.

Evelyn Wu:

Yes, yes.

(myself):

For you, what do you think is the most successful factor in virtual production?

Evelyn Wu:

I don't think virtual production can be justified by success right now, so....

(myself):

What do you think an ideal situation would look like?

Evelyn Wu:

I think the ideal scenario would be "what you shoot is what you see." For example, conventional VFX, they are typically achieved through layering, compositing, and post-production effects. However, with real-time rendering capabilities and the wide color gamut, ultra-high definition, and efficiency suited for film production offered by game engines, I can prepare everything in advance and overlay it on set. This would truly achieve a "what you see is what you get" approach. It is possible that virtual production could eventually reach this ultimate state. However, there is still a long way to go. There are many things that need to be done to achieve this vision.

(myself):

There are so many difficulties at present, and it has not yet reached this stage.

Evelyn Wu:

Whether it's hardware rendering or the colour accuracy of LED screens, there are many things to overcome. Therefore, it is currently in a preliminary stage and can only be used in specific environments.

(myself):

There is still a long way to go.

Evelyn Wu:

Yes, very long.

(myself):

How do you usually introduce ICVFX to the actors?

Evelyn Wu:

We didn't talk to actors very often. Generally, it is the client inviting them over and telling them how to film. What actors see is the ultimate state of a virtual studio. However, their acceptance is actually very high. I have met several actors, and they quickly get into character on set. During pre-production, we communicated with the director, that there is no tangible thing for the director. They either have to draw their own pictures or use 3D rendering to visualise. But for the actors, they come with everything set up on set, and pre-vis beforehand, so when he/she comes to the set, they can quickly get into character based on the script. "I need to have an interaction with something at this time." They no longer need to imagine themselves in a forest or any other environment inside a green screen. And then, after shooting, they can see the final effects in real-time on set. So, their response is, well, the next question, their response is always very good."

(myself):

Yes, it's quite rare and challenging because there are indeed many actors who are used to green screens and rely on their imagination. Now they can see the result on set.

Evelyn Wu:

Yes.

(myself):

The actor can review and even say "Oh, this is not good, I want one more take".

Evelyn Wu:

Yes, yes. So, for actors, they are happy to see it. It improves efficiency and reduces communication costs. Their filming environment is also much safer. In traditional filming, there could be explosions or shooting in outdoor environments with bugs, strong winds, heavy snow, and extreme cold. However, now that everything is done in the studio, the overall environment is much better than before.

(myself):

The actors are much safer.

Evelyn Wu:

They like this very much, at least the few actors I've worked with.

(myself):

Indeed, I heard that you have filmed some scenes like snowy mountains before, and it seems like the actors just need to wear thick clothing and it's okay. They don't have to go to the actual snowy mountains.

Evelyn Wu:

Yes.

(myself):

Great, so let's move forward. Based on your experience, what do you think are the differences between virtual production and the processes involved in other productions?

Evelyn Wu:

As I mentioned earlier, the biggest difference is the pre-production being prioritized. It means that I need to prepare the virtual assets and project them onto the screen before shooting. Otherwise, if you don't have the virtual assets, you won't be able to shoot anything.

(myself):

I would like to ask specifically about your general workflow. For example, after you receive a script, what are the different steps you go through from the script to the final on-screen result?

Evelyn Wu:

Ok. First, after receiving the script, you need to create storyboards. Once the storyboards are done, I have a rough idea of how the assets should be created. The larger the assets, the lower the frame rate on the LED wall. So, it's preferable to have detailed storyboards to understand the camera setups and know which areas of the assets should be more detailed. This is a significant difference compared to the traditional process where storyboards might have been the end of Pre. Now, there might be an additional step where you determine how the LED display's model should be arranged to achieve the camera angles from the storyboards. Once I have that information, I can start creating the assets. How should the assets be built? What should be the perspective relationship? These decisions are based on the storyboards. After the assets are completed, I conduct a screen test to check if they meet the frame rate requirements for the final display. If they meet the requirements, no further optimization. If not, then the art and scene team will need to optimize them to ensure they meet the corresponding frame rate. Then, I proceed to a live rehearsal to determine the camera movements, actor performances, and overall visual effects. See if they all meet the director's requirements. Finally, there is the integration of virtual and real lighting on set, where you may need to modify the lighting effects in the scene. This is generally the workflow for on-set shooting.

(myself):

You just mentioned the lighting, do they tend to adjust the virtual lighting or the actual lighting?

Evelyn Wu:

Both. I'm not sure about the practices in foreign countries, but in Korea, they tend to cooperate and work together. However, in China, the lighting team is usually very dominant, and they will adjust the lighting first, and then we adjust the virtual assets to match their setup.

(myself):

This is the cultural difference.

Evelyn Wu:

Yes.

(myself):

For the workflow, do you have any suggestions? For example, is there anything you think is important and that must be included?

Evelyn Wu:

Like what I just mentioned, storyboarding for Ndisplay. It is very important. The positioning of assets on the screen can have a significant impact. Without this element, it becomes challenging for my virtual production team to understand the specific camera shots you have in mind. So, this aspect is quite important. If possible, it is good to have pre-vis in the virtual environment. This helps to have better results. We should have done more the pre-visualization. For advertising projects where the requirements may not be as high, so we just focus on actual shooting.

(myself):

Some other companies suggest placing colour grading at the end of the workflow, do you have any thoughts on this?

Evelyn Wu:

What do you mean at the end? Do you mean to have a 1st colour grading during ICVFX or after shooting is done?

(myself):

Some companies prefer to add colour grading in post-production. They apply colour grading before sending out the final product.

Evelyn Wu:

This approach is actually not different from the traditional workflow. Colour grading is always needed in traditional shooting. Now we are talking to include colour management during the shooting process itself. From asset production to LED display and on-set primary colour grading, this workflow can make sure that the final

colours seen by the director align with the confirmed colours of the pre-vis assets. But there is a challenge when working on assets creation, such as outsourcing teams. These teams may create assets without a strict color management requirement, combining parts from different places. So it will be hard to control over the process.

And for on-set shooting, unless you have a very strong colourist, otherwise it is not good to have colour grading. So, we need a very professional team member to form a large team. Ideally, the entire team handles asset creation, shooting, colour grading, and post-production to ensure consistency. However, in China, there are not many companies that follow this approach, except for certain companies like the one in Hangzhou. That company has a good team because they have their staff throughout the entire pipeline, which is an advantage. For our team, it can be more challenging as the cost of maintaining a full in-house team is high for larger company. Therefore, we tend to focus on having talent in key areas while outsourcing other aspects, which may result in slightly less control over the process.

(myself):

I see, moving forward, what is currently the biggest challenge for you and your team?

Evelyn Wu:

The biggest challenge is the business logic.

(myself):

Can you explain it more?

Evelyn Wu:

How to say... the biggest challenge is because this is a product. A product needs to have a significant social impact, even if it doesn't generate profits, or it must have strong monetization capabilities to demonstrate its commercial value.

For VP, the entire film and TV industry is not good. Not to mention its high-cost investment. These make it difficult to have the return of interest. So, the challenge we are facing now is how to sustain the operations and survive.

(myself):

Yeah, the cost of setting up an LED stage and buying a GPU is quite high.

Evelyn Wu:

Yes, the cost for LED screens is very high. But this is a business-oriented thing, the biggest question is how to achieve a return on investment and generate profits. Our team is supported by commercial capital, so we can afford to invest such equipment. But for others, it is very difficult to invest for profit. It depends on who is your client?

How much do you charge? What kind of result you want? How to convince other to use this technology? These can be quite difficult tasks.

(myself):

Can you share any challenging or tricky projects you had and how you managed to overcome them at the time?

Evelyn Wu:

One of the most fun and challenging projects for us was a concert where our virtual human performed alongside a singer. The singer had limited time available, approximately six to eight hours, to shoot three songs, one of which involved performing with the virtual human. To ensure the virtual character appeared on stage with the singer, we needed to find a cost-effective solution as post-production would have been expensive. We used XR technology to achieve this. The virtual human was pre-recorded using motion capture data and then real-time overlay next to the singer on the stage. The key challenge was ensuring that the virtual human's recorded movements aligned with the XR coordinate system of the singer. Otherwise, these two would not be on the same plane or in the same position. Additionally, the virtual human needed to move a few steps and interact with the camera. We had to establish the coordinate system, determine the origin point, and engage in extensive pre-production communication to ensure everything aligned. This allowed us to overlay the virtual human in real-time during the live performance.

And then, we faced a question. There is no ground plane for our virtual human, how can we create the virtual human's shadow?

(myself):

Oh!

Evelyn Wu:

Yes. If we wanted to include shadows, we needed to key out a ground for the virtual human, which would block the singer. Therefore, instead of shadows, we decided to use reflection effect. The overall result was still quite impressive, whether it was the character's movements or interactions. This method required an additional machine for us to do the synchronization, rendering, and adjustment of colour, depth, and transparency real-time on-site. Another interesting thing is since we are using virtual human, what is the biggest challenges when combining virtual and real actor on stage? The lighting. How could we ensure consistent lighting for both? To solve this, I replicated all the physical lighting conditions in our virtual environment.

(myself):

Wow.

Evelyn Wu:

Yes. this pipeline was developed by our team. I can ensure that the lighting technician on-site, who controlled the physical lights can send signals to the virtual lights at the same time. With the lighting control console and the DMX protocol, we were able to control both the virtual and physical lights. This allowed us to make sure that all the real lights were properly lighting on the singer while the virtual lights were accurately lighting the virtual human. The overall effect was quite impressive and consistent. It took our technical team three days to implement.

(myself):

Only three days for the entire development and communication?

Evelyn Wu:

No, it was just a technical setup and testing on-site. As for the lighting integration, we had previously conducted technical tests, but it hadn't been implemented in an actual project. Therefore, when it came to the integration of virtual and physical lighting during the live production, it was relatively quick. It's not feasible to spend several days fine-tuning the lighting on-site. We simply brought in a set of lights for testing, and the entire process, including acquiring the lights, matching them, conducting virtual tests and rehearsals, and finally shooting, took only three days.

(myself):

Wow, so everything went smoothly, and you managed to shoot all three songs within eight hours.

Evelyn Wu:

Yes, smooth and with nice output.

(myself):

I am glad that you had the opportunity to work on such excellent projects.

Evelyn Wu

Yes, and it was quite rushed.

(myself):

Having only three days to coordinate everything is indeed a very challenging project.

Evelyn Wu:

Yes.

(myself):

We talked about “forward shifting post-production”, is there anything else you would like to add? What does it mean to you?

Evelyn Wu:

I think it may represent some challenges for traditional industries. However, from my perspective, it is a positive development. The acceptance of “forward shifting post-production” shows that ICVFX has been accepted by the industry, and everyone is willing to move in this direction. It is a positive signal and a promising trend for me.

(myself):

Okay, moving on. Do you have internal meetings and discussions before the shooting? Do you consider this important?

Evelyn Wu:

Of course. Without having meetings, you wouldn't know what exactly the client wants. It is important to discuss how your technical expertise can align with their requirements and how to conduct tests to make sure that their needs are met. The alignment in pre-production meetings is important for a successful result.

(myself):

You mentioned that you spent three days solving the physical and virtual lighting integration issue. So, do you also allocate a certain amount of time for other stages as well?

Evelyn Wu:

Definitely, there are other stages that require time as well. You need to ensure that your assets are running at the appropriate frame rate, calibrate your cameras, adjust asset positions, and fine-tune the overall visual effects. All of these tasks require time. I believe that the pre-production preparation time is an important factor in determining the efficiency of the on-site shoot. However, it can be challenging to control this stage effectively. Ideally, each asset should have half a day dedicated to adjustments to ensure consistency between virtual and physical lighting. Unfortunately, many production teams tend to compress the schedule. Lighting setups often happen very late, usually the day before shooting, giving you only one day to adjust four assets. This timeline is not feasible, but due to cost constraints, it becomes a necessity. It is common for the director to finish their work while the technical team is still adjusting assets on-site to ensure consistent results. This workflow is not ideal, but budget control becomes a limiting factor. Renting equipment for an additional day need extra costs, and nobody wants to pay that. Therefore, this becomes a bottleneck to achieve optimal results. For short-term advertising shoots, if you are not willing to invest more in costs, this limitation may still be there. However, if you are willing to invest more, the results can be significantly better. My suggestion

is to allocate at least half a day for each asset to ensure proper matching of lighting, positions, and visual effects.

(myself):

Overall, in terms of the entire process, such as from starting the project to final screen delivery, what would be your ideal timeline? Would it be one month, half a month, or is there a specific duration that you consider more ideal?

Evelyn Wu:

It depends on the production method you use for your assets because many projects nowadays require quick, cheap and fast. They are often assembled for immediate use. However, if you really want to create high-quality assets, it may take around ten days to half a month during the pre-production phase alone. When it comes to on-site shooting and adjusting the assets, there might be a need to send them back for further adjustments. To achieve a good overall result from asset production to final screen delivery, I believe a month would be an ideal timeframe. After the assets are on-screen, adjusting the lighting and fine-tuning the assets may also require half a day. However, it is crucial to have proper lighting setups in place. If the lighting is not properly arranged, it often leads to chaotic setups with last-minute adjustments and installations taking place during the day, making it extremely challenging to control the time.

(myself):

Indeed, from those film and TV producers' points of view, cost control is always a concern.

Evelyn Wu:

Yes, when it comes to costs, if you can deliver your work on time, it's still manageable. But if everything is delayed, those grips won't care about your progress. Their lighting team tends to work at a leisurely pace. They might bring the equipment to the set around 10 AM, start setting up, and then spend a lot of time adjusting and organizing things, delaying the actual shooting process. It's possible that it's already 8 PM by the time you officially start shooting. This puts a lot of pressure on us to modify the assets.

(myself):

Having everything piled up towards the end is really a problem.

Evelyn Wu:

Yea. This requires coordination between different departments, but they are not under my control. All I can do is wait.

(myself):

Okay, next question, in terms of time and financial costs, do you consider ICVFX as a cost reallocation or a cost reduction?

Evelyn Wu:

I think it depends. For example, if it is advertising. The shooting timeline is short, the costs may not be reduced. Asset production and equipment rental need money. Then, traditional on-location shooting may be better. On the other hand, film and television productions. They have a long shooting period and a volume of footage, so the costs for travel and equipment rentals may be reduced. It depends on the case and there is no absolute answer.

(myself):

Which means depends on the content. For example, if there are many car scenes, then the costs can be reduced.

Evelyn Wu:

Yes, exactly.

(myself):

And I won't use LED for a common daily scene.

Evelyn Wu:

Yes, so it depends on the requirement.

(myself):

OK, next question. What if the director spontaneously decides to shoot some challenging shots, such as wide-angle, physical and virtual set or fast-moving shots, how would you respond and address them?

Evelyn Wu:

We usually plan for wide-angle shots and virtual and physical sets. They are not particularly challenging. The real challenges are fast-moving shots and high-speed filming, which can be more difficult to shoot. In fast-moving shots, we may have to render limitations. To solve this, we either increase the rendering machine or expand the rendering area so that the speed of movement remains in the rendering area. Another challenge is high-speed filming, which can cause flickering or black artefacts. In those cases, we need to have testing during pre-production to test the appropriate shutter angle that can handle high-speed filming. And then we will inform the director to use this setting. Therefore, pre-production testing is important. If there are any challenging shots, it's best to communicate to us in advance rather than improvising on set. By knowing his requirements, we can have tests and provide reliable solutions before shooting to ensure a smooth filming process.

(myself):

It is important for him to notify you in advance, so everything can be smooth.

Evelyn Wu:

Yes, that's correct. So having meetings and aligning the requirements is important.

(myself):

Indeed. Let's move to the next section, which is the final one. What do you think about the future of this industry?

Evelyn Wu:

It depends on technological development. If it continues to develop well, specifically ICVFX it is tailored for filming purposes, it will replace some of the traditional filming requirements. This will enhance its commercial value and lead to positive growth. However, if the industry keeps rejecting it, the results are not getting better, and if the costs cannot be reduced, it is possible that it may become a fleeting trend. It is difficult to say.

(myself):

How do you see the market in China?

Evelyn Wu:

The local market still faces challenges, mainly because the film and television industry are not fully industrialized. It is difficult to use and maximize the potential of new technologies. Currently, the market is relatively complex, and there are a few individuals who have successfully implemented these technologies. There is also a limited number of people who are motivated to push this. It remains to be seen whether influential companies can drive this and inject fresh ideas and projects into the industry. If successful, it could lead to unique chemical reactions and positive developments.

(myself):

It seems that the current market's level of acceptance is not very high.

Evelyn Wu:

Yea, it is not high. Mainly because of the low acceptance from the film and TV industry.

(myself):

Do you think virtual production will completely replace green screens?

Evelyn Wu:

Possible. If game technology develops to a point where it can achieve real-time compositing with the same level of quality as the film industry, it is not impossible. Imagine shooting with green screens and having all the post-production effects processed on set in real-time. If the technology can reach that level of integration and effectiveness, it is indeed possible.

(myself):

It depends on how it develops?

Evelyn Wu:

Yes.

(myself):

Okay, moving. If we aim to achieve cinematic quality, what do you think are the main obstacles to achieving it?

Evelyn Wu:

The poor colour display of LED screens. Also, there are problems with industrialisation and coordination among various departments. When shooting with LED, the final result often looks artificial, and it is easily noticeable that LED screens were used. One of the reasons is the limited colour spectrum of LEDs. It only has RGB colours. This means that the captured footage lacks a three-dimensional feel and looks like a flat image. Low investment in asset production during pre-production leads to assets that don't appear realistic. When directors see such results on set, it is hard to convince them to use them. Because it fails to achieve the expected cinematic quality. To reach cinematic quality, high-quality asset production is needed, which means customizing assets for the project, continuously refining and adjusting them, and ensuring that the on-set hardware supports accurate colour reproduction and spatial perspective. Only when all these factors are perfectly done achieve cinematic quality, otherwise, the result will still look fake. However, this requires significant investment because producing high-quality assets comes with high costs.

(myself):

It has entered a loop.

Evelyn Wu:

What is the biggest requirement to create assets? You need to have excellent environment artists and individuals skilled in UE (Unreal Engine). However, those are working in the game industry, because that industry pays more than the film industry. So, their cost comes at a higher cost. Unless professionals from the film industry transition into the game industry, where the use of UE drives down prices and generates more high-quality results. So, it seems that we can only wait for it.

(myself):

Moving on, this is the 2nd last question. When recruiting talent, what skills and knowledge do you look for?

Evelyn Wu:

For recruiting talent, I believe it's important to assess their learning ability. Since this field is relatively new, it's not necessarily crucial for them to have a related educational background. Instead, what matters more is their overall capacity for learning and absorbing knowledge, as well as their opinion on this thing. These factors are more important.

(myself):

OK, we're nearing the end. Is there anything else you'd like to share or discuss before we finish?

Evelyn Wu:

I don't have anything particular to add. We've already covered quite a lot. I've been in this industry for almost seven years, from 2018 until now.

(myself):

Oh!

Evelyn Wu:

Yes, it has been quite a long time since, witnessed its gradual development into its current state. Hopefully, over these seven years, there will be significant leaps in its progress. Yes, it would be great to see a massive leap forward!

(myself):

Suddenly, I want to ask a question about AI. Does your team use AI? Or what is your view on AI?

Evelyn Wu:

AI, actually we have done some testing with AI. I think AI in virtual production, especially filmmaking, the most potential application is asset creation. But, up to now, it is still not fully realised. The current AI is mainly limited to two-dimensional applications. Three-dimensional asset production has still not yet been achieved. We have been conducting tests, but the results are not ideal. The application of AI in the virtual production process may not happen in a short time.

(myself):

OK, this is the end of the interview. Thank you.

Appendix B: In-Camera Visual Effects Related Terminologies

Throughout the history of live-action filmmaking and VFX, these applications have bestowed filmmakers with exceptional efficiency and creative latitude. As a result, a few terminologies have emerged to encapsulate this pioneering innovation, with designations like LED VP and on-set VP often used interchangeably (Perforce, 2023). Below are other terminologies that are worth mentioning.

Compositing

Compositing, an industry term, refers to the intricate process of seamlessly merging two or more distinct visual elements that have been created separately. These elements are skilfully layered together to culminate in the creation of a final, cohesive synthetic image (Prince, 2012).

Frustum

Figure 18 below shows a typical setup with an LED wall. The arrows indicate the inner frustum, which represents the field of view from the camera's perspective with its current lens focal length. As the physical camera moves within the volume, the area displayed in the inner frustum tracks with it, rendering exactly what the virtual camera should be capturing in the Unreal Engine environment.

Figure 18

A Typical Setup for ICVFX: LED wall with Camera View Frustum



Note Image courtesy of Unreal Engine (<https://docs.unrealengine.com/4.26/en-US/WorkingWithMedia/InCameraVFX/InCameraVFXOverview/>)

Non-destructive Asset

Incorporating precise management, non-destructive assets emerge as reusable digitalized resources that endure throughout the entire production continuum. Rooted in the inherent flexibility of digital software, these assets facilitate redundancy,

enabling duplication as a safeguard without obliterating the original iteration. This property ensures that assets remain traceable to their source without eradicating the initial version. Moreover, virtual scenes can be programmed to revert to their original state, both positionally and contextually. Beyond these advantages, digital assets can be readily expanded, upgraded, and re-textured to accommodate projects of varying scales over the long term. This inherent adaptability allows for more effective budgeting and scheduling throughout the production process.

Parallax

Parallax delineates the apparent shifts in the positions of two objects as perceived from divergent distances. An illustrative instance is observed while driving on a highway, where nearby objects exhibit rapid apparent movement, while objects in the distance display a relatively slower pace of motion.

Real-Time Game Engine

Presently, the market is predominantly dominated by two prominent game engines: Unity and Unreal Engine. Both of these engines are highly suitable for both indie and professional filmmakers, attributed to their freely accessible assets and the extensive support offered by their developer communities. Unreal Engine has gained significant traction among ICVFX filmmakers due to its adeptness in supporting high-fidelity, photorealistic 3D graphics. This preference is further bolstered by its robust software ecosystem and comprehensive collection of plugin packages.

The company behind Unreal Engine, Epic Games(1996), has taken measures to expand its ecosystem by not only acquiring but also developing software tools designed for various purposes. Examples of this expansion include RealityCapture, a tool tailored for 3D scanning, as well as 3Lateral and MetaHuman, both pivotal for digital human creation. Unreal Engine extends its reach beyond its confines by serving as a nexus that bridges other industry-standard Digital Content Creation (DCC) software, which includes but is not limited to, renowned tools such as Houdini (SideFX, 1996) and Maya (Autodesk, 1998). In the realm of ICVFX, Unreal Engine facilitates connections with projection mapping software like Disguise (CETP, 2000) and Notch, enabling the seamless display of scenes on the LED wall. Furthermore, the integration of real-time tracking solutions such as Vicon and OptiTrack enables real-time streaming directly into Unreal Engine, seamlessly integrating these technologies within a production workflow.

According to Green et al. (2014), “[o]ne key component of virtual production is the adoption of real-time graphic techniques on movie projects” (p. 304). Indeed, the essence of “real-time” is intrinsic to the capabilities of a game engine. In contemporary times, real-time game engines encompass functionalities that extend beyond real-time interaction, now encompassing real-time rendering, data streaming, file input/output, and even remote multi-user sessions. These multifaceted capabilities effectively transform the game engine into a creative hub, playing an

instrumental role across diverse domains, encompassing filmmaking, animation, and game development. One of the paramount significances is Unreal Engine's ability to provide photorealistic lighting and assets, positioning it as a foundational cornerstone for the creation of ICVFX.

Virtuality

Despite other socio-technical interpretations, the term “virtual” in this study refers to a CG environment that can provide an interactive experience (Chalmers, 2017; Gualeni & Vella, 2021). Its antonyms are “real”, “actual” and “physical” (Bery, 2008).

Virtual Cinematography

Virtual cinematography involves the emulation of a live-action filmmaking process encompassing elements such as cinematography, lighting and editing occurring in a virtual scene. Virtual cinematography empowers cinematographers to explore and compose and shoot as if the shooting is live-action (Kane, 2007). Virtual cinematography includes the following forms:

Virtual Camera

A virtual camera is a computer graphics camera in a 3D scene that emulates the functions of a physical camera, such as the lens and aperture.

Real-Time Camera Tracking

Real-time camera tracking means the position and movement of a physical camera are being recorded, digitalised, and transmitted as three-axis (X-axis, Y-axis, Z-axis) information to drive a CG camera inside a 3D digital scene.

Simulcam

The simulated camera or simulcam, first appeared as a tablet-like device during the production of *Avatar* (2009). Technically, it is a combination of a virtual camera and a real-time tracking system although the physical outlook is not a cinematography camera. Simulcam emerges from both real-world actors and sets with CG actors and sets while allowing the camera crew to evaluate the shot in real-time (Sargeant et al., 2021)

Volume

Volume refers to a designated physical area for motion capture with real-time tracking (Lewis, 2021; Okun & Zwerman, 2021).