

Academic



Innovation, Collaboration and Resilience

Photo by Will Case, Creative Technology

—— **Understanding the Virtual Production
Industry in the UK and China**

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EXECUTIVE SUMMARY

Global content production has been halted due to the COVID-19 outbreak, which may result in a "content desert" in film and episodic production [1]. While many organisations still have safety protocols in place due to the ongoing pandemic, a drastic decline in content production can cause organisational tension, thus, requiring a new approach to enhance their resilience. Virtual Production (VP) as a revolutionary tool is ramping up globally, which brings virtual effects to physical sets and makes production more flexible and cost-effective [2]. Therefore, the COVID-19 pandemic was a catalyst that helped underscore Virtual Production's value and facilitated its adoption [3]. The system with LED wall developed by Industrial Light and Magic in the production of *Mandalorian*, which garnered numerous awards in recognition for their innovative and standard-setting virtual production practices, has rapidly been adopted across the sector leading to significant skills shortages.

In a post-pandemic production environment, Virtual Production as a method of strengthening resilience, which has become a rapid growing area in content production with reducing costs and maximising freedom: firstly, VP can eliminate unnecessary travel and post-production expenses, which can reduce risks and save up to 60 % of the total budget [4]; secondly, VP makes some of the production processes to take place virtually, allowing creatives to work remotely and broadening opportunity for global collaboration [3]; additionally, VP is more sustainable, which might have been "130 times more effective" in

carbon footprint compared to on location shooting [4].

In the era of COVID-19, remote collaboration has become more prominent than ever. As the Virtual Production industry moves from early adoption to early majority in global creative industry [5], both the UK and China are experiencing a severe talent drought. UK-China collaboration should seize the strategic opportunity of the real-time technology and deepen the foundation of bilateral cooperation since the establishment of "Technology Innovation Partnership" in 2014[6]. The collaboration between the UK and China is conducive to jointly promoting the transformation and upgrading of film and television shooting methods, stimulating the creativity of content creators, strengthening upstream and downstream cooperation within the industry chain, and building a new ecosystem of win-win cooperation.

The "UK-China Research and Innovation Collaboration in Cloud-based Virtual Film Production" project is funded by the Arts and Humanities Research Council (AHRC, UK). The aim of the project is to explore and analyse how research and innovation collaboration between the UK and China in the virtual production industry currently works, how it could be implemented at its best, and how it could operate in the future. The project delivers a thorough market report to build a collaborative bridge in both academic and industry communities from the two countries. The focus is on the understanding of the virtual production industry in both the UK and China, identifying the key

opportunities and challenges of cross border coordination, and offering valuable strategies for the UK-China collaboration, building network in research and innovation including beneficiaries in both academic and industry communities from the two countries.

This report will analyse the difference and intersection between the two markets, identify the policy trends and barriers to overcome, and develop a new guidance and strategy for future collaboration in order to facilitate new collaborations that deliver sustained economic, cultural, and intellectual benefits in both countries. The report consists of five main chapters: chapter 1 will give a brief look at the

different understanding and application scenarios between China and the UK, which leads us to rethink the market motivation and development in two countries. Chapter 2 investigates technology innovation and respective strategies for strengthening resilience at organisational level between the UK and China. The following Chapter will evaluate the UK-China collaboration in the past and identify opportunities in future cooperation. Chapter 4 will discuss resilience development strategies in talent training and education. Chapter 5 will illustrate the completion and contribution of this project.



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METHODOLOGY

A qualitative analysis was primarily utilised in the report to gain first-hand information and experience from leading industry professionals. Specific methods of qualitative research chosen for this research were desk research, interviews, panel discussions and case studies. Adequate desk research was carried out, which not only helped us gain deeper industry understanding, but also prepared for upcoming interviews. Subsequently, 14 semi-structured interviews and 5 panel discussions with participants from the UK and China sides were conducted from April to October of 2022. All interviewees and panellists are company's founders, CEO and management leaders in innovation, business development and

international market. The design of the interview questionnaires was centred on four topics: market, technology, talent, and collaboration. Based on the previous key findings from the interviews, the five panel discussions covered various topics from the perspectives of technical providers, producers, talent trainers, and hardware/software suppliers. The panel discussions provided a deeper insight into technology development, resilience development strategy, international collaboration, and talent training. Case studies contributed a lot for understanding in depth how the leading companies innovate and change the landscape of the industry.

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Chapter I Rethink Virtual Production Technology and Industry

This chapter will give a brief look at the different understanding and application scenarios between China and the UK, which leads us to rethink the market motivation and development in both countries.

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1.1 Definitions of Virtual Production

The concept of Virtual Production is not new, and its roots extend further back to mid-20th century films like *North by Northwest* [7]. With the presence of *Machinima* in the 1990s, where filmmakers began to utilise real-time computer graphics engines and digital assets to create narrative films [8]. The concept of Virtual Production was not widely accepted in Hollywood until 2009 when *Avatar* achieved massive success [9]. In late 2019, the *Mandalorian* became the world's first movie to be virtually produced using LED wall technology, which achieved new heights in Virtual Production [1]. Virtual Production defines a set of new production practices where practitioners work in and interact directly with a virtual

set. VP reduces the need to move crews and equipment to location and enables remote working in Virtual Reality, reducing CVD-19 risks, the environmental footprint, production costs and upends the traditional production process by blurring the lines between production departments. The logical next step in the evolution of the discipline is to transition production in film, TV and broadcast media practices from those that are mainly facilities-bound to working environments that are cloud based remotely collaborative.

To date, media contents related industries have developed various explanations of what VP is and contexts of how it can be applied.

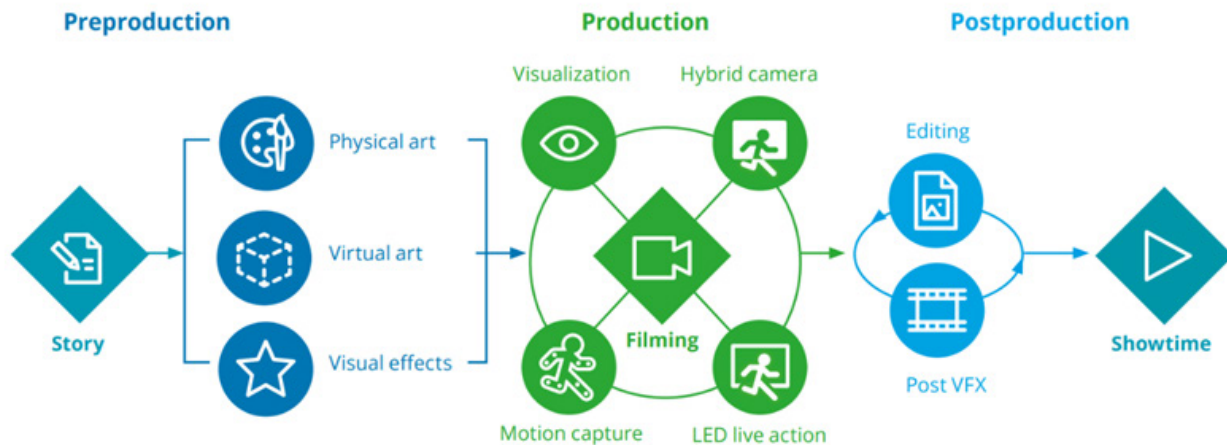
According to Deloitte's "The Future of Content Creation: Virtual Production"

report, VP as a tool of modern content creation, “It is an agile process characterized by starting VFX earlier and leveraging technology throughout the entire production life cycle to enhance the way content is created” [1]. Deloitte

“Virtual Production as a method that blends virtual worlds with real performers, real foreground sets and real objects to make everything appear as though it is in one space.” [11].

Different from Deloitte, Epic Games and

Figure 1. VP workflow defined by Deloitte



Source: Deloitte, *The future of content creation: Virtual Production* [1].

emphasises that Virtual Production lies in technology application, such as visualisation, motion capture, hybrid camera and LED live-action [1].

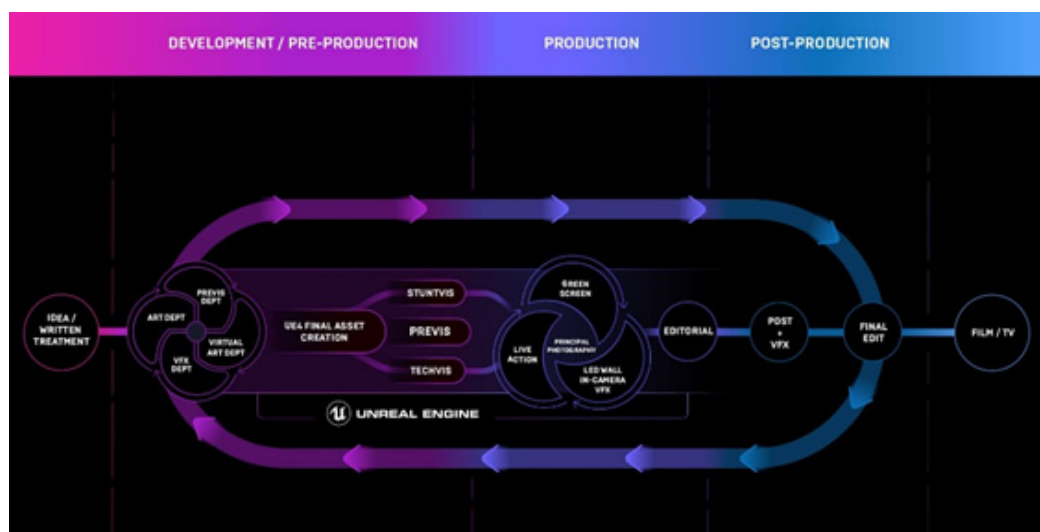
Epic Games defined VP as:

“a broad term referring to a spectrum of computer-aided production and visualization filmmaking methods.” [10].

In the same vein, a London based 3D-tech supplier, Target 3D defined VP as such:

Target 3D referred Virtual Production to a method or pipeline. With the help of real-time tools such as Unreal Engine, the traditional linear process can be turned into an iterative process in Virtual Production, blurring the boundaries between pre-production, production, and post-production, making the whole process smoother and more collaborative [10].

Figure 2. VP workflow defined by Epic Games



Source: Epic Games website [12].

StoryFutures Academy stated in their Immersive Skills Report 2021: “Fundamentally, Virtual Production ‘rolls up’ the previous linear Production process of film and television into a dynamic Production world, bringing together departments that had previously worked sequentially into simultaneous interaction.” [13].

A research team from the University of York, xR Stories, gave the latest definition: “In broad terms, Virtual Production is a way of making film and television which harnesses computer generated content allowing real-time visualisation and control of the digital environment in which you are shooting. Importantly, virtual environments are captured ‘in camera’, rather than added in post-production.” [14]. Combining the definitions from the consulting firm and technical providers, research organisations encapsulated the VP as a broad term in three dimensions: virtual asset creation, workflow management, and technologies usage. It is also noteworthy that the application of VP to film and television has been added to the definition by researchers, which differs from those of the past.

1.2 Redefine and Rethink

To summarise everything under the umbrella of Virtual Production, Chinese industry experts provided insightful interpretations from three dimensions considering different language contexts.

“ 虚拟拍摄 (Xu Ni Pai She) is a new tool. In the process of creation - shooting – post production, 虚拟拍摄 (Xu Ni Pai She) refers to the process in the second shooting stage. It is a production process that creates an immersive shooting environment through various mediums and techniques. 虚拟制片 (Xu Ni Zhi Pian) is a system that transforms a traditional linear process into an iterative process with the

help of real-time tools like Unreal Engine. 虚拟制作 (Xu Ni Zhi Zuo) is a narrower than 虚拟制片 (Xu Ni Zhi Pian), which includes pre-production virtual shooting plus post-production.”

—— Yi Chen, Founder of Timeaxis Digital Studios

Figure 3. Chinese definition of Virtual Production by Chinese industry professionals



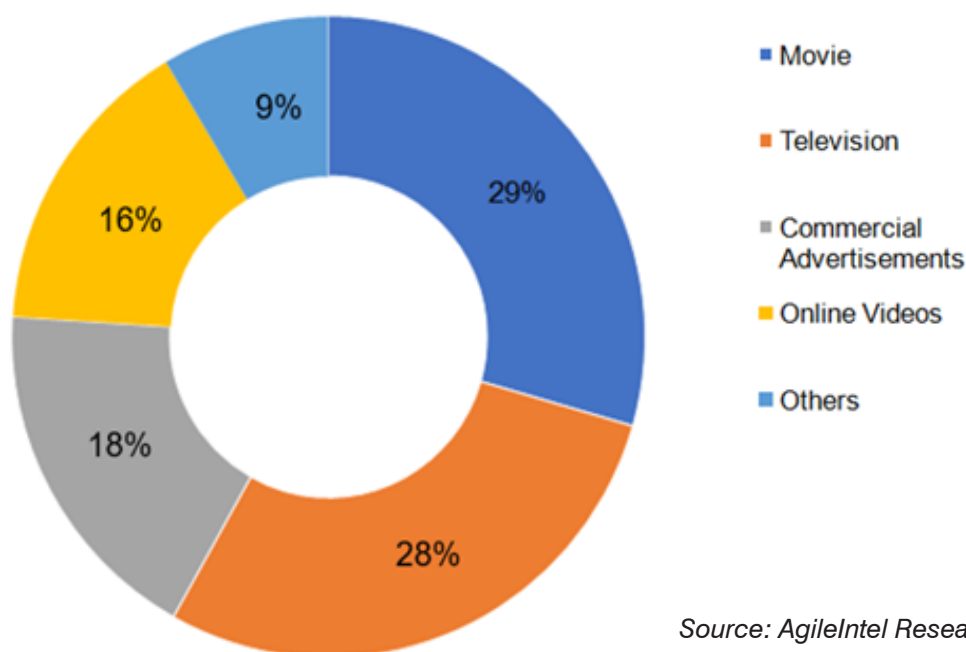
In brief, 虚拟制片 (Xu Ni Zhi Pian) emphasises the sequence and different stages of the entire process. 虚拟制作 (Xu Ni Zhi Zuo), refers to the development of a series of film production procedures and systems that are responsible for both the technical execution and the final outputs [15]. 虚拟拍摄 (Xu Ni Pai She), refers to the production process of creating immersive environments through the use of tools.

According to definitions from different perspectives, Virtual Production is a filmmaking method that combines virtual and physical world, which has been referred to as the new era of filmmaking [10]. Nevertheless, it is worth noting that the applications of VP are not exclusive to movies but are also being used in many other areas, such as TV series, commercial ads, live events, online videos, and others [16].

in the broadcast sector since the 80s. Live sports events and weather broadcasting were the first departments applying real time technology to create virtual environments (Richard S., interview. 2022, April 22; Michael G., interview. 2022, July 28).

“The idea of people being able to create virtual environments and integrate virtual environments with live footage has been

Figure 4. Global Virtual Production Market by End-User in 2021



In 2021, the movie segment dominated the global market with nearly a third share due to a substantial increase in movie production budgets and extensive VFX use. With the growing popularity of smart televisions, television was the second largest segment, accounting for 28% of the global VP market share. Commercial advertisements and online videos made up 18% and 16%, respectively [16].

In the UK, Virtual Production didn't appear overnight, in fact, it has come a long way

something that we've been doing for 30 plus years. We've been seeing it in broadcast journalism where they would shoot sports reports live with a green screen, then replace that green screen in real time with LED background.”
 — Richard Southern, Head of NCCA at Bournemouth University

“Broadcast in the 80s started to do real-time camera tracks, so very often using motion control systems, mechanical encoders, cranes, or tripods on wheels.

It was primarily for broadcast and having the weatherman in it first, and then later entirely green lit studios.”

—— Michael Geissler, CEO at Mo-sys Engineering

Compared to the UK, VP has entered China in the recent years, and firstly into the advertising industry. As a boosting machine for economic transformation, Chinese advertising industry is accelerating the integration of industry and digital technology [16]. The VP technology is suitable for piloting in the advertising industry with short production time and adequate budgets, and then expanding to other content production fields (Chuan H., panel discussion. 2022, October 9).

“Shanghai and Beijing are the centres of advertising production in Asia, and their production amount is quite large. Its cycle is short and its budget is sufficient, so it is naturally suitable to try something new. Some producers, directors, and producers have fully realised the benefits of the Virtual Production, propelling this new technology moving into the film and television industry.”

—— Chuan He, Co-Founder of Leading Digital Post

1.3 Conclusion

A brief look at the differences in definitions and application scenarios between China and the UK led us to explore the reasons behind phenomena and rethink the different impacts on the industry. Neatly defining the concept of Virtual Production is not easy even though it is not new. This is because Virtual Production is rapidly evolving in technology types, methods, usage, and application scenarios [14]. Despite the same technology, applications scope, and scenarios vary between countries, which attribute to different market characteristics and environments at macro and micro level. Moreover, no single technology exists or innovates in isolation, but rather the collective innovation of the industry chain. Those new understandings and differences between two countries have a great impact on this report. Firstly, it expands the research horizon; secondly, it helps us clarify the reasons for the different markets and development strategies between China and the UK; thirdly, it enables us to explore more possibilities for future UK-China collaboration.



Photo by Will Case, Creative Technology

Chapter II Innovation and Resilience Development

This chapter will demonstrate the technology innovation and respective strategies for strengthening resilience at organisational level in both the UK and China.



Photo by Will Case, Creative Technology

2.1 What innovations are made?

2.1.1 Application Scenarios

Globally, there is a wide range of applications for Virtual Production, which is not limited to film and TV, but also includes advertising, online videos, games, automotive, training, and simulation [17]. Looking at the UK and China markets, application scenarios differ considerably. UK Virtual Production market currently focuses on the film and TV sector, which is constantly working on technology and service development in existing markets. Compared to a market-driven UK business environment, the investor-driven Chinese market is

following a diversification strategy, entering a new market with new technologies and products [18]. VP applications in China focus on advertising, TV shows, cultural tourism, and live streaming. Due to the downturn in Chinese film industry, virtual film production is in its infancy and slowly developing (Yi C., panel discussion. 2022, October 10).

VP application in China is more democratized, which is expected to gradually move from the Business-side to the Customer-side, and the market competition will slowly polarize. Considering film production is complex and risky, other areas of low-end applications will become great opportunities for China (Ning X., panel

discussion. 2022, October, 10). From the point of view of resource endowment, China's short-form video industry has been growing rapidly since the 4G network became popular, and has given birth to platforms with hundreds of millions of users, such as TikTok and Kuaishou, which have established a strong influence in the mobile Internet era [19]. Moreover, the popularity of virtual engine technology has lowered the threshold of film and television creation, allowing everyone can produce their own creative work at home [20]. Therefore, the huge market demand and engine technology development will propel the innovation and development of VP technology from the professional high-end level to user-friendly low-end level (Chuanrong J., panel discussion. 2022, October 10).

2.1.2 Technology integration

Virtual Production combines the use of Virtual Reality (VR), Augmented Reality (AR), Computer-Generated Imagery (CGI), motion capture, camera tracking, and game engine technology with LED walls and intelligent lighting system, enabling creators to see their scenes unfold as they are composed and captured on set [21]. The blend of film production and game production technology, which further iterates the technical practice of content production and extends the application types and performance scenarios [20]. Game technologies are designed for speed and interactivity while film technologies are designed for quality. The convergence

between these two fields allows content creatives to generate images at the same frame rates as the footage is being captured. Real-time rendering technology that can generate images of a high quality can allow people to use straight away and then connect it with the events industry - which is producing giant LED panels for shop displays and live concerts (Richard S., interview. 2022, April 22). The rise of Cloud infrastructure enables teams to collaborate remotely and use real-time artifacts across geographically distant locations [22].

Virtual Production can be a gateway to the Metaverse, which is elevated to the next level when these two fields are combined [23]. Virtual Production requires the creation of many digital scenes, most of these scenes are structured in 3D, so that people can accumulate digital assets. When there are enough virtual assets and are ready to connect - a virtual world can be formed. As such, VP is an extension of the metaverse visualisation (Diankui

Z., interview. 2022, March 29). The blend of VP and the Metaverse has a great deal of potential in online games, live events, film, fashion, business [24]. Many UK firms are at the forefront of Virtual Production technology and are exploring metaverse experience enablement in an



The blend of VP and metaverse: Kaskade concert in Fortnite by Epic Games and Disguise. [25]

ever-changing technology landscape. For example, Disguise supported All Of It Now and Far Right Productions to achieve a fully-immersive concert experience for fans within Fortnite and Rocket League's [25].

2.1.3 Pipeline revolution

The traditional project pipeline is a highly linear path: Directors and cinematographers prepare storyboards and shot lists; actors shoot on location; and editors and VFX artists start work after filming. This one-way flow has followed a defined timeline of pre-production, production, and post-production, allowing filmmakers to rely on “fix-it-in-post” [10]. Now, Virtual Production is iterative and parallel, which reflects a more of an agile development model [10]. Overall, Virtual Production means what you see is what you get, which has blurred those defined lines by starting VFX in pre-production [11]. In this case, digital assets are available for planning and shooting, which means elements can be constantly changing and the final output more easily refined during production (Yi C., panel discussion. 2022, October 10). Contemporary Virtual Production closes the loop between the real and virtual (Richard S., interview. 2022, April 22), which means that it allows

real-world and digital platforms to be integrated using a game engine to create virtual environments as the film is being produced [26].

One of the big differences between traditional filmmaking, and film making in Virtual Production is massive data management (Stacia P., panel discussion. 2022, September 22). Digital assets are an important part of data management as Virtual Production involves creating many digital assets [27]. To streamline digital asset management and improve interdepartmental communication, Virtual Art Department was then created, which not only understands the VP process but also delivers camera-ready assets for production. Using real-time animation, Virtual Art Department bridges the gaps between traditional art departments and pre-visualization departments. By acting as a liaison between creatives and artists, Virtual Art Department ensures that all stakeholder feedback is incorporated into all the assets [28].

Figure 5. Virtual Production Workflow

Source: cgspectrum [26].



2.1.4 Business ecosystem

In recent years, Virtual Production has become a revolutionary tool in film and television technology to innovate collaboration methods and reshape the ecosystem [29]. With the rapid development of Cloud computing, XR, AI and other technologies, UK and China have begun to form a digitised and complete ecosystem, further enhancing the level of industrialisation of the film industry.

As a hotspot within the global VP market, the UK is renowned for its pioneering technologies, equipment manufacturing, and large-scale Virtual Production capacity. The UK infrastructure and ecosystem have been evolving to meet the expectations of the growing number of productions that are utilising Virtual Production technologies. Relying on world-class VFX supply chain, and agile innovation, and professional workforce, UK has been fast scaling VP production capacity in recent years. To date, there are

a total of 40 VP stages in the UK, ranking second in the world. The UK studio space expansion in 2021 added 1.5m sqft to the capacity [30], aiming to double its studio space throughout the country by 2025 [31]. See Table 2 in Appendices about primary LED stages in the UK.

In 2021, the Virtual Production market in China was estimated to reach more than US\$130 million [16]. Due to rapid market growth, Chinese filmmakers and creatives are increasingly adopting new technologies to reduce the costs of VFX (Chuan H., panel discussion. 2022, October 9). Therefore, the Chinese government is accelerating the policy, funds, and talent support of the immersive technology industry, propelling the hardware manufacturing, software development, content creation, LED volume studios services to a complete production chain, and accelerating the construction of Virtual Production industry clusters [32]. See Table 3 in Appendices about Primary LED stages in China.

Figure 6. Virtual Production industry chain in the UK

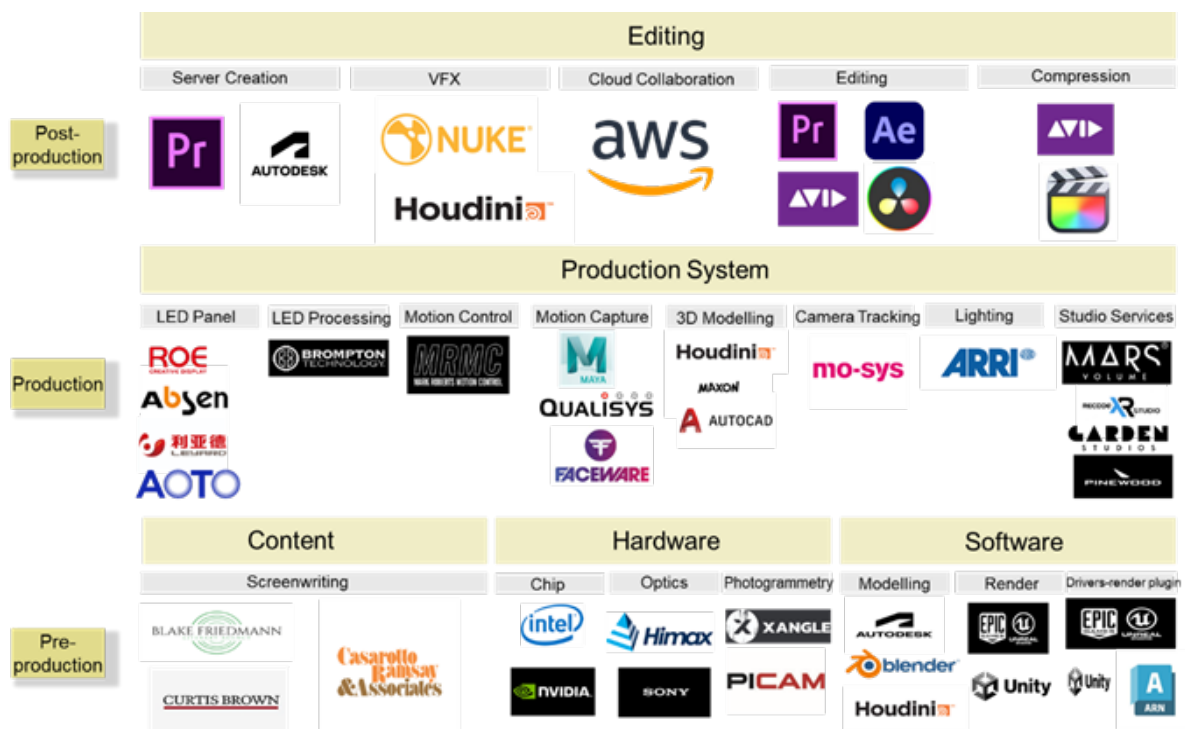


Figure 7. Virtual Production industry chain in China



2.1.5 Policy

In order to stay at the forefront of innovation, UK government has funded several R&D programmes to support creative and immersive technologies in recent years through UKRI. For example, CoStar, a £100M programme was launched in 2022 to establish a new national lab for Virtual Production technologies and three network labs for the screen sector [30]. To sustain growth the during a talent drought, UK government have added almost all artist and production roles in the VFX and animation industries to the Shortage Occupation List (SOL), which could mitigate the restrictions on workforce mobility after Brexit [33]. In terms of tax incentives, for all UK qualifying films of any budget level, the film production company can claim a payable cash rebate of up to 25% on UK qualifying expenditure [34].

To accelerate technological breakthroughs, the latest Chinese government documents the 14th Five-year Plan highlights innovation as the core of modern development. The government encourages film innovation by using cutting-edge film production technologies (e.g., virtual film production, Cloud production, AI film production, and computer animation) [35]. In 2022, Chinese government has released action plans, dedicated to establishing public service platforms in the field of immersive technologies, which provides technology test, data sharing, innovative start-up business support, talent training and other public services [32]. By doing so, China is gathering resources to accelerate technology innovation and improve synergy amongst upstream and downstream companies of the industry chain.

2.1.6 Talent training and education

With the expected growth in the next 6 years, Virtual Production is experiencing a significant bottleneck of talent, resources and deep knowledge (Vincent S., panel discussion. 2022, September, 22). To fill the skills gap and address the lack of knowledge within the thriving VP industry, individual companies, training schools, universities and government agencies have been closely collaborated to provide various short-term courses and degrees. Apart from funded by sufficient market capital (Michael, M., panel discussion. 2022, September 28), companies and individual schools are able to quickly modify and launch courses that help students understand the VP workflow and provide them with job-ready skills and placement opportunities (Jon W., interview. 2022, June 27). Companies and training schools tend to offer hands-on training through small group activities by seasoned tutors with a portfolio of industry work spanning years of knowledge.

Universities and colleges, as main suppliers of the industry's next generation of creative and technical talents, are attempting to design and launch VP-related courses. Compared to other training intuitions, most of universities and colleges are unlikely to quickly respond to ever-changing market and technology, because they are constrained by being an institution with degree awarding powers (Richard S., interview. 2022, April 22). Moreover, as VP is at early stage and constantly evolving and rapidly changing, no one truly understands all the aspects of VP. People only know an ever-changing technology through practice and production (Rehan Z., interview. 2022, May 16). Nowadays, more and more higher education institutions are working closely with industry as a production partner, an example of academic-industry

coproduction is Final Pixel Academy and the University of Greenwich (Chris N., panel discussion. 2022, September 28). See Table 1 in Appendices about VP-related coursed in the UK.

2.2 Who are innovators?

DNEG

As a global leading visual effects and animation studios for feature film and television, DNEG has over 20 years of industry experiences and have won seven Academy Awards for 'Best VFX' in recent years [36]. As a provider of bespoke virtual production solutions, DNEG simplifies the processes and tools so directors, producers, and crew can better understand how to use them [37]. In addition to technical services, they also provide consulting services for solutions (Guanglei J., interview, 2022, May 13). Their end-to-end approach services is designed to customise the entire digital production of the project with an experienced team [37].

Localize the business model and strategy entering China's market

Interviewee: Guanglei Jia—Director of Business Development at DNEG

- In 2012, the film market in China was booming and the film and television industry developed well. The film and television market breaks the box office record of the previous year and works of various themes are also quite popular. China is not short of funds but production experiences which should be learned from cooperations.
- We are doing better and better in China, more and more Chinese film-makers are coming to us. In China, we need to understand government policies. Whether it is the central or local government, or

some supportive and financial policies, we need to make a balance before deciding how to conduct business expansion in China.

- The UK may have surpassed other countries in terms of Virtual Production, even the United States. The UK has a lot of experience in post-production and many technologies in the early stage. There are a lot of research and development began in the UK. The visible and invisible output value of related industries brought by the British film industry are very large. If there is a bridge between China and the UK, the Chinese firms could easily import pioneering technology from the UK, the whole Virtual Production industry in the UK may have hundreds of billions, which can provide employment for hundreds of thousands of people. Entering China's market, we adjusted our strategy by offering consulting service of technical solution and post-production experiences first to bridge the two countries.

Mo-sys

Mo-Sys is an award-winning manufacturer of Virtual Production solutions, Virtual Production training, camera tracking, image robotics and remote production for film, HETV & Broadcast [38]. As a technical innovator, Mo-sys stands out from competitive markets by constantly identifying what is needed and making adjustments as needed (Michael G., interview. 2022, July 28). They are working in a highly innovative way in workflow innovation, product optimisation, and training offerings to match the ever-changing needs from clients.

Virtual Production will happen much more in even office spaces

Interviewee: Michael Geissler—CEO of Mo-sys

- Virtual Production promised lower costs and higher quality of production, but at the moment, it's not doing so. It's going the wrong way, as there are still people investing in crazily large LED Volumes, and that will soon be a thing of the past. Everybody thinks it needs to be bigger and bigger, which is wrong because nobody can afford it. It's crazy, and it's damaging the reputation of Virtual Production. What's happening is "Virtual Production 3.0." which means we're having a smarter Virtual Production happening now, not with unaffordable large LED Volumes.

- In the future we will have different stages. Let's say corporate stages, which could be a green screen, or educational stages with the green screen that are much cheaper. If you know what you're doing, you can achieve amazing quality. The strength of Virtual Production is where there are budget limitations. You will always go to the real location if you have an unlimited budget.

- The interesting part is the users. What we're now experiencing is that there are a lot of people who want to use or get into Virtual Production. And at the moment they're held back, because it's still very, very expensive, but the market is opening. Virtual Production was initially in studios, and now it will happen much more in even office spaces. Universities and creative companies that want to demonstrate to their customers and win customers by demonstrating Virtual Production scenes. You can do this from an office space today.

- There are a lot of universities under real pressure right now that are fighting for film students who want to go somewhere with Virtual Production skills. What we now do with universities is supply three things:

we have our own curriculum; we train the trainers, and the teachers; and we supply the equipment. We don't want to do this course remotely, but we are interested in finding partners where we can scale.

Epic Games

Unreal Engine from Epic Games is one of the most popular engines, with more than 2 million games made by it [39]. Unreal Engine dominates in the rendering market and is differentiated from other competitors by offering the world's most open and advanced real-time 3D creation tool for photoreal visuals and immersive experiences [40]. To maintain its leadership position in the market, Epic Games is constantly innovating in terms of technology and products. The latest Unreal Engine 5 is dedicated to help developers build next-generation games, digital films, and the initial outposts of the metaverse [41].

Virtual Production producer roles are becoming increasingly in demand with the industry rapidly evolving

Interviewee: Nancy Xu—Virtual Production Producer at Epic Games

- The role of a Virtual Production (VP) producer involves three main areas of responsibility. Firstly, the producer is responsible for crewing the right team with the right skill sets and personalities to work together effectively. The producer must also understand the number of people needed and the range of specialised skill sets required to complete a project. In VP a number of new specialisations are needed and this needs to be reflected in the crewing. Secondly, the producer is responsible for scheduling, which involves mapping out the journey, the process, setting clear milestones, and keeping the client and

team accountable. The pipeline in VFX is clearer and more linear, in VP (real time workflows), everything can change until the last minute so this is harder to nail down. Thirdly, the producer is responsible for budgeting. In VP, the producer is often dealing with on set production costs in addition to content delivery.

- Pipeline is one of biggest VP innovations. In a VFX process, the workflow is usually specified by the VFX supe and designed/implemented by the CG supe. The asset & shot pipeline for content production is usually a multi-year process to build, it needs to be robust & can scale to large productions. VP has the additional part of real time content management to the wall. There are also many other new parts in a VP volume that is directed by the VP supe, that usually comes down to how we are approaching the shot (what's in CG, what's practical, what will be handled by volume lighting vs physical lighting). There are also brain bar operators that have knowledge across the stage's signal chain, colour management, device sync etc to get this beast of a system up and running.

- There are several ways to fill in the skills shortage in the VP industry. Firstly, it's amazing to have support and funding from the government. Secondly, looking at longer term we target the educational facilities. Thirdly, the industry can bring in mentors and offer masterclasses to help people gain expertise in the field and gain confidence in the technology.

ARRI

ARRI is a leading designer and manufacturer of camera and lighting systems for the film, broadcast, and media industries, with a worldwide distribution and service network. Along with offering exclusive technologies, ARRI Rental's first-

class services and equipment provide camera, lighting, and grip packages to professional productions around the world. ARRI Solutions offers high-quality virtual and traditional production infrastructure solutions and efficient, integrated workflows to a broad range of studio operators, producers, and enterprises [42]. ARRI Academy offers a wide range of multi-day training courses, individual sessions and educational events in different countries and languages worldwide [43].

Adopting policies to facilitate China's increased collaboration and international engagement is crucial

Interviewees: David Levy—Director, Business Development, Global Solutions at ARRI

Tiger Kang—China Sales and Marketing Director at ARRI

- We went from mechanical to digital, and it was our job to work as a trusted tool maker with the customers. We go on the journey with them, and we work with that transition of education in changing their approach to how they produce content. We want to work globally with each other. We want as many people to understand and utilize this technology as possible because it just means that more content and more stories are being told.

- ARRI has become a technology supplier to Tencent. We assisted them in enhancing their system and became a consulting partner for the duration of the project. The transformation from hardware to software is straightforward. The crucial component, however, is the skilled trainer. Our obligation as an institution is to accelerate the development of local talent, so we want to discover and create a solution to improve Virtual Production development.

- In terms of talents, we want to provide universities and the academic community with the resources and information necessary to educate future generations of filmmakers, storytellers, Virtual Production professionals, and all of these other individuals. A benefit of this workflow technology is that these positions are professional, well-paid, and creative. They are professions. Because these occupations are creative, humanitarian, culturally sensitive, and long-lasting, they are not particularly susceptible to AI replacement.

- I would suggest government and private investment, not only monetary investment but also investment of time, resources, and people. Collaboration and communication are critical. The key to this is an investment at the local, national, and federal levels. Establishing relationships between individuals who are engaged is essential to its success and growth.

Creative Technology

Creative Technology is the world's premier provider of outsourced technology, staging and production services to event organisers and content creators. Creative Technology provides innovative technological solutions to host and stream cutting-edge, fully interactive virtual or remote events. They also provide a seamless and fully integrated creative service with guaranteed delivery from supporting the concept development to making the content[44]. In 2021, Creative Technology partnered with ARRI, opening one of the biggest permanent mixed reality production spaces in Europe [45].

The transition from normal production to Virtual Production is difficult

Interviewee: Tom Burford—Head of Technical Services at Creative Technology

- It is a complex subject. We are still learning. We are still making it up. It's such a difficult transition. The only way virtual production can make it work, from a production point of view, is if you can achieve lots of shots in the same period, therefore lowering the effective cost per shot. If you can get the efficiencies of that working, then it makes sense. The problem with that is that you have to start planning. You need to know exactly what the environments are. I think the danger of using real-time rendering engines is that people are told on the promise that you get absolute flexibility and can change things right up until the last minute. There is disastrous Virtual Production experience. That is because people are approaching it in the wrong way, not allocating the appropriate amount of pre-production time or giving the process the appropriate amount of respect.

- Understanding how that LED screen works as a light source within the space is the first thing, and then you could start pointing a camera at a screen and then attempt to tie in a foreground background element. Lighting, or light control, is probably the biggest first step in Virtual Production. The second thing that becomes a problem is depth focus, handling a subject versus your background elements. Those are the two things that we want to mitigate.

- You can learn the theory of how to build an Unreal level or how to take a video file and play it on the screen. But the hands-on experience is an important part of that. We have been thinking a lot more about how to engage with universities and educational facilities about getting people practical experience. It's always a tricky conversation, because it's always that it's a commercial stage. It needs to be the viable control project versus actually we need to think of the future, and we need to

be getting more people skilled up. Hence, it's a balancing act.

National Film and Television School

As the leading centre for education in film and television programme making, National Film and Television School launched a new part-time course—Virtual Production (Filmmaking with real-time technologies) in accordance with market changes. This course in partnership with leading companies in the industry, which offers theoretical and practical experience to students who desire to upskill and work in the thriving VP industry[46]. NFTS also actively develops international cooperation, broadens the education market, and accelerates close cooperation between industry and academia.

To have a course that can work with all the other courses would be really valuable

Interviewee: Jon Wardle—Director at National Film & Television School

- Regarding teaching and educating Virtual Production, the biggest challenge is how you bring them together for this new approach—to take separate disciplines in visual effects, games, production design, directing, and cinematography—and bring them together to do collaborative projects as part of the curriculum. That's definitely a very real challenge. NFTS is quite fortunate to have all those disciplines, and we teach all of those specializations. But the students who have traditionally been taught Unreal or Unity want to make games. They don't want to make films or TV. They came to the NFTS to make their own games. So we need to think about how we give greater access to Unreal or Unity skills development so that we are not relying entirely on the game students to drive that activity.

- The other challenges in this world are that, once the virtual art department is set up, they have to negotiate with a real developer. And often, right now, one of the challenges is that those people tend to come from a gaming background, not a film background. And they place less emphasis on things that we would see as important in the film. In games, they're happy to bend and break those rules. In films, you can't really do that.

- The third challenge is the time it takes to do all the pre-production before you can go on stage and shoot anything. In this scenario of Virtual Production, you have to be writing the script; you have to have written the script and developed it sufficiently in advance so that you can create a window to create all the unreal assets before you go on a stage. Most films aren't organized enough to do that. They're writing the script, right up until the point of shooting. That's a problem if you need to create a lot of very expensive assets in Unreal. So, a lot of it comes down to the production process, etiquette, and collaboration.

- There are three things we're doing. One is the specialist course in this area, which is for people who are already working and is a part-time course that they do alongside their work. And then we're also trying to create workshops that embed in our existing courses, production, design, cinematography, games, and directing. All have moments in their courses where they work with the technology, explore, and experiment. The third thing we're doing is looking at expanding our course footprint to embrace two or three new areas. One is real-time animation. What we might have is a course in real-time animation. That's something we've been exploring because that technology is now fundamental to lots of things. So, to have a course that can work with all the other courses would

be really valuable. And the other one we're actively looking at is the Virtual Art Department Course.

UK-China Film Collab

The UK-China Film Collab is an independent non-profit organisation set up to inspire and invent film related collaboration and cutting-edge debate between the UK and Greater China [47].

Talent is not lacking but screenplays are severely deficient

Interviewee: Hiu Man Chan—Director at UK-China Film Collab; Lecturer in Creative & Cultural Industries at De Montfort University

- There has always been a need to collaborate with the UK. The UK has been providing services to Hollywood since World War II, and it has amassed a wealth of knowledge and skill. This year's Oscar nominees include all the brilliance behind the scenes, with the majority of the winners are British or British-born. As a result, there are prospects for Virtual Production, particularly via collaboration between China and the UK. The most pressing issue that must be addressed right now is not a technological one. For many years, beginning in 2015, it has been seen that what is currently missing is a screenplay.

- The cooperation between China and the UK is very important. Although it has been difficult to promote in the past few years and it is not clear yet, it is very important for the next stage of the development of China's film industry. But how to cooperate also needs to be discussed. For example, there are many talents and experiences in the UK that can be exported. It is not necessarily a creative cooperation -- it could be a consultative cooperation for a

Chinese blockbuster. For example, DNEG provided post-service for "Eight Hundred", and such exploration has begun.

- For the UK, a new wave is urgently needed to make UK films independent from Hollywood's influence and highlight British identity. Due to a severe shortage of scripts, it would be beneficial for the UK and China to cooperate on screenplays, as the traditions of British films and Chinese films are very similar, particularly in ordinary people. For example, many British people and their fathers or grandfathers were born in Shanghai. So, the connection between Britain and Shanghai is very meaningful.

Mirror Pictures

Mirror Pictures is a platform operating company with film and television technology as its core competitiveness. In line with the concept of "sharing", Mirror Pictures has created a "film and television technology + cultural and creative" platform—the M-Station, a shared space for film and television technology in Pudong International Film and Television Industry Park [48].

Using the cloud as a key application scenario in film production is an unavoidable development

Interviewee: Chuanrong Jiang—CEO of Mirror Pictures technology co., Ltd

- Applying cloud to the film and television industry, there are four primary features. The first is the combination of low latency and high bandwidth. Real-time transmission is high-bandwidth transmission. The second is endless storage. The third is supercomputer processing power. Security is the fourth core. In comparison to the present Internet age, many areas of the Internet,

like gaming, are now controlled by their own hosts. Some high-quality games are clearly downloaded from their own machines for control. In terms of the film and television industries, in reality, they are extremely compatible with the four qualities. For starters, with the digitalization of our film and television industries, the data capacity of standard definition, high definition, 2K, 4K, and even 8K is quite huge, necessitating extremely fast transmission rates. The last consideration is security. Film and television place a high value on intellectual property, with protection being the most crucial. Its security, particularly throughout the transmission process, will be critical. As a result, using the cloud as a key application scenario in film production is an unavoidable development.

- Creativity is required in film creation. Because production offers cloud-based possibilities, it has a direct impact on the early stages of entrepreneurship. Its length will be increased both upstream and downstream. The film video is a lengthy industrial chain. There are also upstream and downstream ends, as well as creative and extended product ends, including distribution and extended product ends, so the whole upstream and downstream will expand out. Because of cloud production, there are higher capabilities, more choices, and a shorter time commitment in the creative process. like Virtual Production, may shorten the production cycle and be backed by the cloud, making it more convenient. The artist's creativity will be unrestricted, and they will be able to fully express their limitless ideas. This returns to the origins of film making and allows for more liberated expression. This kind of concept may be realized via controlled production. The cloud may also be used to enhance the product experience, including scene experience, immersive experience, various

types of on-line and off-line experiences, and numerous extensions supported by different clouds. As a result, from the standpoint of the complete industry chain of cinema, television, cultural, and creative sectors, it gives a better orientation for future growth.

- An online management system must be used in the Cloud in order to generate content there, in addition to virtualizing clips and processing sound there as well. Each employee functions as the present command system and is capable of direct point-to-point communication. The production management method also reflects this. Direct communication between the director and each individual who does the rendering, synthesis, or editing is possible. The director demands that each feedback's development be meticulously documented and made searchable in the records. According to the producer's judgment, it will manage its development, regulate its expenses, and carry out proper quality control. Finally, there is a director system for quality control and artwork control. As a result, it involves the administration of two systems: the director system for creative creation and the production management system for cost control. The two systems are merged into a single piece of software and handled in this manner, with information radiating to each branch and direct creator.

2.3 How to keep innovative to help the industry sustain resilience?

2.3.1 Cloud-based platform establishment and sharing

Cloud technology is a cornerstone for future content production. For Virtual Production to be widely adopted and used, it must be based on the Cloud platforms (Ning X., panel discussion. 2022, October 10). Cloud-based platforms

enable to make content production and distribution of film and TV become more efficient and reliable, relying on the features of Cloud technology — low latency and high bandwidth, unlimited storage, strong computing power, security (Chuanrong J., interview. 2022, March 29). For example, Cloud operation is useful for intellectual production, such as collaborative asset creation, which allows numerous individuals to edit the same document simultaneously. There are more pre-processing jobs that may be accomplished by spreading computation to the Cloud (Richard S., interview. 2022, April 22). With growing demand for real-time interactive media grows, Cloud computing can not only be applied to film making (Rehan Z., interview. 2022, May 16), but also to variety show, animation, live stream, etc [22]. Therefore, Cloud-based platforms are driving the rapid growth of Virtual Production, which can meet the needs for strong computing power, remote collaboration, and asset management in content production sector.

2.3.2 Innovation and breakthrough of content

Despite the proliferation of immersive technologies, content innovation is the core of technology development (Yi C., panel discussion. 2022, October 10), to achieve content breakthrough, technology has to integrate with following aspects. Creative storytelling: In the era of “Content is King”, success has always been a result of partnering with creatives to tell the story by building the tools (David, interview. 2022, June 1). Both China and the UK are eager to produce influential works to open up the domestic and international markets, leading the film industry as a centre of excellence. Digital assets sharing: Creatives can utilize existing digital assets libraries rather than having to create assets from scratch [49]. For example, the Epic marketplace is a platform that

allow developers and artists to share or sell assets online (Rehan Z., interview. 2022, May 16). Remote production: The development of technology has made it possible for filmmakers to build up their decentralized teams and create virtual content no matter where they are located (Rehan Z., interview. 2022, May 16). China and the UK are highly complementary in hardware and software facilities, natural and cultural resources, and professional talent supply, which is suitable for remote shooting and production.

2.3.3 Strategies for enhancing resilience in the UK

Resolve technical defects

Technical problems exist that hinder the development and popularity of Virtual Production. Primary technical issues that production crews are facing on set include light contamination, focus issues, and timing skew (Tom B., interview. 2022, June 30). Moreover, filmmakers are not able to get camera tracking data if they are using a traditional film camera, which limits the directors to that classic film look (Gavin R., panel discussion. 2022, September 12). As such, the optimisation of lighting, camera and stage are crucial because a rapid development of the industry lies in technology as a key productive force.

Increase attention on APEC markets

Although Hollywood will continue to lead the global Virtual Production market in the coming years, the Asia Pacific market is becoming to be the fastest growing segment, which is expected to reach the highest CAGR of over 19% by 2029 [16]. Virtual Production technologies are increasingly being used by countries such as China, India, Australia, Japan, and South Korea, which are expected to provide a substantial amount of future growth for the industry [16]. Particularly,

the interdependent technologies and resources between China and the UK have laid a solid foundation for the cooperation amongst upstream and downstream of the industry chain.

Diversify application scenarios

From the global market view, the film and television series segments made up the largest market share since 2020 and are expected to continue to dominate the market in the following years. Driven by huge demand, commercial ads are becoming a significant part of future market size growth. Over the next few years, the increasing transition of movies from cinema halls to Over the Top platforms (OTT) and online video platforms, which are expected to drive market growth [50]. Virtual Production can also be applied to many other fields, such as mental health, heritage tourism, medical applications (Martin M., panel discussion. 2022, October 19). Hence, diverse application scenarios provide Virtual Production solution providers with many revenue generation opportunities.

Accelerate talent training and education

There is a huge demand for skills training and education to maintain a steady supply of talent from all backgrounds. As the VP technology are rapidly evolving, it is essential that information and expertise can be shared to train the next generation [51]. Compared with the Degree courses in universities, the short-term courses offered by training schools and individual companies are more flexible and practical-oriented, which work closely with industry cooperation. A few of them even have degree power, making it more competitive in the training market. As the studio time is extremely expensive, companies expect students to have a good understand of the workflow and grasp job-ready skills from relevant project experience so that

they can get into the swing on set (Martin M., panel discussion. 2022, October 19).

2.3.4 Strategies for enhancing resilience in China

Diversify the application scenarios

As more traditional manufacturing companies, fast-moving consumer goods (FMCG) companies, and fashion companies are taking advantage of XR and other Virtual Production technologies to create short videos and medium-length ads, those industries will drastically stimulate the Chinese Virtual Production market. Despite the slump of the film industry, user-oriented new media sectors such as digital human, cultural tourism, fashion, and metaverse, are expected to become the most promising application segments due to its strong manufacturing capabilities and rapidly growing Internet economy (Ning X. panel discussion. 2022, October, 10).

Forge relationships across the UK and Europe

Virtual Production technology has made waves in the UK and European film and TV industry. The UK is developing the global standard to ensure the UK becomes a global centre of excellence for the next generation Film and TV industry [30]. Europe Virtual Production Market is estimated to grow at a CAGR of 14.1% from 2020 to 2026 [50]. Both the UK and Europe have highly skilled and adaptable workforce, rapidly growing VP stage capacity, pioneering techniques, rich historical and natural heritage for screen storytelling. Consequently, international collaboration will offer opportunities for China to expand its market, increase the competency and access and share talent with other countries.

Enhance the integration of content creativity and technology

In the era of “Content is King”, the ultimate goal of all creatives and marketers is to create fascinating content. Content innovation is the essence of Virtual Production development, which aims to deliver creative content by taking advantage of various technical mediums (Yi C., panel discussion. 2022, October 10). VP technology has not only brought about revolutionary changes in filmmaking technologies, but also propelled the innovation of script creation and narrative methods (Hui Man C., interview.2022, April 28). Nowadays, China is lacking an extremely successful and influential film in global market, which requires a stronger integration of content creativity and technology (Guanglei J., interview. 2022, May 13).

Improve innovation and collaboration in 5G Cloud technology

Information and communication technology has become a key factor in remote collaboration and industrialisation of the film industry. The number of 5G Chinese mobile network sites accounted for 70% of the global sites, reaching 2,102,000 in 2022 [22]. As China's 5G network deployment reaches global leadership with a huge new media market, Virtual Production development should be anchored in the Cloud, which can be a key competitive advantage for China (Ning X., panel discussion. 2022, October 10). The integration of content and technology enables industry chain stakeholders to improve the industrialised standard system of the film and television industry through high-bandwidth transmission networks, broadening the opportunities of cross-border collaboration and production [22].

Develop talent training and education

The Chinese screen sector is currently facing unprecedented demand for Virtual Production talent at all levels, especially technical artists and Unreal Engine developers (Diankui Z., interview. 2022, March 29). Compared to the UK, VP talent training and education in China is at an early stage. Higher education resources in China are excellent and abundant, unfortunately, they are not being fully tapped at present (Ning X., panel discussion. 2022, October 10). Similar to UK practitioners, Chinese practitioners expect students to understand the entire workflow, strengthen interdepartmental communication skills, and master job-ready skills (Chuanrong J., interview.

2.4 Conclusion

This chapter identifies VP innovations in terms of application scenarios, technology integration, workflow, business ecosystem, policy, and talent education, and illustrates industry focus and first-hand industry information by listing Q&A interviews from leading companies and school in both the UK and China. A detailed description of the characteristics of the Virtual Production markets between China and the UK is further examined. Based on different market characteristics, strategies are proposed in both China and the UK to enhance resilience. By implementing those sustainable business practices, companies may become more resilient, helping them avoid crises and cope positively with unexpected situations.



Photo by Will Case, Creative Technology

Chapter III Collaboration and Resilience Development - The Past and Future of UK-China Collaboration

This chapter will evaluate key barriers and successful cases from the UK-China collaboration in the past and explore opportunities in future collaboration in the film industry.



Photo by Will Case, Creative Technology

3.1 Collaboration barriers

3.1.1 Impact of Covid-19

There has been a devastating impact on the global film and television industries due to the Covid-19 pandemic (Guanglei J., interview, 2022, May 13). According to a report by Creative UK Group, the UK film, TV, radio, and photography industries have lost nearly £2.6 billion in gross value added (GVA) during the pandemic [52]. This was due to the long-term lockdown, cinemas across China have been ceased operations, the box office loss was expected to exceed £3.5 billion in 2022 [53]. Moreover, the advent of the COVID-19 outbreak has significantly disrupted film collaboration between the UK and China. Due to travel

restrictions and quarantine measures, film collaboration over the last couple of years has drastically slowed down, especially in co-productions that requires shooting in both countries [54].

3.1.2. Policy and regulation issues

The policy is one of the biggest risks for UK investors to consider when making business decisions (Richard, S., interview, 2022, April 22). Firstly, foreign companies are prohibited from holding more than 49% ownership of a registered company in China (Guanglei J., interview, 2022, May 13). Moreover, China has no film-rating system, meanwhile enforcing one of the strictest censorship regimes in the world. Co-produced films must be reviewed by various institutions and adapted accordingly to match the political,

social, and cultural needs of the Chinese government. Additionally, there is no guarantee that the film will eventually get screened in cinemas [55]. Additionally, the risk of intellectual property theft hedges against the potential bridge between collaborators, which also creates complicated legal problems for governments of both countries [56]. Lastly, the growing geo-political tension which may potentially dampen bilateral relations and collaborations including this industry.

3.1.3 Different market focus

The UK film industry has close ties with Hollywood and European market. The UK has become one of the most important suppliers of Hollywood with a wide range of production elements including actors, equipment, studios, and technologies (Hiu Man C., interview. 2022, April 28). The British Film Commission and the Spanish Film Commission signed a Memorandum of Understanding in October 2021 to support high-end film and television productions on both sides [57]. By contrast, apart from hardware manufacturing, China is less advantaged in expanding its international footprint in the global VP market. While the VP application in film industry in China is struggling to take off, other application scenarios such as new media, tourism are thriving quite rapidly (Ning X., panel discussion. 2022, October 10).

3.2 What can we learn from the previous collaboration pattern?

In terms of China-UK cooperation, technology and resources are highly complementary between two countries, which provides a strong base to deepen bilateral collaboration mechanism [7]. Co-produced productions only require foreign companies to pay 10% of income tax and are free from custom duties in China

[58]. In 2015, the UK and China signed a co-production treaty to inaugurate an era of film collaboration. UK/China: Film Co-Production Agreement not only exempted import and export duties and other taxes but also lifted any quota restrictions that would apply to the import, distribution, or exhibition of the film. This means that a China-UK coproduced film will be exempted from the quota system that only 34 films can be imported from abroad every year [59]. In 2017 UK and China signed jointly agreed strategy to boost science and innovation between the UK and China by innovation platforms establishment, mutual access to research infrastructure, open access to data, intellectual property rights protection and application, etc [7].

UK-China film collaboration has steadily progressed since the golden era of UK-China relations. In April 2015, Shaun the Sheep launched a charity run as part of a series of programs for the 2015 UK-China Year of Cultural Exchange. Over 20 Chinese films and television dramas were shown during prime time on Prospero TV from September to December 2015 [60]. In spite of the epidemic, UK-China film collaboration has not been completely hampered by travel restrictions. The UK-based shooting — UNTAMED, a first official China-UK co-produced film to be shot since the outbreak of the COVID-19 pandemic. This is also part of the “Collaborative China” section in the “All Under One Moon 2021” online campaign presented by the China National Tourist Office, London [61]. Other co-produced films made by the UK and China, including a BBC Earth Documentary (Earth: One Amazing Day, 2016), a UK-PRC-US Jackie Chan movie (The Foreigner, 2017) and a Northern Irish-Chinese comedy (Special Couple, 2019) [54].

The UK and China's cooperation is very essential (Hiu Man C., interview.2022,

May 13). For UK, a new wave is urgently needed to make UK films independent from Hollywood's influence and highlight British identity. Due to a severe shortage of scripts, it would be beneficial for the UK and China to cooperate on scripts, as the traditions of British films and Chinese films are very similar, particularly in ordinary people. For example, Agent Bean goes up against international assassins hunting down Chinese Premier Xiang Ping in movie Johnny English Reborn. This story shows a good tie of UK-China relations and has never occurred in Hollywood history (Hui Man C., interview.2022, April 28).

3.3 Future UK-China collaboration—how to strengthen resilience?

3.3.1 Policymaker perspective

The UK and China governments should optimise the bilateral collaboration mechanisms, enhancing complementarity, and promote cooperation in more areas, deeper aspects, and higher qualities. Firstly, in terms of tax incentives, while the cost of LED panels is usually the biggest chunk of the cost structure for setting up a stage, import duty relief on the LED panels from China to the UK may lower the cost of VP Volumes. Secondly, the UK and China signed a co-production treaty in 2015, however, subsidies and lots of feedback are not as competitive as those in Europe (Hui Man C., interview. 2022, April 28). Therefore, governments from both countries should explore establishing collaborative environments, push forward new areas of VP collaboration and champion the success of the creative industries. Furthermore, based on the joint research centres established in 2014, the two countries are expected to create new joint laboratories and research centres to complement their respective strengths in creative industry [7]. Moreover, by enhancing intellectual property policy

and collaborative environments, push forward new areas of VP collaboration and champion the success of the creative industries. Furthermore, based on the joint research centres established in 2014, the two countries are expected to create new joint laboratories and research centres to complement their respective strengths in creative industry [7]. Moreover, by enhancing intellectual property policy and service mechanisms IP rights will be better protected and IP collaboration will be facilitated [7].

3.3.2 Technology perspective

The partnership with the UK will boost Chinese IT companies. On the one hand, Chinese companies will no longer need to ship large amounts of materials overseas to create the basic modules, and parts of the hardware and systems can be manufactured domestically, thereby improving cost advantages and the controllability of overall back-end system development. Thus, it contributes significantly to the development of technological tools. On the other hand, the majority of Chinese companies strive for fast commercialisation and sell products in the interest of short-term gains. In contrast, a long-term perspective is sought by western companies, who evaluate each factor methodically and scientifically. As a result, the advanced scientific measurement systems will assist Chinese companies in setting up industry standards (Xiong W., panel discussion. 2022, October 14). Lastly, everyone can contribute digital assets and the crew can find assets by global sourcing. To balance the shared digital assets and customized content, standardisation of the assets is expected to set up from the industry (Guanglei J., interview, 2022, May 13).

3.3.3 Enterprise perspective

Enterprises from both countries should

strengthen innovation cooperation and to promote joint technology development and application. The form of collaboration amongst companies could be diversified and innovative. Firstly, the postproduction part can be done in the UK considering world-leading production skills and other production-related parts can be done in China considering the labour costs and infrastructure. For example, UK-based production companies can run video editing, composition and rendering software on China-based Cloud processing services at a cheaper cost. Additionally, China and Britain can strengthen cooperation in the script creation and the export of copyrights overseas, as they have developed similar creative traditions. Ordinary people would be a suitable topic (Hiu Man C., interview.2022, April 28). Moreover, Chinese studios are primarily geared towards tourists, so they lack international management systems. By cooperating with the UK companies, Chinese companies can learn more about virtual management systems, such as logistics, virtual management, and remote film management (Hiu Man C., interview.2022, April 28). Lastly, China and UK have rich natural and historical

resources, thereby global assets sourcing will be ideal through those resourceful cultural elements could be applied to film production.

3.4 Conclusion

This Chapter evaluates the macro business environment that companies are facing, including pandemic impact and political barriers, thereby differentiating technology development paths and market focus in both countries. By comparing different markets and national conditions, we summarize previous successful cooperation patterns in the field of film and broaden the possibility of more UK-China cooperation in content creation area. As the UK and China are complementary in technologies and resources, as well as having similar development goal, the future collaboration offers both countries a valuable opportunity to leverage their strengths and enhance their resilience.

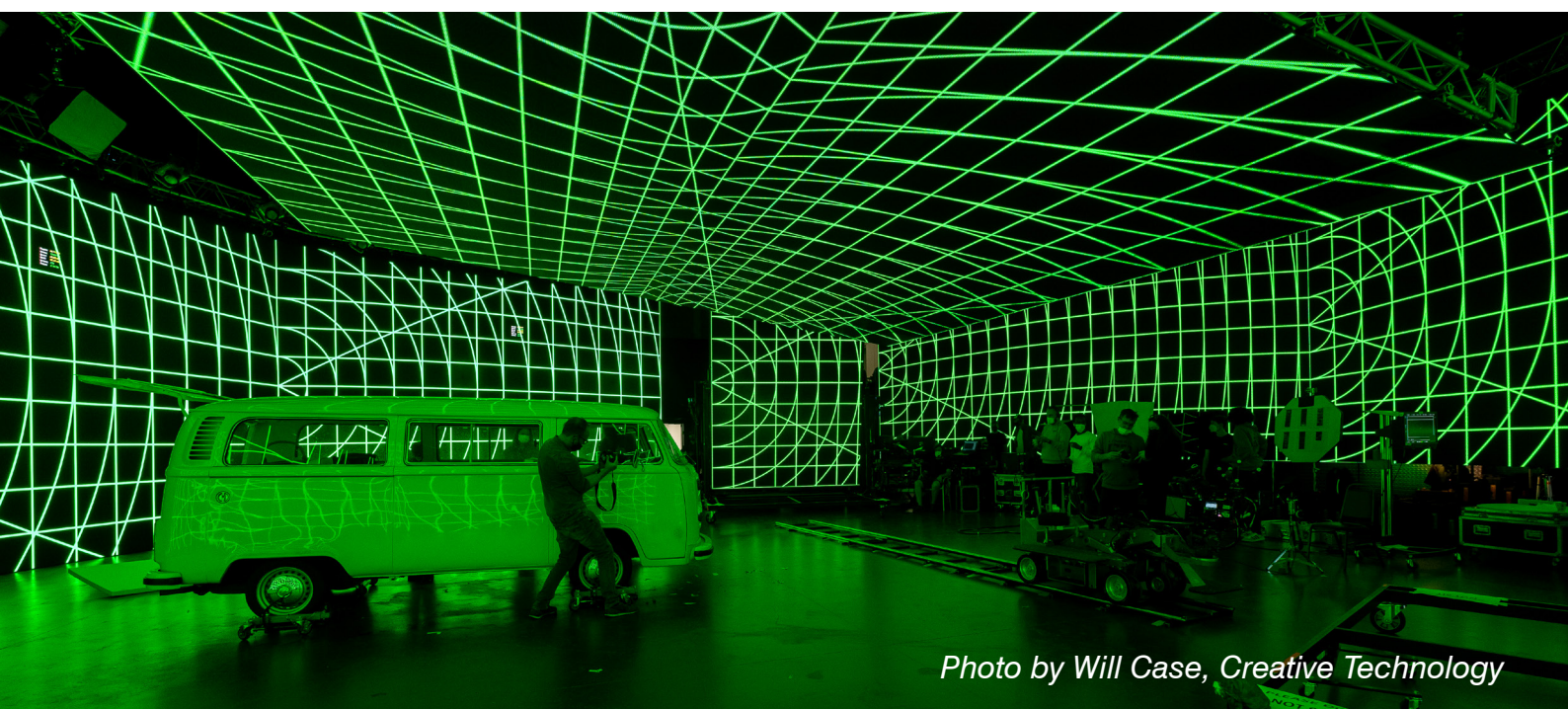


Photo by Will Case, Creative Technology

Chapter IV Talent Training and Resilience Development – Talent Training and Education in the UK and China

This chapter will specify the roles that are in great demand, as well as demonstrate partnership and collaboration opportunities as an important part of resilience development strategies in terms of talent supply sustainability.

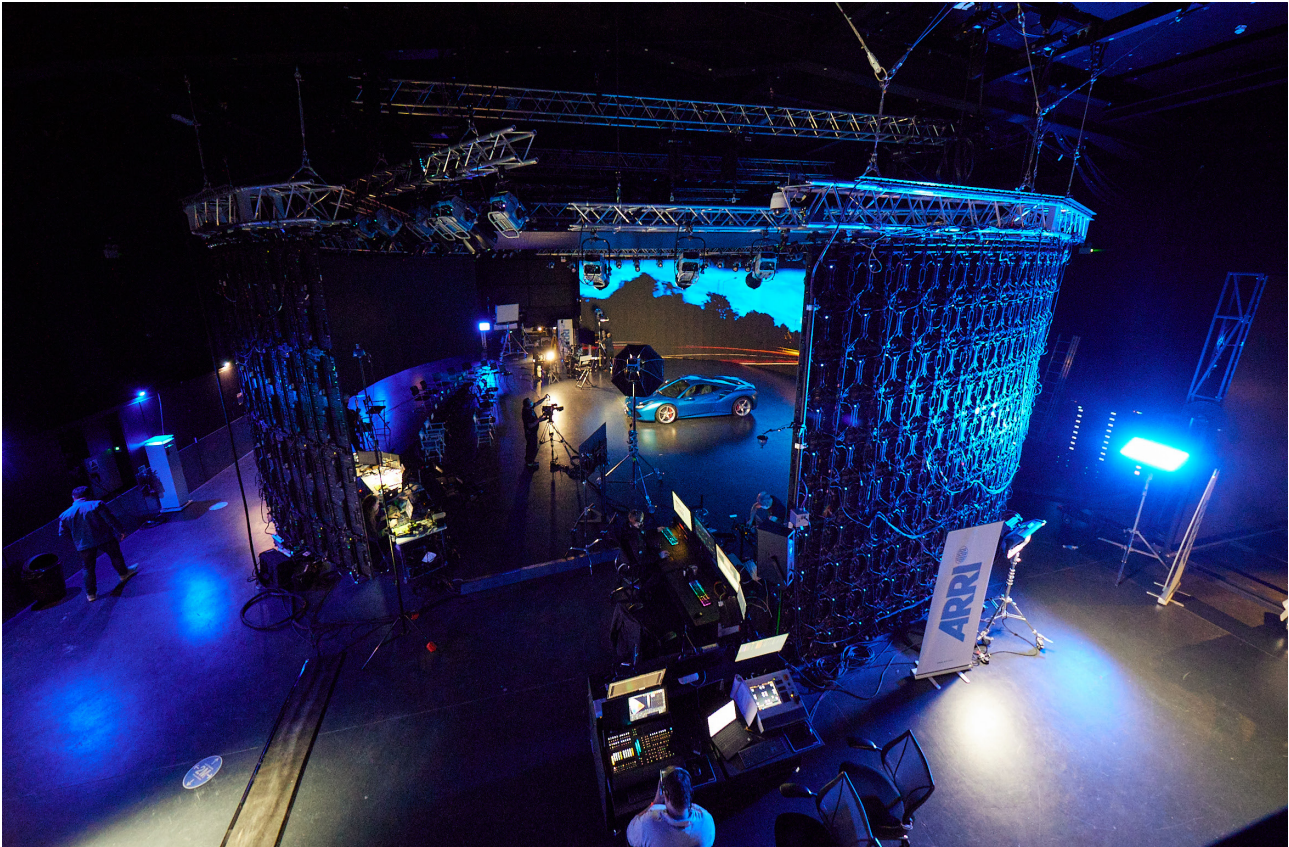


Photo by Ian Wallman, ARRI

4.1 What roles are in high demand?

Technical Artists

Technical artists are the most challenging position to fill as they are required to have technical mindsets as well as creative abilities (Nancy X., interview. 2022, August 4). Technical artists act as a liaison between the creative team and the programming team, writing code, solving problems, communicating effectively with the creatives, and resolving complex technical issues [13].

Stage Operators

This is the second most shortage position (Nancy X., interview. 2022, August 4). Stage operators are known as brain bar who can manage the entire stage. The team of artists and engineers operate the equipment and understand different aspects of the stage, including content distribution, image manipulation, camera tracking, recording, and creative visualization of data [62].

Virtual Production Producer

The core responsibilities of a Virtual Production producer are casting, scheduling, and budgeting (Nancy X., interview. 2022, August 4), which are the same as a traditional producer. Notably, in this new world of Virtual Production, clients often need more assistance with the workflow than they would with a traditional project, therefore, a VP producer is supposed to guide them in a supportive manner [63].

Systems Administrator

A systems administrator is an IT professional overseeing all the different systems on a Volume such as network infrastructure, media servers, and spectrum management. The role of systems administrator is complex and technical-oriented as a movie set gets involved in a large collection of equipment, all its systems can double or even triple the overall technical complexity [64].

Virtual Production Supervisor

The Virtual Production supervisor oversees all aspects of the VP package on set, as well as design and manage the workflow for each show [13]. The role of VP supervisor acts as the link between the real-time crew, art department, VAD, physical production, visual effects, post-production. Technical mastery and interpersonal skills are essential for this position [64].

Unreal Engine Developer

Real-time game engines have become a critical part of the Virtual Production pipeline [65]. An engine operator maintains and operates the real-time engine, loads, and operates assets within the Volume. It is essential that the person in this position has deep knowledge of all relevant aspects of real-time animation software, such as Unreal Engine, Unity,

or one of the bespoke/vendor-specific engines such as ILM's Helios [64].

LED Engineer

As LED panels are an integral part of a VP environment, it is vital to have an LED Engineer or LED Technician on set to ensure their proper functioning [65]. LED engineers oversee the operating and maintaining LED panels and video processors. They specialise in cable management, colour science, basic IT, and video signal flow technology, and testing [64].

Virtual Camera Operator

Virtual Camera Operators are responsible for virtual cameras using external devices such as tablet computers. For this role, it is essential to have a solid understanding of cinematography and a strong desire to stay up to date with the latest equipment, software, and techniques. Those who have experience with creating computer-generated animations using game engines would also be a good fit for this position [65].

4.2 How to sustain growth during a talent drought?

4.2.1 Universities and Colleges

Based on our interviewees, talent training courses should not only be closely integrated with practice, but also strengthen interdepartmental communication skills. On the one hand, the industry expects students to have the relevant knowledge and practical skills to be able to get into the swing of the real-world projects (Chris C. panel discussion. 2022, September 28). On the other hand, VP workflow requires a smooth interdepartmental communication instead of working in solo, production crews need to understand the production

process, learn how to communicate with other different departments and think their requirements (Richard, W. panel discussion. 2022, September 22). Hence, higher education institutions are supposed to set up interdisciplinarity courses that are open to all students coming from different backgrounds and teach them how to apply to theory to practical situations (Rehan Z., interview. 2022, May 16). In terms of forms, launching a module under a banner of like Creative Filmmaking technology is more feasible for universities (Chris N., panel discussion. 2022, September 28).

4.2.2 Companies

Current VP training market is dominated by technology companies and training schools. Students from different backgrounds can gain practice-oriented knowledge from short-term and intensive courses at all levels, including Virtual Production artists, technicians, producers, directors, etc. To address the lack of talent and knowledge within the industry, it is essential for individual companies to make efforts to bridge the gap between the academia and industry coproduction. For example, Final Pixel Academy partnered with University of Greenwich. They have partnered to launch a VP skills course to third-year film and TV students. The course is called New and Emerging Technology, has embedded a practice-led, eight-week course which help students learn how to implement iterative workflows and cluster key elements of Virtual Production into key themes [29]. From Chinese market side, Alibaba Pictures, NVIDIA, Virtual Point, SHOWHO and other partners in jointly released the Future Virtual Filming Program, which aims at young directors and producers to carry out virtual filming talent training and talent support [66].

4.2.3 Governments

Ultimately, the new technology, processes, and workflows of the VP centre around the development of a rapid skills pipeline [13]. The UK and Chinese governments should take advantage of this global innovation opportunity to rapidly upskill, train, and invest in their R&D capabilities. For China, a more flexible admissions requirements should be encouraged by the Chinese government. Some film production courses are not available to art students since they are considered computer-based courses by governments, such that universities must spend a great deal of time cultivating tech-focused film talents into artistically minded film talents (Youdong D., panel discussion. 2022, October 14). For the UK, government is expected to make more efforts to help companies reduce the costs of acquiring talent after Brexit. Despite almost all VFX and animation artist and production roles on the Shortage Occupation List, extending visa requirements to EU and Non-EU citizens will cost employers at least £2.5 million per year, and these application costs continue to rise [67].

4.3 How UK-China collaborate in talent training and education?

4.3.1 Higher education institutions

There is a need for higher education institutions in the UK and China to strengthen the talent education cross-border and promote the integration of industry and education more effectively. Through Sino-foreign educational cooperation programs (e.g., VP Master Courses), the brightest VP talent from China and the UK will be able to develop their skills, merge their respective disciplines and utilize a mutual platform for creating future productions. From industry perspectives, Universities and colleges are expected to develop an industry standard for the use of LED and VP in the future as it is difficult to produce such

standards in business setting (Shuangnin W., panel discussion. 2022, October 14). Furthermore, the UK and China may be able to set up a joint innovation and research platform as a step towards combining their respective strengths in research and technology areas. This could ensure mutual access to research infrastructure and the exchange of data and research between the two countries.

4.3.2 Companies

It is important to accelerate the development of the UK-China business partnerships at the company level, particularly extensive cooperation in education and training, in order to address the problem of talent shortages in the industry, thereby forming a sustainable ecosystem of talent development. Firstly, it would be beneficial for the UK and Chinese companies to offer joint internship programs, and to set up training funds and scholarships, enabling the next generation of talent to gain first-hand industry experience from real-world projects. Secondly, the UK and Chinese companies are expected to establish talent exchange platforms and organise industry-related events to promote the sharing of industry experience in all aspects. Lastly, it is recommended that UK and Chinese companies hold job fairs at universities in both countries so as to acquire talents and facilitate the employment of the next generation talent.

4.3.3 Individual training schools

As Virtual Production technology are rapidly developing, both the UK and China are experiencing a severe skills shortage in the following years. Individual training schools as one of the main talent suppliers, they are more agile at in response to the markets and enable to quickly update the latest programs that

meet the ever-change market needs. Training schools from both countries are expected to launch partnership schemes that encourage an exchange of skills and expertise across the border, such as student exchange and staff exchange. Staff exchange is particularly valuable for teaching staff to spend time in a different institution or country. They can bring back knowledge of how technologies are being deployed, how other working practices are being implemented, and how different cultural norms are being used (Jon W., interview. 2022, June 27).

4.4 Conclusion

Virtual Production have flourished during the pandemic, and yet, a shortage of trained VP talents undermines its success. Both the UK and China are facing rapidly growing skill pipelines in Virtual Production, which has become a common issue in the global Virtual Production industry that needs to be tackled urgently. A variety of talents are urgently needed throughout the entire VP workflow, such as Technical Artists and Stage Operators. To recalibrate how people work in this new cutting-edge technology, different stakeholders are supposed to actively working to ensure the substantiality of talent supply by providing training and education opportunities to attract more people to the field.

Chapter V Conclusion

The project delivered a thorough market analysis of the Virtual Production market in both the UK and China. This report identified key market forces and industry dynamics shaping the evolution of the film production industry in the UK and China and developed valuable guidance and strategies for resilience development and future collaboration in the creative industry. The findings were disseminated to the public and relevant stakeholders via Beyond conference, BFX festival, British Computer Society, social media platforms, online panel discussions, and international workshop. This report developed a deeper mutual understanding of the dynamics impacting upon UK-China film industries-related collaboration, including different industry landscapes, policy and regulatory factors, market characteristics, cultural differences, etc. Our project sheds new

light on VP technology innovation and further taps the potential of collaboration, which bridges the research-industry partnerships between the UK and China across the breadth of the creative industries. The next stage of project will continue to co-develop courses and textbooks, and establish talent training platforms, aiming at fostering greater collaborative opportunities and facilitate long-term creative and commercial relationships that support mutual success in the UK and China. Based on the concept of "co-creation," we are striving to develop a new industry-education model and launch a new type of joint training institution between the UK and China, which will be a resource to drive and support a scaling up of talent supply in the immersive technologies between the UK and China.



Photo by Will Case, Creative Technology

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APPENDICES

Table 1. VP-related courses in the U.K.

Organisations	Training/Courses	Duration	Location
Training institution-Led			
National Film and Television School (NFTS)	Virtual Production (Film-making with real-time technologies)	24 weeks (part-time course)	Hybrid (On-site: Beaconsfield/online)
Story Futures Academy (run by NFTS and Royal Holloway, University of London)	Virtual Production Skills Labs: Producers	1 day	Beaconsfield (NFTS)
	Game Engine Labs	1 day	Royal Holloway University of London in Egham, Surrey
Backstage Academy	MSc Virtual Production	1 year (full time, 2 years (part time)	Pontefract
Company-Led			
Mo-sys	Operating Virtual Production Course	5 days	London/Los Angeles
	The Full Virtual Production Foundation Course	10 days	London/Los Angeles
	Masterclass: Virtual Production for LED Volumes	3 days	London/Los Angeles
Final Pixel	Virtual Production Starter Pack	2 Weeks	London
	On Set Technical Artists - Level 1	3 Weeks	London
	On Set Technical Artist Level 2	2 Weeks	London
	Virtual Production for Advertising Producers	1 Day	London
	Virtual Production For Directors	1 Day	London
	Virtual Production and Sustainability	1 Day	London
	Unreal Engine Expert: Optimisation for Virtual Production	2 weeks	London
	Unreal Engine Expert: Basics of using Perforce P4V	1 week	London

Mars Volume	VP101	5 days	London
	VP Scheduling and Financials for Producers	2 days	London
	LED Systems for Film Crew	4 days	London
	VFX Artists on Set	5 days	London
Escape Studios& ScreenSkills	Step Up To Unreal	5 days	Online
	Introduction to Virtual Production for film	5 days	Hybrid (On-site: London/online)
	Film Setiquette For Virtual Production	3 days	Hybrid (On-site: London/online)
	Budgeting and Scheduling for Film Virtual Production	3 days	Hybrid (On-site: London/online)
University-Led			
Bournemouth University (coming soon)	MA	1 year	Bournemouth
Confetti Institute of Creative Technologies (Nottingham Trent University)	BSc (Hons) Virtual Production	3 years	London
Nescot (North East Surrey College of Technology)	An Introduction to Virtual Production in Unreal	6 weeks	London
Greenwich University partnered with Final Pixel	New and Emerging Technology	8 weeks	London
Government Agency-Led			
ScreenSkills	HETV Virtual Production Training Days – New Entrants	1 day	Pontefract
	High-end TV and Film Virtual Production Taster Sessions	1 day	Online
Northern Ireland Screen	Stepping Into Virtual Production	5 days	Belfast

Table 2. Primary LED stages in the UK

Studio	Location	Stage space	LED size	Status	Studio Characteristics	Main purpose
ARRI X CT LED Volume Studio	Uxbridge, London	7621 sqft	Equipped with an LED volume comprising 343 square meters of 360 degree LED wall, installed in partnership with NEP Live Events production and technical specialist firm Creative Technology.	On operation	The studio is one of the biggest permanent mixed reality production spaces in Europe. Much like the modular facilities, technical support can be tailored to the requirements of each production.	Short and long-form productions of any kind, as well as for events, education, and R&D.
Mars Volume	Ruislip, London	8000 sqft	220-degree 25.5 x 5m curved LED wall and 108m² lighting LED ceiling provides the most versatile and accessible Virtual Production facility.	On operation	Hollywood level expertise that specialises in simulated driving scenes. Cost effective and time efficient solution for car scenes. Handcrafted volume for car work with a 220 degree LED wall Fully capped LED ceiling for seamless reflections. Movable LED wild walls for the ultimate 360 lighting wrap. Fully customisable flooring solutions	Movie, document, advertisement, live-performance, video game, music video.
Target 3D	Hackney Rd, London	Unknown	Unknown	On operation	The Studio is Central London's newest largest volume studio and home to the widest range of motion capture (mocap) and tracking and technology under one roof. The Virtual Production (VP) stage in Guildford offers state-of-the-art LED screen facilities.	VR & AR, Virtual Production, Training & Simulation, Robotics, Animation & VFX, Biomechanics
Recode XR Studio	Manchester	1076 sqft	150 Degree Curved LED wall, size 16m x 4m, 8 sqm of moveable LED totems, configurable in a range of custom configurations.	On operation	Recode XR provides a turn-key service from our state of the art virtual production volume. From real time content creation, to fully serviced virtual production shoot, through to world-class visual effects and post-production.	Television commercial, broadcast, drama, corporate film
80-six (Virtual Production Stage)	Slough, London	3500 sqft	From 180-360-degree LED Volume(18m x 4.5m) , that wrap around the talent, to four-sided LED cubes or straight LED walls with 90-degree returns.	On operation	80-six is an independent video technology company lead visual innovation by integrating existing and emerging technologies, inspiring new ideas and delivering visual excellence	Live entertainment, concert touring, virtual production, film & drama, TV & broadcast, sport and corporate events
80-six (xR Stage)	Slough, London	1600 sqft	ROE Diamond 2.6mm LED walls ROE Black Marble 4.7mm LED floor	On operation	The multi-disciplinary black box studio boasts an uninterrupted 10,018 sq ft space and a 1,725 sq ft open plan production office. At 23.5m wide by 32m long, the studio is ideal for production rehearsals and tour prep when using services from 80six.	Immersive virtual conferences, corporate events and music videos
Garden Studios	Central London	4800 sqft	LED dimensions – 12m x 4m LED curve angle – 120-degrees	On operation	Garden Studios is a technically advanced film production complex, designed specifically to support the latest production technologies as well as decades of future innovation.	A variety of productions, including film, TV, short-form promo, commercial or music video, etc.
Treehouse Digital	Poole	Unknown	Unknown	On operation	Treehouse specialises in telling stories by using the Unreal Engine.	Realtime film maker
MBS Equipment CO.	Slough, London	Unknown	Unknown	On operation	One of the world's premier lighting rental resources. We are extremely proud to support Cinematographers, Gaffers and Crews right around the world on all manner of productions.	Movies, Television, Broadcast, Event and Media Production
Pinewood	Slough, London	Unknown	Unknown	On operation	UK based Pinewood and Shepperton Studios comprise 40 Stages, including the 59,000 sq ft 007 Stage, the globally unique underwater filming stage and one of the largest exterior tanks in Europe, 3 dedicated state of the art TV studios and associated production accommodation, a comprehensive post production division and lighting.	Indie film, TV drama, feature film, light entertainment TV, commercial, games, business, industry events, photo shoot, music video, location, suppliers
Silvertown studios(Royal Docks Studio)	London	6000 sqft	12m X 5m LED screen	On operation	High Resolution LED Volume available for Virtual Productions.	LED screen hire for virtual production, film production, music, live streaming, brand awareness, fashion shows, product launches
Silvertown studios(Elephant & Castle Studio)	London	1400 sqft	5.5 X 3m LED screen	On operation	1,400 sq ft film studio in London with large LED Backdrop, perfect for as Live Filming, Social Content & Music Videos. This studio space is also very well suited for Virtual Productions.	
ONEG	Central London	Unknown	Unknown	On operation	Unknown	Feature film, television and multiplatform content.
Production Park XR Studio	Yorkshire	3660 Sqft	Unknown	On operation	Industry-leading technology includes our extensive ROE LED video wall, Unreal Engine environments, and Disguise media servers.	Film, TV, and digital production, music, theatre production, show and band rehearsals, serviced conferences and events, creative spaces and education
Royal Lancaster London	Lancaster Terrace, London	Unknown	7.3m (w) by 3.6m (d) by 2.5m (h) LED set backdrop and LED floor- high resolution Roe LED panels, Large XR & green screen stage with high-res LED floor and walls	Unknown	Unknown	In partnership with 4Wall, Studio 19 at Royal Lancaster London is a unique virtual and hybrid event studio located exclusively on our 19th floor. Featuring the very latest in extended reality technology, green screen, virtual production and more, the Studio offers an innovative opportunity to host bespoke hybrid and virtual events with the option to either pre-record or live stream content.
White light Amart stage	Jubilee Way London	1291 sqft	Unknown	On operation	White Light has established itself as a leading supplier of video technology. From providing the technical solutions to live television broadcasts to projecting HD images onto historic buildings or even installing LED walls in bespoke spaces, we appreciate the importance of high-quality video technology and the impact this can have.	Education, corporate communications, financial services, broadcast, E-sports, government

Table 3. Primary LED stages in China

Company	Status	Location	Scale	Volume size	Start	Characteristics	Main Purpose
Versatile (杭州博彩)	On operation	Hangzhou	2 stages	6m X 24m/8mX24m	Since 2019	Self-developed technology; full-process, full-production	Commercial Ads, film, TV series, etc.
Starpark (北京星光影视基地)	On operation	Beijing	1 stage	6m X 16m	Since 2021	No top LED, ground LED, Disguise system	TV shows
Xiangshan Starlight Film Town (象山影视城)	On operation	Ningbo	1 stage	Unknown	Since 2022	Unknown	Film and TV series
Timeaxis (横店时光坐标)	On operation	Hengdian	1 stage	Unknown	Since 2022	Small composite group	Advertising
Beijing Film Academy (北京电影学院)	On operation	Beijing	Small LED test environment	5m X 8m	Since 2020	Small LED test environment	Test, student experiment
Wuxi Taobao Film and Television Base (无锡淘宝影视基地)	Under construction	Wuxi	1 stage	10m X 30m/8m X 22m/6m X 15m	Completion of construction in 2022	GLASSBOX of the United States provides an overall virtual production solution (virtual photography, production process management, real-time performance capture, intelligent lighting system) based on the UE engine, using ROE BP2/BP2V2 screen or Chuangxian COB LED	Film, drama, advertisement, MV, animation, game animation, interactive drama and various production contents
Wanda Cinema (万达长春影视基地)	Under construction	Changchun	1 stage	10m X 30m/8m X 22m/6m X 15m	Estimated to be completed on 2023 Spring	GLASSBOX of the United States provides an overall virtual production solution (virtual photography, production process management, real-time performance capture, intelligent lighting system) based on the UE engine, using ROE BP2/BP2V2 screen or Chuangxian COB LED	Film, drama, advertisement, MV, animation, game animation, interactive drama and various production contents
Shanghai Media Group Lingang Film and Television Base (SMG 集团上海临港影视基地)	Under construction	Shanghai	3 stages	10m X 30m/8m X 22m/6m X 15m	Estimated to be completed on 2023	GLASSBOX of the United States provides an overall virtual production solution (virtual photography, production process management, real-time performance capture, intelligent lighting system) based on the UE engine, using ROE BP2/BP2V2 screen or Chuangxian COB LED	Film, drama, advertisement, MV, animation, game animation, interactive drama and various production contents
Qingdao Oriental Movie Metropolis (青岛东方影都)	Under construction	Qingdao	1 stage	10m X 30m/8m X 22m/6m X 15m	Completion of construction in 2022	GLASSBOX+BASEFX	Film, drama, advertisement, MV, animation, game animation, interactive drama and various production contents
National XR Virtual Photography Experiment Center (国家XR虚拟拍摄实验中心)	Under construction	Beijing	1 stage	8m X 22m/6m X 15m	Completion of construction in 2022	GLASSBOX cooperates with the Film Technology Research Institute and the China Radio and Television General Design Institute to build a research type test studio designated by technical research and industry standards	Test and standard research
Dahooo (德火 LED 测试环境)	Under construction	Beijing	Test environment	Unknown	Unknown	Unknown	Testing and promotion
iQIYI Virtual Production (爱奇艺XR虚拟影棚)	On operation	Langfang	1 stage	Unknown	Unknown	Unknown	Film, drama, advertisement, MV, animation, game animation, interactive drama and various production contents

INTERVIEW QUESTIONS

1. Market

- Can you describe the characteristics and trends of the Virtual Production market in your country?
- What is the difference between China and the UK in the VP market?
- What factors may affect the development of the Virtual Production market in your country?
- Looking to the future of the Virtual Production, where do you see potential business opportunities?
- Will the technology of VP Virtual Production allow ordinary people to change from Professionally Generated Content (PGC) to User-generated Content (UGC)?
- What is your business model? Who are your competitors?
- What are threats of new entrants who wants to enter the Virtual Production industry?

2. Technology

- In your own words, what is Virtual Production? What technologies are involved in Virtual Production?
- What are the advantages/disadvantages of Virtual Production?
- Are there particular pain points that you have encountered when trying to implement Virtual Production?
- How do you see Virtual Production evolving in light of the need for Cloud-based collaboration?
- For the film and television industry, what are the characteristics of cloud?
- Which sectors can the Cloud-based film and television be applied to?

3. Talent

- What skills does a Virtual Production talent need? Specifically, what roles are in high demand?
- It is generally believed that talent is in great demand for the future development of the VP industry. What does your organisation think? What is the way forward? Does the government provide support? If so, in what way?
- What is the general strategy of your organisation regarding the academic-industry cooperation? Are there any successful cases?
- How to China and the UK collaborate in talent training?
- How to bridge the academia-industry gap?

4. Collaboration

- Can you share your company's experience in China-UK cooperation with us?
- Where could UK-China collaboration be carried out? (For example: technology, production process, copyright, talent, education, content, market ...) And how?
- What factors may affect the UK-China collaboration? Have there been any successful or failed cases before?
- What are challenges or barriers in collaboration you are facing?
- How could the UK and China collaborate in terms of talent training and education?
- What do you think is the difference between China-UK cooperation and China-US cooperation?
- How to facilitate the UK-China collaboration?

Academic
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