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Case study

Teaching virtual production: the challenges of developing a formal curriculum

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Abstract

In this article, we explore how the recent proliferation of the virtual production stage with its promise of real-time visual effects has not only changed the working environment of the film studio, but also introduced an urgent need for new training and teaching approaches – not only for current and future film students, but also for educators and practitioners. This case study examines a research project involving students from Ravensbourne University London, UK, in collaboration with industry partner Mo-Sys Engineering, a leading manufacturer of virtual production solutions. The complex demands of new, multidisciplinary job roles in virtual production have created a skills shortage in the UK film and television industry. We illustrate the challenges of training not only film students but also educators for a continually changing workplace dominated by disruptive technologies and shifting skill sets.

Keywords virtual production; film education; Unreal Engine; Mo-Sys; LED volume; skills shortage; UK film industry; curriculum development; knowledge exchange; upskilling

Introduction

Much attention has been given to the film studio infrastructure, production culture and workforce, most recently by Jacobson (2020), Street (2021) and Mereu Keating (2021). However, little consideration has been given to the growing importance of virtual production stages – used most famously in Disney's *The Mandalorian* (2019–present) – and the unprecedented impact they are having on traditional skill sets and working practices. Unreal Engine and real-time camera tracking have transformed the studio space into a virtual wonderland far beyond the traditional green-screen stage, creating new job roles and career opportunities that require not only expertise in film practice, but also specialist knowledge in game design and animation. The complex requirements of these new 'hybrid' roles have triggered a skills shortage in the UK film industry, prompting an urgent call for up-to-date training in higher education (Howe and Cortvriend, 2022).

Ed Thomas, Head of VFX at Dimension Studio London, was the first of our industry collaborators at Ravensbourne University London to confirm the issue of a skills shortage in virtual production. During the Covid-19 pandemic, the use of virtual production stages to create 'in-camera VFX' (visual effects) – as Ed Thomas calls this process – grew exponentially (Dimension Studio, 2021). Even though the technology was still in its infancy, productions transitioned to virtual production to keep filming during the period of lockdowns and travel restrictions. Equipped with LED walls and green screens, these stages – also termed volumes – have now become almost ubiquitous, creating new job roles and an acute need to update and expand existing skill sets.

Over the last three years, the practice-based Digital Film Production BA course at Ravensbourne University London has collaborated with several industry partners to respond to the call for up-to-date training. Mo-Sys Engineering, Epic Games (developers of Unreal Engine) and Dimension Studio London are among our key collaborators and supporters in addressing the industry's skills shortage. This article presents a central case study outlining the complex challenges of introducing virtual production into the curriculum at Level 5 of the BA course in Digital Film Production. Moreover, we examine the difficulties of working with rapidly developing technology at the cutting edge of innovation, and how these affect our own professional development as educators and practitioners. Given the newness and unfamiliarity of these technologies, one of the key issues with providing virtual production training to students is the need for educators to be trained first. Naturally, this carries the risk that virtual production will evolve into something radically different – and, potentially, more sophisticated – by the time our knowledge of the technology has caught up. There is a danger we might find ourselves caught in a continuous 'skills lag' (Munk, 2018) regarding curriculum development. This, in turn, raises issues around the financial sustainability of a virtual production set-up in a higher education (HE) institution, as the required infrastructure can be cost prohibitive, particularly at a time when university budgets are under significant pressure.

While we consider students' employability to be an integral part of our mission as educators, it is by no means the most important factor affecting curriculum design. We strongly believe that the intermedial aspects of virtual production, complex as they may be, provide a range of excellent teaching tools that can empower students beyond mere technical proficiency. Apart from enabling students to maximise their creative potential, these tools also help them to develop important soft skills along the way. Today's students need to be independent learners who can work and collaborate across disciplines with other co-creators. As we will argue, virtual production plays a crucial part in this, teaching students the importance of previsualisation (previs) during the planning stage of a film. Unreal Engine is becoming an industry-standard previs tool that can be used in the classroom, irrespective of the LED volume. With its help, students learn to pre-light a scene, plan camera movements and create set designs, thereby focusing and refining their creative intention (Pires et al., 2022).

We are, therefore, greatly interested in exploring these new tools, and their application within the curriculum to unlock our students' creativity and storytelling abilities. Unreal Engine and virtual production are continually evolving, making it difficult to predict their impact on the industry in the long term. It is possible that neither technology may find widespread industry adoption in the future. As teaching tools, we argue that they remain of value, however. The fundamentals of Unreal Engine provide basic creative tools for students, not unlike editing skills. To teach these skills, however, we ourselves need to become experts in the subject. If we fail to do so, we will require the continued assistance of industry experts, which is arguably not a sustainable model for higher education institutions.

The pilot project that serves as the basis for our case study – outlined below – was conceived as a co-creation opportunity for students, working as partners with educators and industry.

The case study: educational approach and background

In seeking to form our pedagogical approach, the requirement to balance the development of creative work (as enabled by a technological tool) and the ability to respond to a still evolving workflow constituted the design of our teaching. We wanted the students to engage with game-engine powered film-making in a multidisciplinary, practice-based learning experience, allowing them to explore the potentialities and limitations of the technology. The learning outcomes were: (1) to explore and experience the workflow and process of virtual production; (2) to collaboratively solve creative and technical challenges; and (3) to understand the need, and develop the ability, for continued learning, especially within the context of an evolving technology.

We focused primarily on the co-created, integrative principles of inclusive learning design, as outlined by Rossi (2023). These principles seek to equip learners with the ability to take ownership of their learning, to practise continuous life-long learning and, consequently, to develop into responsible and contributing members of society (Blessinger and Sengupta, 2017). The principles also form the basis of the creative process: the mindset of an artist is the result of a life-long journey as practitioner, while their work is a reflection and interpretation of their response to the world around them. According to Foley (2014), teaching creativity involves teaching and assessing the methods, evaluation expertise and mindset of an artist.

Furthermore, our core intention was to engage students as co-creators and partners. Our teaching approach was not only based on Freire's (2005: 81) method of students becoming 'critical co-investigators with the teacher', but also reflected our own exploration of the limitations and potentialities of the technology alongside the students. We explained this to the class from the start, pointing out that we would not have the answer to every question, and that even a search through various publications on the subject would reveal different, sometimes diverging, approaches and recommendations. Such an approach, we argue, is essential to working with an evolving technology, and is a useful and transferable learning experience. At the same time, it presents a great opportunity for students to gain a sense of ownership of their own learning, and enables them to actively explore and discover approaches, workflows and creative guidelines. The students' work and progress was continuously tutor- and peer-assessed, supported by live portfolios of production documents, group reports and mini-presentations. The continuing monitoring of the students' progress helped identify areas where they required support, and enabled us to adjust and taper off the scaffolding to guide them through Vygotsky's zone of proximal development (Vygotsky, 1978, as subsequently explored by McLeod, 2023). We challenged ideas and workflows, encouraged questions to the rest of the class, and instigated discussion.

The benefit of using virtual production on a film course stems from the technology's intrinsic use of a 3D environment. According to Ruzic (1999, cited in Dalgarno and Lee, 2010), this provides opportunities for situated learning and active practice, as well as mastering of tool and context (including the world in which the tool is used) through individualised, interactive and realistic learning in a 3D virtual environment. Csikszentmihalyi (1990, cited in Dalgarno and Lee, 2010) further proposes that environments possessing the fidelity and the immersiveness of virtual production can potentially engender enough motivation and engagement to produce a feeling of flow in the learning process. The advantage of virtual production is, moreover, that it is not merely a simulation constructed for the purpose of teaching, but embodies in itself a process of previsualisation and development (via Unreal Engine) for the purpose of remote collaboration, creative development, presentation and pitching.

Technical set-up

While detailing the full workflow of virtual production is beyond the scope of this article, the main elements comprise: a camera for recording with a tracking system to capture the position and focus of the camera in the space/studio; servers running Unreal Engine to manage the 3D model of the background (called 'the asset'), and to render it in real time according to the camera tracking data; and the output for the rendered background (Mo-Sys, 2023). The background output can be implemented as a green-screen live composite, or can be displayed on a projection screen or LED wall during the recording of the image, as a background to the physical stage. This is generally referred to as 'in-camera VFX'.

Our aim was to make such an approach accessible to BA Digital Film Production students at Level 5. We therefore had to establish a cross-media infrastructure that would allow students to be trained in Unreal Engine, and enable them to access a soundstage big enough to host a virtual production set-up. We planned the introduction to virtual production as a practice-based process in two stages. The first was intended to introduce the students to the basic ideas and workflow of the virtual production process, using a green-screen stage with which learners had had previous experience, and which could thus serve as a basis for them to progress to the more challenging volume set-up. The second stage was planned

Figure 1. Level 5 students on the school's green-screen stage

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as a follow-up practical session exploring a more elaborate, projection-based virtual production stage. During the first stage, we introduced students to virtual production as part of a module called Emerging Film Technologies. Using tools and infrastructure that we were able to source from the university, we organised a two-day shoot using green-screen, live-keyed Unreal Engine assets, and a prosumer-grade camera tracking system. The set-up is shown in Figure 1.

This also embodied our first practice-based venture into multi-departmental teaching, drawing on the combined staff and resources of Ravensbourne University London's film, game-design, post-production and research departments. The required computing hardware of 25 workstations running Unreal Engine were supplied and overseen by the games department, the HTC VIVE tracking system was provided and set up by the research department, while the camera kit – consisting of a Sony FX6 and Canon EF lenses – was sourced from the Digital Film Production unit. These tools enabled us to stage a virtual production shoot that allowed students to gain hands-on experience with a combination of technologies both familiar (cameras, lighting, green screen) and new (tracking, Unreal Engine). For the second stage, we progressed to a more elaborate, industry-ready system. After examining the available options, we chose to work with a projection screen as an alternative to the LED wall, as shown in Figure 2. A projection-based solution is being explored in film and television due to its environmental sustainability and cost-effective nature. Using a projector plus a large-size screen offers lower cost, flexible use of space and, crucially, much lower energy consumption (Helzle et al., 2021). The light output of a projector is, however, relatively weak compared to an LED wall, making it more difficult for the screen image to cast

Figure 2. Projection-based virtual production with camera tracking

realistic lighting effects and reflections on the physical set and actors. Colour fidelity is also an issue, as we found out during our tests.

To implement this second stage of the pilot project, we collaborated with Greenwich-based company Mo-Sys Engineering. Consulting with their engineers and production staff, we gathered information on the workflows, technical parameters, and practical uses and limitations of the technology. Furthermore, we attended Mo-Sys's five-day training course for media professionals. These industry-led training sessions gave us hands-on experience from a user perspective, as well as the necessary knowledge to impart to students. We negotiated an agreement with Mo-Sys to loan us the processor, hardware and tracking component of the system for the duration of our pilot project. The equipment consisted of three computers used as Unreal Engine editors and render nodes; the Mo-Sys tracking system (ceiling markers, optical tracking sensor and processor for the tracking data); a digital camera with a calibrated zoom lens; and the Mo-Sys Unreal Engine plug-in managing the tracking data and the virtual environment. The robustness of the tracking solution, and the processing power of the hardware, was a considerable upgrade from our first stage. It enabled us to produce high-quality results, and to provide students with up-to-date learning, practice and problem solving on an industry-standard system. After procuring a suitable high-powered laser projector, we built a 12-by-7-metre projection screen to complete the system. During the installation and tuning of the set-up, we worked with the Mo-Sys engineers, and we documented their process to further consolidate our knowledge.

Teaching methods

Students were asked to work in groups. At Ravensbourne, group work is the default mode of teaching in film-making, to promote the communication of ideas, the development of a common creative vision and collaboration among craft departments. These are core skills of industry practice, as well as transferable employment skills (Leipzig et al., 2016). Group work is even more important in the case of virtual production, because new skill sets require cross-disciplinary knowledge. Further, group work enables both students and practitioners to collaboratively find solutions to practical limitations, and to successfully tackle workflows that are still being developed and tested (Petty, 2009). Within the groups, the students were encouraged to negotiate and allocate the production roles based on their individual strengths. In a simplified mirroring of the industry roles, we required the following key roles to be allocated within each group: director/writer, Unreal Engine artists, cinematographer, camera assistants, gaffer/chief lighting technician and lighting technicians.

To more effectively support the students' learning and self-motivation (and to allow them to learn from each other's work), we broke down the process into smaller, more manageable sub-goals. Even if this does not fully reflect the complex interaction between departments in virtual production, it still manages to 'provide immediate incentives and guides for action … [and] serve[s] as an important vehicle in the development of self-percepts of efficacy' (Bandura and Shunk, 1981: 587). The directors/writers were tasked with drafting a short narrative scene featuring two or three characters. They would then work together with the Unreal Engine artists to design an appropriate virtual asset for their scene (not surprisingly, neon-drenched science-fiction motifs proved popular with students). Having access to 25 desktop workstations, we grouped the students together for a series of Unreal Engine lessons provided by one of the technical tutors from Ravensbourne's Game Design department. Between classes, the students worked independently on their Unreal Engine assets, either from home or in the school's lab. The latter was crucial for accessibility, as many of our students do not own powerful laptops or workstations. The technical tutor was on hand to provide guidance regarding Unreal Engine design, while the module lecturers were supervising the development of the productions.

The next step was to team up the writers/directors with the cinematographers to plan the shoot on the green-screen stage. The challenge for the lighting crew was to match the lighting design and colour concept of the virtual asset to the physical action on stage. Supervised by the cinematographer and gaffer, the stage crew had to pick the appropriate light fixtures and colour gels for the scenes, basing their decisions both on the director's creative intention and on the design of the virtual asset. They also had to light the green-screen backdrop appropriately to pull a successful chroma-key.

The shoots took place over two days. Each of the four groups was given three or four hours to capture their scene in front of the green screen. This included time to set up the lighting and to rehearse the actors on stage. The filming gave students an opportunity to experiment with the technology, finding solutions to convey their creative intentions. While the lecturers were on site to supervise and guide the process, the students were ultimately in charge of staging their scenes and making them look as good as possible. The virtual assets and the live action were composited in real time on set by a Game Design research fellow, to allow the students to have live visual feedback.

During the following semester, we launched the second stage of the pilot project. Due to the technical aptitude required, and based on the students' response to the first stage, we ran this second stage as a sign-up project for a smaller group of Level 5 students who expressed interest and enthusiasm for more in-depth practice with virtual production. We also invited Game Design students to collaborate as Unreal Engine artists, a cross-disciplinary collaboration that reflected contemporary practice in the industry. In our experience, such collaborations lead to higher quality results and, crucially, pose the challenge of working with artists and technicians from different disciplines, in turn creating the need to find a common creative 'language'. Working with the equipment loaned from Mo-Sys Engineering, we invited the students to shadow the company's engineers during the installation work.

Our second stage was implemented as a self-directed application of the students' learning from the first stage, aiming to consolidate existing knowledge, and to extend it to a more challenging set-up. We supported students throughout the tasks that were technically and creatively more challenging – such as the visual interaction between the live action and the digital asset, and the blending of the two – and we revisited or clarified areas that they were uncertain about, prompting more in-depth analysis of the workflows together. Most of the assets had to be amended once they were projected on screen for the first time and tested for real-time performance. This part of the process was a particularly valuable learning experience for the students, who initially created their assets without the context of the virtual production volume and physical stage. The students experimented with variations of the scenes, different camera movements and shot sizes, lighting and different digital environments.

Observations and feedback

We collected student feedback using a structured interview questionnaire. Interviews were conducted in person with students who had participated in both stages of the project. We used open-ended questions for qualitative insight into the students' response to the learning process, and to gather their opinions on virtual production as part of their creative journey and professional development. The questionnaire is shown in Table 1.

Table 1. Student feedback questionnaire

Number	Question
1	What did you learn from participating in the school's virtual production projects?
2	Did you research Unreal Engine/virtual production before or after the project(s), and, if so, which resources did you consult?
3	Which resources (online or otherwise) did you find most useful?
4	How do you feel about learning a new skill set without a formal 'textbook'?
5	What benefits do you see for pilot projects with industry and tutors, such as the Mo-Sys collaboration?
6	What do you see as the biggest challenge(s) of using virtual production in your own projects?
7	What more would you need to learn to feel confident working in virtual production?

Students' responses are quoted anonymously in this article as a basis for our observations and reflections.

Most of the students commented on the technical and cross-disciplinary challenges of virtual production. Overall, the majority were interested in learning about virtual production, but their engagement with the learning and the tasks varied. A few of the students were very interested in Unreal Engine design, and hence became the engagement drivers for some of the groups. These tended to be mainly students with pre-existing post-production and VFX interests and skills, perhaps unsurprisingly, as these skill sets have commonalities with the Unreal Engine workflow. Based on their experience on this module, two of the students even decided to transfer from Film Production to the Game Design BA. Furthermore, we noticed that cinematography and production design students demonstrated particular engagement with the learning and the task. This is consistent with what is perceived as the more direct involvement of cinematographers with the technical set-up of filming in the 'volume'. Similarly, production design students were already familiar with aspects of technical planning, previsualisation and computer-aided design through their previous training and practice.

The implementation and evaluation of the first stage of the project revealed that our choice of green-screen-based virtual production set-up had, in fact, imposed considerable limits on the quality of the final output – which, in turn, impacted student engagement. Although relatively affordable and straightforward to use, the HTC VIVE tracking solution did not prove as reliable as expected. Moreover, the computing power of the Unreal Engine set-up was not sufficient to render the student-created assets in high quality and/or real time. As displayed on the monitors, the render quality of the final output image did not have the level of detail and/or texture that they had come to expect from Hollywood films. This is not unusual, and, in fact, it is often the case in actual productions where asset optimisation is indeed a limiting factor. Generally speaking, the solution is to use a proxy render (of lower resolution) during the live shoot, with the full render substituted in post-production. This, then, was a valuable learning point for the students – as well as for us as tutors – in regard to the strict parameters of a successful virtual production implementation, and the range of knowledge and skills integration required, especially in an evolving technology context. As one student put it in the questionnaire: '[the result] shows you need people that know what they're doing. It's an extensive thing. If you don't do it well it's noticeable. It's very specific and has to be done very well to be successful.' Unfortunately, the consequence of this was that the students, who overall were eager to take part in the pilot project, became less engaged when the results fell short of their expectations. As tutors, this was perhaps an indication that we did not manage their expectations enough in advance to mitigate the demotivating effect of a suboptimal output. This was a result of our limited time and experience with the system during the testing phase, when we too were essentially on a parallel path of discovery with the students – and, hence, equally unprepared for the impact of the computing power and asset optimisation requirements.

A number of questionnaire respondents stated that they preferred the second stage of the pilot project to the first one, finding it more impressive and engaging. As one student commented: 'When I got into the room and saw the asset on the screen, it was fascinating. I felt I was in the film. It felt like magic.' As a learning environment, the immersive 'live' nature of the projection-based volume made virtual production more tangible to the students, allowing them to work with a background asset that directly interacted with the action and set lighting. The same student added that 'you only get the real feeling with the projection system', as opposed to the green screen, thereby implying an almost visceral reaction to the second stage of the project. According to Quinlan (2016), such emotional rewards are very important in shaping a positive learning experience for students. If we had had access to a full virtual production 'volume' for the first stage of the pilot, we may have been able to achieve this positive response from students earlier in the project.

One student commented that they found practising with Unreal Engine of particular use for learning about lighting design. Unreal Engine allowed students to pick virtual light fixtures, and to find the best application to illuminate the asset. This enabled learners to explore various moods during the previsualisation stage, without needing access to physical lights. As the course curriculum is practice-based, it incorporates many opportunities for students to shoot scenes and engage in 'hands-on' film-making. However, the availability of the school's technical resources was limited, making it difficult for students to gain the desired amount and range of practice. Using Unreal Engine in the classroom to experiment with different approaches to scene illumination and production design can therefore offer more learning opportunities. It can help teach scene lighting and shot composition, both on site and in a blended learning environment. The use of Unreal Engine in this context offers further opportunities for a flexible and adjustable design for learning (CAST, 2018). One student, for instance, was diagnosed with autism spectrum disorder. This posed challenges to the student's collaboration and interaction with team members, despite the appropriate support and adjustments from the university. Unreal Engine provided an opportunity for them to practise in a realistic but personalised virtual environment that they were able to control themselves. While it does not replace hands-on practice, the customisation offered by this approach can amplify the learning potential, and can support equitable and inclusive teaching.

A number of students responded critically to virtual production, perceiving it as a very high-end, expensive technology that is out of reach for them. One remarked: 'VP [virtual production] is confusing. It's to bring an easy solution to something that is hard, i.e. travel … I don't see it as something important at my stage in my career. It's too much out of reach for us students. It's not accessible yet.' Another student reflected: 'It's something completely new. I would consider it if it's cheaper. Don't see myself as working with those skills. Look up those with relevant experience when I need them.'

Such perspectives mirror current scepticism within the industry itself that virtual production infrastructure remains expensive and best suited to specific productions. However, if we consider the wider range of game-engine-supported workflows – in particular, previsualisation, virtual scouting and remote working – the benefits of virtual production, and its relevance to lower budget productions, becomes more evident. The ability to produce photorealistic set-ups – including accurate lighting, framing and production design – makes visualising with Unreal Engine more iterative and immersive compared to conventional animatics or storyboards. This is the process that we intended the students to experience. However, as the focus was more on the final output, due to the novelty and the limited time and resources, students rightly saw the development process as a means to an end. In retrospect, and for future modules, we intend to delineate visualisation and production as two separate learning outcomes, with corresponding deliverables and assessments.

The potential of embedding Unreal Engine in the wider curriculum for visualisation and development purposes is particularly beneficial to traditional film-making subjects such as directing, cinematography and production design. And, in fact, we argue that its usefulness extends across departments; for instance, Ravensbourne's Architecture and Fashion Design courses are both exploring the use of Unreal Engine for the purpose of visualisation and demonstration. Since 2022, the Fashion Design course has been organising virtual runway and digital fashion shows. In response to our findings, and as a reaction to perceived industry trends, the university is currently designing cross-departmental modules to teach Unreal Engine as part of the 'fundamental skills' training recommended for all content-creation and design courses.

Considerations for wider curriculum integration

Further to our findings from the case study, we have identified a number of challenges that might impede the provision of targeted virtual production training – as requested by the industry – within HE institutions. These observations are again based on our own experiences working in the HE sector and, more precisely, within the specific context of a BA-level film course. To some extent, the issues also apply to the wider framework of teaching innovative technologies and, correspondingly, to the development of a formal curriculum.

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The first challenge pertains to the cost and availability of resources and equipment. One of the biggest obstacles facing HE institutions is the sheer cost of the resources and, potentially, the space required to run a virtual production stage. This is exacerbated by the fact that the technology is still relatively new, and hence developing at a fast rate, making any kind of investment risky. The short-term solution for us was to seek a knowledge-transfer partnership with industry: Mo-Sys loaned us their hardware-based solution for a period of two weeks to complete our projection-based virtual production pilot for the second stage of the project. This gave us access to industry-leading equipment for a limited time, allowing us to explore the potential of the system and, at the same time, to provide hands-on practice for the students. The projection-based set-up was an attempt to lessen the environmental footprint, proposed by Mo-Sys, who were interested in more data on the usefulness and sustainability of the technology. There is still uncertainty in the industry as to a long-term, sustainable and cost-effective solution. This uncertainty is a major obstacle to the integration of virtual production into the curriculum.

While we found during the first stage of our pilot project that it is possible to use more affordable equipment for virtual production, such as the HTC VIVE system – and a case could be made for pushing the democratisation of these tools even further for the sake of accessibility and inclusion – we admittedly also struggled to deliver high-quality results.

A second challenge relates to the lack of multidiscipline experts and tutors in HE contexts. Finding a skilled Unreal Engine artist who could help us train the students proved more difficult than expected. As virtual production is an emerging technology, there were limited numbers of VFX artists and film educators with training in Unreal Engine at the time of our pilot project. This issue is exacerbated by a lack of formal training in the industry itself, creating a vicious cycle that results in education falling behind at an exponential pace.

Most trained Unreal Engine artists have a background in game design, but not necessarily in film production. The Unreal Engine artist, however, plays a key part in the design of the virtual asset and its integration into the virtual production pipeline – a workflow that is highly disruptive because it turns the traditional idea of the filming process on its head. The linear order of pre-production, principal photography and post-production no longer applies in virtual production, because Unreal Engine assets are created in pre-production and serve as final renders during filming. It is now possible to achieve VFX 'in camera' with the help of LED volumes and projection-based systems. Ed Thomas refers to this as the 'parallelisation' of the film-making process (Dimension Studio, 2021).

As a result, the disruptive nature of virtual production has created several new roles that lack clear definition. When we discussed this with Tom Murphy, marketing manager of Searchlight, a media industry recruitment company, he insisted that the industry is struggling to wrap its collective head around the exact definitions of these roles. Many companies are hiring external consultants to help them identify the workforce pool they should be recruiting from, or offering upskilling incentives to. The multidisciplinary skill sets of these hybrid roles combine traditional film-making skills with aspects of game design and 3D animation. Our industry partners are therefore looking for digital artists who know as much about lenses and lighting as they do about asset creation in Unreal Engine. To create realistic environments in Unreal Engine, students must also understand shot composition, lighting and lens selection – the classic skill set of a cinematographer.

It is beyond the scope of this article to explore all the emerging jobs in virtual production, but a quick look at the profiles posted on industry recruitment platforms reveals a growing number of 'hybrid' roles: virtual production supervisors, volume technicians, Unreal Engine operators/artists, on-set and near-set data management, virtual art department and real-time 3D artists. The increasing complexity of these roles makes it very difficult to find skilled lecturers and tutors, and also to create formal training pathways for students within the HE environment.

A final challenge pertains to limited access to knowledge and training resources. Teaching an innovative subject based on cutting-edge technology is a challenge because there are, as yet, no widely established practices. Technical and creative know-how is constantly evolving. Consequently, we do not have the traditional corpora of knowledge to refer to. Although a number of companies and practitioners are developing new technologies and adapting existing techniques, such knowledge is not easily accessible. A proliferation of blogs and articles provide some insight, but the accuracy and robustness of these sources is questionable, let alone their suitability for educational purposes. Jonathan Munk (2018) suggests that the perceived skills shortage or gap is actually a 'skills lag' that generally follows a certain pattern or cycle: a new field emerges; specialised jobs are created; jobs remain unfilled; informal skill development proliferates; formal skill development follows. The recruitment requirements for new specialised roles drive the demand for upskilling of the workforce, but the training available is still of an informal nature. In relation to virtual production, we define 'informal' as any learning gathered online via websites, social media or blogs (that is, sources that are not validated by industry or educational institutions). Hence, the information gathered is not necessarily accurate or reliable.

Companies such as Mo-Sys, Final Pixel and Epic Games have begun to operate training sessions themselves, either in collaboration with subsidiary companies or on their own. The intention, depending on the company and its business model, is: (1) to encourage engagement with the equipment and expand the client base; (2) to train existing clients; or (3) to ensure access to, and recruitment of, professionals who can be further trained on the job. In our discussions with these companies, however, we learned that institutionalising and sustaining such training is not an effective or productive use of their resources: for this, they look to established educational institutions. One of the main benefits for an industry partner to collaborate with an educational institution is therefore the supply of trained graduates with up-to-date knowledge. Mo-Sys responded to our approach for exactly this reason: they outlined their need for graduates with proficient transferable skills to be employed and trained further. From the start of our collaboration, the company made it clear that it was beneficial to them to support us by training educators before students. In turn, they facilitated the supply of their technology to the university and, more specifically, to our project.

Conclusion

Based on our case study and analysis, we find virtual production and Unreal Engine to be useful teaching tools which provide a range of transferable skills and opportunities for situated learning and even remote training. As we have sought to demonstrate through this case study, this skill set has the potential of being integrated into the curriculum of higher education institutions. Basic Unreal Engine knowledge might well become a core skill for future film-makers. Developing and approving curricula is, naturally, a lengthy process dependent on long approval times (Applin, 2019). Institutional inertia, however, is not the only challenge facing the integration of virtual production into the curriculum. As we have outlined above, the key issues that need to be addressed in the development of a formal curriculum are: (1) the high cost of technological infrastructure, and the risk of investing in technology that is in the process of ongoing research and development; (2) the lack of an established and robust knowledge base that is readily accessible; (3) the limited availability of experts to share their experience and knowledge with students, which in turn affects the training and upskilling of educators and academic technical staff; and (4) the need to clearly define new roles and skill sets.

In a rapidly changing world that increasingly relies on multidisciplinary knowledge and dynamic job roles, the importance of soft skills, active learning and adaptability is pivotal (Sutherland and Bibby, 2020). To keep pace with and support technological, economic and social transformation, our approach to education needs to be synergetic: a collective enterprise with industry and policymakers (Schleicher, 2015). This case study has sought to demonstrate that an effective way for educational institutions to address such challenges is to develop strategies of knowledge exchange with industry, and/or to establish collaboration hubs with other HE providers. In this way, educational bodies can benefit from industry resources, technical expertise and skilled personnel. In return, they can provide access to test beds, time and resources for further research, which – as a result of this mutual effort – optimises the curriculum and helps graduates to meet the recruitment needs of the industry.

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Declarations and conflicts of interest

Research ethics statement

The authors declare that research ethics approval for this article was waivered by Ravensbourne University ethics board.

Consent for publication statement

The authors declare that research participants' informed consent to publication of findings – including photos, videos and any personal or identifiable information – was secured prior to publication.

Conflicts of interest statement

The authors declare no conflicts of interest with this work. All efforts to sufficiently anonymise the authors during peer review of this article have been made. The authors declare no further conflicts with this article.

Filmography

The Mandalorian (US 2019–present, various)

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