Teaching Virtual Production in Higher Education

Lessons Drawn from the VPSN Research Project

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ABSTRACT

Virtual production (VP) are technologies and processes to combine digital environments with physical stages to create content for entertainment industries like cinema. As teachers in related areas, we aim to keep our students up to date with VP skills, as they grow in demand from creative industries, and harnessing them requires significant learning commitment and financial investment. This paper presents a research project, the Virtual Production Studio Network (VPSN), which is aimed at addressing the previous demand, by providing knowledge resources and training. Drawn results from these activities enforce the idea that VP is not a universal solution to shooting films, and given its financial requirements, cost-effective alternatives must be sought to sustain learning. Independently of these challenges, VP holds immense potential, therefore we will keep pursuing ways to integrate its knowledge and technology into our lectures to augment the students' readiness in this field.

CCS CONCEPTS

• Applied computing → Education • Applied computing → Arts and humanities → Media arts • Computing methodologies → Computer graphics → Animation.

KEYWORDS

Higher Education Learning, Virtual Production, Cinema

1 Introduction

Virtual Production (VP) is reshaping classical filmmaking, as well as practices in the creative industries and in the education sector [1]. VP aims to move film production into the digital space as this enables cost-effective shooting using realistic scenarios, real-time editing and visualization, while sustaining distanced collaboration. VP encompasses technologies, procedures and knowledge to blend digital and physical worlds on Extended Reality (XR),[1] cinema production stages. Further, VP can cover both lower budget films and big productions by providing either window-sized or 270° (plus ceiling) digital stage environments. The VP concept is constantly evolving, and bound to complement classical filmmaking, as it won't replace green or blue screens, as these are still adequate technologies to shoot either huge backlot or tiny spaces [2].

Independently of the traction gained by VP, it is crucial for higher educational institutions to integrate it into their curriculums to prepare future filmmakers to respond to the evolving demands in this industry [3].VP is widely known for using LED screen volumes, game engines and motion tracking to sustain dynamic backgrounds with many benefits merging physical acting with interactive virtual worlds [2], [4], [5]. Still, VP VFX[2] is far from being a contemporary possibility [5],[6], as it can be traced back to rear projection in the 1934 feature film Liliom by Fritz Lang [6]. Today, VP sustains realistic backdrops, e.g., used in the Fallout (2024) or in The Mandalorian (2019-present) TV series, streamlines pre-production workflows and multidisciplinary team collaboration, among others benefits [4].

However, VP also poses challenges, e.g., its technical nature can cause actor-director dialogue disruptions that affect performances [7]. Such disruptions are due to frustration felt by actors who must perform by imagining non-physical digital counterparts beyond their classical training, while being poised by miscommunication or misunderstandings that pave inconsistent performances in VP acting contexts. Such inconsistencies have led to efforts to provide actors with equipment to visualize digital surroundings and their counterparts in real-time [8]. Other challenges exist, combining stage and LED volume lighting can lead to unwanted light that bleeds on props or actors, something that takes a lot of time to deal with. Also, as VP gains traction, the available skilled workforce declines [5], something hard to address by the educational sector, given VP's complexities and costs [3]. This shortage is of concern to us, as we lecture in areas of study proximal to VP, as such, this paper presents findings gathered from training carried out in the scope of the Virtual Production Studios Network (VPSN) research project, [3] and

[1] Extended Reality (XR) encompasses immersive technologies, such as Augmented Reality, Virtual Reality and Mixed Reality.

[2] VFX (Visual Effects) refers to digitally created or enhanced imagery used to achieve scenes that cannot be captured during live-action filming.

[3] The VPSN is research project consortium involving Denmark's VIA University College, Netherlands Breda University of Applied Sciences, Portugal's Polytechnic Institute of Cávado and Ave (IPCA), and Norway's Nord University, the latter ceased to participate in a later stage.

presents the hypotheses developed to capitalize on this training in classrooms.

2 Method

Beginning in September 2022, *the* VPSN project was set out to address the identified skilled workforce shortage by providing training for educators and students to prepare them for this new tech-driven, creative, filmmaking landscape. Training consisted of blended-learning courses that finished in one-week presential workshops hosted at Breda University Applied Science's (BUAS) XR stage, part of which is depicted in Figure 1.

Figure 1: BUAS XR stage: digital camera with motion capture (MoCap)[4] crown on a cart (left), stage area with actors on adjustable platforms, boom operator and LED volume in the background (middle), upper LED volume (top), traditional light projector on a tripod, and led light panel (right). Training session photograph by the VPSN team in 2024.

Training was aimed at two target groups, educators followed by students, as these would be mentored by the former and by BUAS staff. Each group consisted of a team comprised of members from all the consortium's institutions where each member assumed a particular traditional film or VP role. Activities started with the study of educational materials, while maintaining dialogue with other team members through the Discord platform,[5] to negotiate design and practical aspects of production. To support initial learning both teams were provided with a base script, *Greenhouse Insanity*, a 3D environment template, film pre-production manuals developed by BUAS staff focused on VP, the Unreal game engine [6] and Davinci Resolve tutorials.[7] Pre-production tasks consisted in elaborating creative visions, storyboards, breakdown-sheets, tech-plans and a movie previz - an animation draft that illustrates the aimed result. Students opted for an alternative script that was different from the original provided to them (which was the same for teachers). Each short was shot in the BUAS XR stage during the presential workshops and resulted in distinct productions. As of this writing both videos were accessible on the VPSN YouTube channel.[8] A detailed account of these activities can be consulted in a previous publication [9].

Perceptions of the learning practices were drawn from learning practices, through the analysis of responses to questionnaires and of results, grounded in bibliographic references. Data collection was structured empirically by part of the team that left the project, yet its rationale was still deemed adequate to probe VP role participant's know-how.

3 Problem

At first glance, the experience was enriching for both students and educators as an opportunity to acquire holistic knowledge to do VP, or to strengthen individual know-how. It acted as an eye-opener for the potential of VP procedures and pipelines, for and beyond cinema. This positive stance is grounded by interviews to probe ability levels in VP and traditional film roles,[9] before and after the workshops. Statistics gathered from a small sample of participating educators are illustrated on the graph in Figure 2.[10]

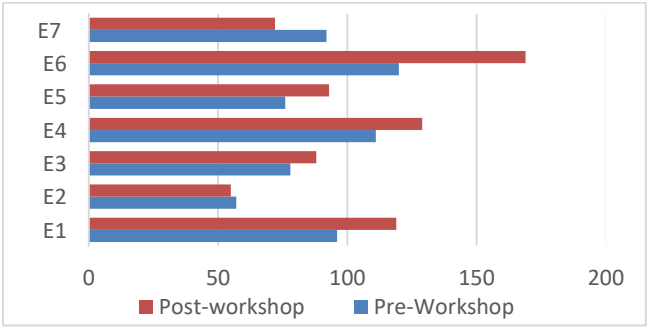

Figure 2: Graph depicting the educators' competency growth before and after their training workshop in 2024.

Rank for the knowledge of roles is coded in blue for the pre-workshop and red for the post-workshop. Each skill/role was

4 Motion Capture (MoCap) is a technology used to record and digitize movement to develop realistic animations for video games and VP, among other areas.

5 Discord is a communication platform for text, voice, and video, popular among gaming and online communities.

6 Unreal is a game engine developed by Epic Games since 1998, used for creating high-quality interactive experiences, like video games, simulations, and virtual production, it is renowned for its photorealistic graphics and real-time renderings.

7 DaVinci Resolve is a professional video editing, color correction, and post-production software developed by Blackmagic Design since 2004.

8 As of December 12, 2024, the student's VP thriller short could be accessed at: https://youtu.be/2J2jvsrDcfg?feature=shared and the educators VP *Greenhouse Insanity* short could be accessed at: https://youtu.be/Y5L59vZqN98?feature=shared

9 These roles were: Production Designer; Director; Producer; First AD; Second AD; Line Producer; Art Dep. Crew; Sup. Art Dir.; Props; Set Design; Model and Mins; Greens; Sup. Art Dir.2; Virtual Env. Designer; Digital Assets Creative; Digi Assets Tech; Digi Backlot; VP Supervisor; Media Server Operator; Developer; LED Technician; Digi Imaging Tech; Motion Capture; Camera Tracking; Performance Capture; DOP; Camera Operator; Assistant Camera; Grip; Video Assist; Gaffer; Lighting Crew; Prod Sound Mixer; Boom Operator; Utility Sound Tech; VFX Supervisor; Compositing Tech Artist; Colour Tech Artist; Systems Integration; IT Services; Performance Tracking; Craft Services; Editor; Assistant Editor; Post-Prod VFX; Colourist; Sound Designer; Assistant Sound Editor; Composer; Post-Sound Mixer; ADR; Foley; Re-Record

10 We were only able to rank the competency growth of the educators, as student post-workshop data was not gathered.

quantitively ranked from one (awareness of skill/role but no competence), to four (competent and apt to train the skill/role). The graph depicts the sum of the ranking for each educator involved (all anonymized), and points to an increase in competence for five educators. Beyond this positive note, **learning compromises** had to be made, as team members had little time to delve into subjects and to operate equipment beyond the roles they were assigned to. These compromises were due to the tight physical week shooting schedule, and the urge to deliver an acceptable result, because, as stated by the student enrolled as Director, "The biggest challenges were technical ones, which came down to software and it not working as it was supposed to do. I did not overcome it, because it was not my expertise". The previous statement points that, for those inexperienced, the physical week proved insufficient to gain holistic, practical knowledge, as this was the only moment to access and operate VP equipment in an XR studio.

Also, keeping up with VP technical requirements is not within budget constraints of all tertiary education institutions [9], [10] [11], such as IPCA. Even the most basic studio infrastructure, with a LED volume, hinges on substantial financial investment, which is plagued to become obsolete in three to five years [12], hindering VP adoption [9].

The **VP hype** frames VP as a cost-saving, cool technological means to shoot what would be difficult otherwise [6],[2]. However, VP can also be a sledgehammer too big to drive a small nail, as in the words of a student in the role of director of photography, "I think in a sense, [that VP is] also a waste of money. I don't think it's that important. (…) There are still minuses using CG as very good tool being amazing but still looking sometimes very fake if not used correctly".[11] This hype hinged on the idea that VP was the savior of filmmaking during the COVID19 storm, yet VP flopped as its discussion was narrowed to IT contexts, instead of being opened to filmmakers and producers. This hype became a defunct recipe due to investment in VP technology without financial return, yet, the VP potential continues in good health, as it is used by small entrepreneurs with sensitivity to use just enough technology to produce distinctive work [4].

Another big challenge to advance VP research is the lack of collaboration between the industry and the academia, as "When industry professionals approach us with a project and request student involvement, they often need quick results that don't align with academic timelines [and they also display] hesitations due to competition [albeit nowadays these] are gradually changing" [9], a limitation that needs to be addressed to maintain students, educators and technicians VP up-skilling [3]. We argue that VP up-skilling, as with any other field of study, depends on several factors, like the student's intrinsic motivation to learn according to their personal goals [13], which in our case is aimed at gaining proficiency in VP tasks, supported by trained educators. These goals vary from harnessing Unreal, piping its 3D virtual worlds into LED volumes and operating camera [9].

As such, **VP can affect teaching itself,** specifically in proximal areas to our own, like Game Design and animation [11], as the VP pipeline itself can sustain the production of animations. However, distinctive work hinges on reflection and critical thinking, which if in short supply can lead to casual work, something visible in the film script developed by students, to be used in their workshop. Although this script was good for testing VP, it lacked concept and narrative depth as pointed by the student enrolled as Director of Photography, "I didn't like the story of script that we were shooting at, so that was a bit discouraging".

VP hinges on multidisciplinary teamwork, which is why seamless **communication between disciplines is key**, e.g. team members working in the field of ludology have different vocabularies than those working in the field of animation. Miscommunication gets further complicated as getting along with others requires interpersonal skills which need more attention by educational institutions [16], who also need to prioritize circular flows of power in their hierarchical structures to empower team members to use their strengths in project based curriculums [17]. With the previous in mind, we witnessed a lack of dialogue right from the student's online training portion, with clear implications during the in-person shooting week, as pointed by the student enrolled as Set Designer: "(…) we weren't really listening to each other and communicating well - especially online - some people took more leadership role, and I felt they should have communicated more to the rest of the team. (…) I didn't have a lot of space to share my opinion on the things I believe could have worked in a set". Having identified these problems, next we delve on objectives parallel to those of the VPSN project: exploring VP knowledge to enhance animation and video curriculums lectured at IPCA.

4 Discussion

The **VPSN answer** for institutions without VP infrastructures who wish to embrace VP education hinges on two stages: 1) providing online materials for autonomous learning, 2) knowledge transfer and hands-on experience hosted in institutions with an XR stage, supported by Erasmus+ EU funding. An alternative to this scheme is learning in collaboration with industry, through full semester, project-based curriculums, where students acquire skills by enrolling in professional studios to work with VP equipment [18]. We note that there are many similar ventures for teaching VP beyond the VPSN suggesting similar outputs, and restrictions for the education sector [19], that we chose to not report here as this goes beyond the scope of this paper.

Without working with a LED volume learners are not exposed to learning challenges that they won't get by with green screens [9], which is why blended-learning schemes are not exclusive to the VPSN project [12], and why applying such schemes to co-design activities can improve the understanding, innovation and access to immersive technologies [4]. As equipped XR studios are still not democratized commodities, this piques the interest to seek

[11] Here we will identify the students using the roles they assumed during the workshops to keep their identities anonymous.

ways to do VP on a budget, by using a webcam to shoot and a smartphone to do motion tracking [20], by improving pattern detecting algorithms to enable real-time physical camera MoCap with smartphones [22], or by pinpointing low to high-end hardware to **improvise meager VP setups** on a budget [22].
There are of course other not-so-cheap alternatives with specific benefits, e.g., the *Sony PCL's virtual production*, is built with a Sony's 8K Crystal LED and a cinema VENICE camera, allows to shoot computer-generated backgrounds with very low latency and real-time focus [23], a big advantage as avoiding the LED volume Moire effect [12] often requires defocusing such backgrounds [5].

One can also look at uses for VP pipelines and software **beyond cinema**, e.g. MoCap systems can facilitate the responsiveness and adaptation of curriculums that foster problem-solving, creativity and technical skills, and the readiness to work in the industry [15]. These technologies are engaging platforms for motivating and enhancing the student's understanding over complex subjects, as they allow to perceive the impact of one's work in real time [24], e.g., by using ecosystems like *Farsight,* that integrates virtual location scouting with in-app Unreal editing of MoCap, virtual and in-camera VFX, AR [13] without calibration or tracking, simulcam,[14] and seamless data flow across [25].

Animation is a teaching area that can benefit from the previous pedagogical approach, because it shares VP preproduction aspects like scripting, storyboarding, concept art and creative visions. Game design students can also use MoCaP systems to help them do realistic character animation and facial expressions, reducing production time, and learning animation principles using these systems' multi-sensory inputs [25][22]. Early film production stages were reinvented through a new pipeline from Sony Pictures Imageworks, where sequence and shot-based work begins with the Unreal Engine, by exporting Universal Scene Description files [15] to other Digital Content Creation (DCC) software [26]. Further, VP procedures can be used to explore animated aesthetics, e.g., glitching [16] can enhance dynamics, themes, or the protagonists emotional or psychological states, such as fear or loneliness [27].

The **knowledge** transfer required for VP to gain traction in Academia and Industry suffers from a vicious cycle, the lack of formal training in the industry itself, something that affects educators who need to learn to keep up with this area's teaching demands [3]. Formal VP learning can begin with extra-curricular activities sustained by educational materials, and as confidence settles in, by integrating this into VP and VFX running credited courses during one semester, to address the shortage of VP skills. Still, it is still difficult to negotiate studio and academic work agendas, to secure students' practices supported by industry [9].

Team miscommunication has a negative motivational impact on students, and as animation projects entail teamwork challenges, it is crucial for students to be intrinsically motivated to gain skills in communication and project management [5],[28], as for e.g., work will flow better in game design courses when development and art students hold interpersonal soft-skills, are knowledgeable in DCC software and master distinct discipline vocabularies [15], like the adaptability that shapes the industry's 'ideal employee', as seen in the perspective of these future professionals [16].

5 Conclusions and Future Work

By now it is evident that VP cannot serve as a universal solution in the film industry, still, as pointed out earlier, VP advancement can pave great things if employed with reasonably [14], that is, according to available skills and budgets, and by paying close attention to creative artistic rules of film and video animation like story, character design, or simply, the used lenses on digital cameras [29]. With these factors in mind, we aim to integrate VP knowledge and technology into our lectures through improvised lean setups tailored to our disciplines and improved educational materials to augment our students' readiness in this field.

Balancing the VP hype – technical ambition – with VP workflow needs – prioritizing creativity and narrative – is actively sought by institutions [19], with similar outcomes and pitfalls to the VPSN's. Time allowed us to distance ourselves from this experience to identify challenges in educating VP, but due to the limited sample of participants, and preliminary nature of our study, we could only report the experience and its overall insights.

Finally, VP hinges on technical resources, and we pointed out a couple of lean setup guidelines and empirical hardware case studies by YouTubers – either independent professionals, studios or individuals enthralled by VP – in a pace that is hard to keep up with, while pointing to a future research vein to develop detailed implementation VP guidelines or evidence of their effectiveness in classrooms.

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[12] The moiré effect is a visual distortion pattern that occurs when overlapping grids or lines interfere with each other.

[13] AR (Augmented Reality) overlays digital content onto the real world, enhancing the physical environment with interactive virtual elements

[14] Simulcam are systems that merge live-action footage with virtual elements in real-time for on-set visualization

[15] The Universal Scene Description is an open-source 3D scene interchange format developed by Pixar, to enable collaboration and interoperability in 3D workflows.

[16] Glitching as art is a creative practice that uses digital or analog errors, like distortions or malfunctions, to produce aesthetically intentional artworks.

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