CAGA24

THE CONFERENCE OF AG ANIMATION 2024

The (R)Evolution of Animation:
Current Challenges and Future Directions

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CAGA24:
The Conference of AG Animation 2024
The (R)Evolution of Animation: Current Challenges and Future Directions

By Bue Holmsgaard Fyhn, Juergen Hagler, Lana Tankosa Nikolic, Andrea Polywka, Jakob Borrits Skov Sabra, and Peter Vistisen (eds.)

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Editorial – CAGA 2024

Welcome to the Proceedings of the 7th Conference of AG Animation 2024 (CAGA), hosted by The Animation Workshop, VIA University College in Viborg from September 10th to 11th, 2024. CAGA 2024 served as a nexus for scholarly discourse, professional exchange, and creative exploration, uniting academics, industry practitioners, curators, and enthusiasts within animation & the visual arts. The conference was dedicated to rigorously examining the rapid advancements, emergent trends, and substantive research that are collectively reshaping the field of animation and visual storytelling.

The conference theme, "The (R)Evolution of Animation: Current Challenges and Future Directions", was chosen to reflect the dynamic state of contemporary animation – a field undergoing not merely incremental change but a fundamental transformation. This evolution is driven by technological innovation yet simultaneously challenged by complex ecological, political, ethical, and industrial forces. The conference sought to identify and analyze the catalysts for this growth while confronting the significant impediments currently facing the field. This volume compiles the output generated during these focused discussions, providing valuable perspectives on the current state and prospective trajectories of animation art, practice, scholarship, and industry.

The conference was anchored by four thought-provoking keynote addresses that illuminated the technological and artistic currents reshaping animation today. Bonnie Mitchell opened the programme by demonstrating her stewardship of digital heritage, drawing on her decades-long quest to preserve and contextualise the SIGGRAPH media archives – capturing the fluidity of the digital material over time. Photomedia artist Boris Eldagsen followed with a candid account of his headline-making "Electrician" intervention, framing generative AI not as a threat but as an extension of the photographer's craft that still demands rigorous concept and composition. Shifting from images to moving sets, Henrik Schønau Fog showcased Aalborg University's rear-projection Virtual Production Training Facility, illustrating how real-time game-engine pipelines are lowering barriers for filmmakers, animators, and students to experiment with volumetric worlds. Finally, directing duo Michelle and Uri Kranot unpacked the collaborative research methods behind their award-winning immersive works, arguing that expanded animation's capacity for embodied, participatory viewing can revivify animation's core when fused with meticulous hand-crafted aesthetics. Together, the keynotes charted a continuum from preservation to provocation, from technical infrastructure to experiential artistry, and set the thematic stage for the contributions that follow.

Within these pages, the breadth of contemporary animation research is on full display. A significant portion addresses the profound impact of technological shifts, particularly the increasing integration of advanced computational tools and real-time technologies. The paper *Real-Time Animation, AI and Virtual Production: Opportunities and Challenges* directly engages with this intersection, exploring the potential of real-time animation and AI to enhance virtual production workflows, while also considering the practicalities of establishing accessible training facilities. Expanding on the pedagogical dimension of these technologies, *Teaching Virtual Production in Higher Education* investigates the challenges of skills transfer in virtual production, drawing upon insights from the *Virtual Production Studio Network* (VPSN) research project and advocating for cost-effective educational strategies to bridge the existing knowledge gap. Artificial intelligence emerges as a particularly transformative, and at times contentious, area of focus. Its application is shown to extend beyond contemporary production into the critical analysis of historical materials. *AniVision: New Technology-Assisted Approach to Studying Animation History* presents an innovative methodology utilizing machine learning and computer vision to systematically analyze large corpora of ephemeral films, thereby facilitating the discovery and study of previously overlooked animation practices embedded within these historical documents. Further exploration into the intersection of AI and archives is provided by *Brosch AI - Distorted Dreams: Expanding and Animating an Archive With AI*. This project demonstrates the use of AI, including style transfer, to expand and animate archival artistic works, prompting essential discussions on the preservation of artistic integrity, the definition of authenticity, and the inherent technical and ethical complexities, including intellectual property and potential distortions, raised by such applications. The broader ethical landscape of AI-driven creativity is also considered, with themes aligning with discussions captured

in contributions exploring AI image generation examples and ethical context, highlighting ongoing debates around copyright, algorithmic bias, and the responsible deployment of AI in creative processes.

The expanding horizons of animation also encompass its integration into immersive environments. *A Pathway to Immersive Storytelling: from Linear to Participatory* charts the evolution towards more interactive and participatory narratives within extended reality formats like VR and AR, moving beyond traditional sequential structures. A critical challenge within these new spatial computing contexts is the effective guidance of audience attention without breaking immersion or limiting user agency. This challenge is specifically examined in *Guiding Attention in Virtual Reality Theater - A case study of the VR Performance Symmetry*, which draws on a VR theater production to analyze techniques for directing viewer focus in immersive experiences. As the field embraces these new forms, the importance of preserving earlier digital forms is also recognized. The paper on the *Preservation of Web-Animation in a Post-Flash Era* contributes valuable research into the methods and archival efforts dedicated to safeguarding web-based animation, particularly those created with technologies like Flash, acknowledging its historical significance and the complex relationship between legacy and emerging media platforms.

Beyond technological advancements, the conference proceedings address critical industrial, societal, and cultural dimensions of animation's evolution. The human capital within the industry, specifically leadership models and workplace dynamics, is explored in *Leading the Future: Exploring Transformational Leadership in the European Animation, Games, and VFX Industries*. This research identifies a crucial industry shift away from traditional 'crunch' cultures towards more sustainable and supportive environments, emphasizing the increasing value placed on emotional intelligence, mentorship, and shared team ownership in effective leadership within creative sectors. Complementing this internal focus, the papers also highlight the industry's growing responsibility towards environmental and social sustainability. The paper, *From Carbon Footprint to Social Justice* further underscores the urgent necessity for clear guidelines and dedicated research into sustainable production practices, detailing the significant environmental footprint of traditional production methods and advocating for robust social guidelines addressing labor rights, mental health, and diversity.

Perspectives from diverse global contexts reveal unique adaptive strategies and challenges. Insightful analyses of the South African animation industry are given in *South African Hacked Animation Methodologies* and *South African Animation: Decolonial Framework and IP Control*, which illustrate how local animators strategically employ innovative, often 'hacked,' production methods to navigate significant economic, political, and infrastructural limitations. These approaches frequently leverage internet-based distribution and prioritize the retention of intellectual property as a means of fostering sustainable practices and asserting creative autonomy. Crucially, these contributions argue for a re-evaluation and decolonization of the academic discourse surrounding South African animation, urging the adoption of analytical frameworks that acknowledge and value these localized adaptive practices over restrictive, externally imposed notions of "authentic" African animation. Finally, the capacity of animation to serve as a tool for critical social commentary and speculative future-casting. *Black Pudding: A Speculative Visual Index* undertakes a transgressive methodology utilizing AI-porn content generators to investigate the potential and limitations of generative AI in creative pornography production. The paper extends the discussion of AI-generated pornography beyond the prevalent focus on deep fakes, raising crucial ethical concerns regarding the use of such tools for creative research, and suggests a need to 'hack' the metaphor of "unlimited" AI content generation by revealing its representational constraints and proposes that moderation strategies from existing non-live-action media platforms could inform more effective governance of AI-generated content. Finally, the work *On-Screen Prototypes: Making Speculative Designs for and Through Animation* illustrates how techniques derived from speculative design and design fiction can utilize animated prototypes to critically examine the potential impacts of media technologies and stimulate important discussions about plausible future realities.

Looking across these diverse contributions, a powerful narrative emerges. The challenges discussed, spanning technological disruption, ethical quandaries, environmental responsibility, organizational culture, and systemic inequalities, are not merely impediments but rather potent drivers for innovation and critical engagement within the field. The research contained within this volume collectively demonstrates a community of practitioners and scholars characterized by adaptability, critical reflexivity, and a clear orientation towards shaping the future. From pioneering accessible virtual production methods and employing AI for historical analysis, to advocating for sustainable practices, decolonizing creative discourse, and exploring new narrative forms in immersive media, the work presented here exemplifies a field actively engaged in its own transformation.

The "(R)Evolution" of animation is undeniably underway, characterized by both revolutionary technological leaps that redefine production possibilities and a necessary, evolving critical awareness of its broader social, ethical, and environmental responsibilities. The papers compiled in these proceedings offer not only a valuable snapshot of this complex moment but also provide foundational research and strategic insights crucial for navigating the path

forward. As we absorb the diverse findings and consider the implications of these contributions, we are equipped to view the future of animation not with uncertainty, but with a grounded optimism for its continued capacity for creative, technological, and societal impact. The challenges ahead are substantial, but the intellectual rigor and innovative spirit reflected in these pages suggest a field well-positioned to meet them, fostering a future for animation that is both technologically advanced and deeply engaged with the complexities of the world it reflects and shapes.

We hope you will enjoy and engage with the contributions in these proceedings!

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AniVision

New Technology-Assisted Approach to Studying Animation History

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Abstract

The digital humanities project *AniVision* uses machine learning and computer vision to explore a large corpus of animation in ephemeral films produced in Austria, East Germany, and West Germany during the Cold War. Ephemeral films are a diverse group of films produced for specific utilitarian purposes. While there is animation in these films, it has been comparably neglected in animation studies. In recent decades, technological advances have created opportunities to improve this situation. In *AniVision*, a machine learning-based approach is developed to automatically classify animated material within a large corpus of ephemeral films. A collaboration between animation scholars and computer scientists, the project aims to study a previously understudied corpus and to develop methods suitable for the analysis of other similarly structured corpora. This paper provides an overview of ephemeral film and its relationship to animation, before introducing the *AniVision* project and presenting some of its results.

CCS Concepts

•Applied computing ~ Arts and humanities ~ Media arts •Computing methodologies ~ Artificial intelligence ~ Computer vision ~ Computer vision tasks ~ Visual content-based indexing and retrieval •Computing methodologies ~ Machine learning ~ Learning paradigms ~ Supervised learning ~ Supervised learning by classification

Keywords

Animation, Computer Vision, Ephemeral Film, Useful Cinema, Utility Film, Machine Learning

1 Introduction

Until now, research on the history of animation has "focused overwhelmingly on its historical role in art and entertainment" [7, p. 197], with less interest paid to so-called ephemeral film [24, p. 51], one of several terms used to describe a large group of films produced for specific utilitarian purposes that includes advertisements, educational films, corporate films, newsreels, amateur films, and public service announcements. Within these films there is widespread integration of animation [7, p. 197], ranging from basic formal-functional elements like titles and credits to complex sequences.

One possible reason for this lack of interest may be the difficulty of studying animation in such a vast and often poorly documented area of film production. Because of its comparably high production costs, the use of animation in ephemeral films tends to be selective, making brief sequences embedded in live-action material more common than fully animated films. When metadata is created for a film, such sequences are often not considered or recognized as animation. As a result, simply identifying relevant material can become a labor-intensive task for animation scholars wishing to study ephemeral film. To improve this situation, the *AniVision* research project takes advantage of developments in computer vision and machine learning to develop automated content-based visual retrieval methods for animated material.

AniVision is a systematic, large-scale, data-driven analysis of animation styles and their historical development in ephemeral films in Austria, West Germany, and East Germany during the Cold War. It is an interdisciplinary collaboration between computer scientists and animation scholars that follows a distant viewing approach, i.e., "the application of computer vision methods to the computational analysis of digital images" [2, p. 3]. Such methods allow the analysis of larger corpora, which should provide greater insight into stylistic patterns and their evolution in the animation production of the countries considered. However, this first requires the development of computer vision methods tailored to the characteristics of the corpus, e.g. small amounts of different animation techniques embedded in a majority of live-action material. In their design, these methods should be applicable to other similar corpora, allowing more comprehensive histories of animation to be written. This paper will first provide an overview of ephemeral film, its various subgroups and its relationship to animation, before introducing the *AniVision* research project and presenting some of its current results in the form of a short case study.

2 Genre in Ephemeral Film

Much like the term ephemeral film itself, there are many, often overlapping, terms for its subgroups. Most are derived from either a film's institutional origin, i.e., its sponsor, or its utilitarian purpose, i.e., its function. Frequently used sponsor-based terms are corporate film, industrial film, science film, and amateur film. Sometimes used synonymously, the first two terms describe "films commissioned and used as a communication tool by corporations and business associations (excluding advertising spots)" [27, p. 104]. Science films are produced by institution

engaged in scientific research, and amateur films are defined by the fact that they are produced by laypeople; the latter's classification as ephemeral is debatable [24, p. 52–53], as the ephemerality of individual films is highly circumstantial.

Common function-based terms include advertisements, health education film, educational film, training film, work safety film, newsreel, public service announcements, and research film. Advertisements are films produced to promote commercial products, services, or companies. Health education films are "produced with the intention of reforming or reinforcing public health beliefs and practices" [3, p. 1]. Educational films are produced to educate their audience, and training and work safety films are two subgroups of it with more specific educational goals, the former preparing for a defined task and the latter teaching how to avoid workplace accidents. Newsreels are short documentary films shown in movie theaters that cover current events and other miscellaneous topics and set the template for later news formats on television. Public service announcements, usually sponsored by government agencies, are produced to inform the general public. Finally, research films are produced by scientists "in order to document phenomena or processes" [9, p. 90], and differ from educational films in their assumption of an expert audience [9, p. 90].

Both types of classifications have their own advantages and disadvantages. The advantage of sponsor-based classifications is that many organizations sponsoring film production have apparent defining characteristics. The problem is that individual organizations may sponsor a wide variety of films, which reduces the significance of grouping these films together. This is the advantage of function-based classifications, which emphasize how films sponsored by different types of organizations may serve similar functions. The problem with these classifications is that identifying a film's function can be a relatively interpretive task. For this research project, it was decided to include both types in our metadata schema, treating all terms as fuzzy, non-exclusive categories so as not to preemptively impose a restrictive framework on their understanding. Since ephemeral films are never meant to be "self-sufficient entities for aesthetic analysis" [15, p. 11], these categories, which effectively quantify many of the practices surrounding their production and reception, are an important aspect helping to research larger corpora and allow the identification of relationships between the practices they encapsulate and the aesthetic design of individual films.

3 Animation in Ephemeral Film

From its inception, animation as a filmmaking practice has "also appealed to experts working in other professional fields, from science and medicine to education and advertising" [7, p. 197]. As a result, it was quickly used in various types of ephemeral film, with examples from the early twentieth century including Arthur Melbourne-Cooper's stop-motion advertisements [13, p. 30], mathematician Ludwig Münch's educational films [14], and training films made for the U.S. Army by the Bray Studios and Max Fleischer [13, p. 58].

The use of animation in ephemeral films often serves one of several common functions. One is to capture and hold the audience's attention through a distinctive visual presentation. Typical examples of this are advertisements, where the use of animation ranges from appealingly drawn characters to stop-motion techniques animating immobile objects. Another is to "visualize relations and show things that could not be photographed or seen with the naked eye" [7, p. 197], with an obvious example being the use of time manipulation techniques in science films. In the case of drawn animation techniques, this function often goes hand in hand with a third: to create visual as well as intellectual abstractions [12, p. 43]. To this end, animation is used to depict, among other things, medical procedures and biological processes. These functions overlap with the use of animation in entertainment and art, with a particular closeness to animated documentaries, as evidenced by some early studies of the latter including ephemeral film [10]. In addition, these functions also point to seldom considered relationships, such as those between animation and illustrations made in educational and scientific contexts.

To date, there is only a small body of scholarship on animation in ephemeral film that considers these two aspects equally. Examples include the edited collection *Animation and Advertising* [4], monographs on the war efforts of the Disney and Warner Bros. Studios [18], contributions to edited collections [6, 19, 21, 22], and journal articles [7, 17]. Beyond this, most research on the topic comes from either animation studies or scholarship on ephemeral film [7, p. 197] and tends to treat the other aspect in a more rudimentary manner.

In animation studies, ephemeral films are considered in both broader histories of animation and monographs on individual animators or studios. In the former, they are sporadically acknowledged [13, p. 228], but more time is spent on them only when they have historical relevance [13, p. 79] or double as experimental animation [13, p. 87]. In the latter, individual films receive more attention, but because the subjects are usually important animators [8] or studios [18], there tends to be a strong overlap with the ephemeral films considered in broader histories. In all of these, the focus is usually on advertisements, thanks to them having "been central to the work of famous animation studios and celebrated artists" [5, p. 1]. From a different direction, scholarship on animated documentaries [10, 11, 16, 25] provides valuable input for considering animation in ephemeral film, even if most of it is not concerned with ephemeral film per se.

In studies of ephemeral film, the presence of animation is often acknowledged without further elaboration. For example, Rick Prelinger's study of the films of the Jam Handy organization notes their "frequent deployment of animation, including a number of striking stop-motion animation sequences that recall the work of Oskar Fischinger" [20, p. 215], but does not explore this aspect further.

On the level of individual research, this lack of consideration of animation in ephemeral film is often dictated by both subject matter and film access. Collectively, this has resulted in an impoverishment of the documented history of animation. Given

both the often regional nature of ephemeral film production and the frequent use of animation in these films, it is reasonable to assume that even in countries with little documented animation production, there would have been animation production for ephemeral film. Even if these films have been archived, it is still a great challenge for scholars to find them. *AniVision* aims to improve this situation by developing computer vision methods tailored to this task.

4 *AniVision*

For *AniVision*, a corpus of ephemeral films was assembled from material provided by thirteen archives, five Austrian, eight German, including corporate, governmental, and animation-specific archives. At the time of writing, the corpus consists of approximately 2000 digitized film files, of which over 850 are annotated to some degree, for a total running time of over 210 hours of annotated material. Initial assumptions about the presence of animation in this corpus could be confirmed, e.g., that there would be few fully animated films, but many short segments embedded in live-action material. To develop computer vision methods for the automated analysis of animated films, parts of the assembled corpus were manually annotated with a controlled vocabulary. Structured in a hierarchical template, this vocabulary, consisting of defined scholarly concepts, formalized the annotations and ensured their machine readability. This allows them to be used both as quantitative data for scholarly research and as reference data for machine learning.

Once a sufficient number of films had been annotated, the computer scientists began machine learning experiments. Because the initial experiments were based on single frames, and because several animation techniques in the corpus are indistinguishable from live-action without considering motion, an originally planned first step of classifying images as either live-action or animation was replaced by the proxy task of classifying images as either photographic or non-photographic compositions. A model capable of doing this would already be able to distinguish many common animation techniques from live-action. During the experiments, the application of an explainability algorithm made it possible to better utilize the expert knowledge of the animation scholars by improving their ability to evaluate the experiments. The best experiments on this task achieved test set f1 scores close to 95% [1, p. 10], suggesting that a resulting model, especially when combined with other types of visual retrieval, should be able to achieve high accuracy in automatically classifying animated film.

Another task for the computer scientists was to design a database and frontend for uploading annotations and entering metadata. Metadata included the aforementioned genre classifications and, where possible, credits from either the films themselves, available paratexts, or existing databases. Effective access to both metadata and annotations is required to enable large-scale corpus exploration for the purpose of distant viewing. Such a distant viewing can reveal larger developments within the corpus, as well as professional networks of animators and production companies. Caution must always be exercised, however, as the poorly documented and archived status of ephemeral film production limits the representativeness of any assembled corpus. Nevertheless, trends can be observed, especially when focusing on subgroups of the corpora, where representativeness is easier to determine.

5 Case Study: The Institute for Scientific Film

A well-documented subgroup of the *AniVision* corpus are the films of the Institute for Scientific Film (IWF), a major West German producer and distributor of science films. Existing from 1956 to 2010, its founder, Gotthard Wolf, once wrote that "the science film does not strive for illusion, but for the objective reproduction of reality" [1] [26, p. 477]. In light of this, it is particularly interesting to look at how the organization's films have used animation, since its ontological status puts it at odds with typical notions of objective representation.

For *AniVision*, the assembled films were preselected to focus on those that might contain animation, and more than 150 were manually annotated. In total, more than 33 hours received a label indicating a basic image type, with more than 16 hours annotated as animation and about 10 hours as live-action Looking at the temporal distribution of animation in these films, there are noticeable peaks at the beginning and end, reflecting the frequent use of animation for titles and credits. At 8 hours, the largest group of animation are cutouts, followed by 3.5 hours of time manipulation and 3 hours of cel animation.

There are several possible explanations for this distribution of animation techniques. Cutouts can be created from a variety of materials, reused across multiple films, and adapted from existing scientific illustrations with comparable ease, making them a cost-efficient form of animation in this production context. Their drawback, that they, while efficient at depicting the motion of objects fixed in shape, are themselves less malleable, is less problematic in science films, where animated objects are often both visual and intellectual abstractions, their fixed shape sufficient for supporting the audience's understanding of what they signify. Time manipulation being the second largest group reflects animation's continued use to "show things that could not be photographed or seen with the naked eye" [7, p. 197]. Finally, cel animation can fulfill similar functions as cutouts, but can more easily depict objects that change shape, such as growing plants.

Returning to Wolf's statement, the use of both cutout and cel animation may have been legitimized by them being interpreted as a continuation of established scientific visualizations that were perceived as objective representations. Regarding the frequent use of time manipulation, Wolf himself spoke of such filmmaking techniques as a way to overcome the limitations of the human sensory apparatus [26, p. 477]. However, simply mapping Wolf's statement of intent onto broader stylistic patterns does not fully do

[1] "Der wissenschaftliche Film erstrebt nicht die Illusion, sondern die objektive Wiedergabe der Wirklichkeit" (English translation by author). Beyond the general philosophical implications of this statement, it must also be read in the context of the IWF's organizational self-interest. Framing science as an objective, apolitical endeavor supported ignoring the organization's entanglement with the RWU, its predecessor in Nazi Germany [23, p. 280–290].

justice to the IWF corpus. Between the IWF's changing leadership, its collaboration with scientists based elsewhere, and its occasional distribution of films produced by other organizations, preliminary close readings suggest that the corpus includes a broader range of ideas about what constitutes acceptable use of animation in science films.

At this point, the findings on the IWF corpus confirm some basic assumptions about the role and presence of animation in ephemeral film. The dominance of several animation techniques may be linked to the intended utilitarian function of these science films, while their appearance also suggests how production contexts, in this case the IWF's own history and understanding of its role as part of a scientific community, influence aesthetic choices. The amount of animation present in this corpus, a corpus not usually perceived as an important site of animation production, suggests the sheer volume of existing animation whose obscure position has so far stifled attempts to study it.

6 Conclusion

The *AniVision* research project is an interdisciplinary analysis of a large corpus of ephemeral film. By using computer vision to explore a previously understudied corpus, it contributes to both computer science and animation studies. While recent years have seen strong developments in computer vision, its application to animation remains comparatively niche. The results of the project's initial machine learning experiments suggest that the goal of automatic analysis methods tailored to animation is feasible. The need for such models arises from the existence of large, poorly documented film corpora that are likely to contain animation. In the past, attempts to study animated material within these corpora have been prohibitively expensive due to the amount of work required just to identify it. The proposed model for the automatic classification of animated material will assist in this task, thereby enabling the study of animation to include such understudied corpora. Furthermore, the corpus assembled for this project is itself understudied. Thus, its study contributes to animation studies in its own right, for example by identifying other topics of interest within it, such as previously unknown animators.

7 Acknowledgments

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The principal investigators are Dr. Franziska Bruckner (FHSTP), Dr. Erwin Feyersinger (UT), and Dr. Matthias Zeppelzauer (FHSTP). On an interim basis, Dr. Vrääth Öhner (FHSTP) additionally managed the project. Team members are Andreas Babic (FHSTP), Clemens Baumann (FHSTP), Roberto Labadie-Tamayo (FHSTP), Mahboobeh Mohammadzaki (UT), Kristina Schmiedl (FHSTP), and Claudius Stemmler (UT). Additional support has been provided by Dr. Victor Adriel de Jesus Oliveira (FHSTP). Mónica Apellaniz Portos (FHSTP) and Patrik Lechner (FHSTP) are former team members.

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A Pathway to Immersive Storytelling: from Linear to Participatory

– Reflecting on the Artistic XR works of Michelle & Uri Kranot

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ABSTRACT

This paper contributes to understanding XR, animation, and participatory storytelling intersections by documenting and reflecting on creative processes. This account illustrates the Kranots' trajectory through six stages of practice and research, illustrated by personal artistic works. The authors argue that the integration of performance, animation, and XR enriches creative industries and educational contexts, adding meaning and practical value. Their process begins with 'performative immersion', followed by 'passive witnessing' and 'immersion through interaction'. The process is further explored in 'immersion through being' and 'immersion through shared experience'. Their current stage of investigation concludes the process with the examination of 'real-time narratives'. This research traces a personal artistic journey from linear to participatory storytelling, while providing a structured pathway for other artists and researchers to explore similar practices.

CCS CONCEPTS

•Applied computing ~ Arts and humanities •Social and professional topics ~ Professional topics •General and reference ~ Document types ~ General conference proceedings

KEYWORDS

Immersive Storytelling, Participatory Art, XR, Virtual Worlds

Introduction

This contribution is a reflection on the story design process through an account of personal creative milestones in our professional practice. By testing the frontiers of immersive art and moving images and activating participation in location-based experiences, we are compelled to ask how the medium is changing the way we tell a story? Specifically, how does the development of technologies offer artists new tools and opportunities, and what steps are involved in the transition from traditional to participatory storytelling? Our objective is to offer a basic theoretical framework outlining the practical and conceptual progression from screen-based linear storytelling to interactive, collective experiences – while pointing out interdisciplinary strategies in support of this trajectory.

Background

According to the European Commission's science and knowledge service, new virtual environments are expected to bring transformative shifts in technology, society, and the economy (Hupont Torres et al., 2023). This research is conducted in the practical framework of collaborations with companies and cultural actors in the digital media and animation industry, set within the broader context of the European cultural and creative industries (CCI) ecosystem.

Immersive Storytelling, or XR, builds on the ongoing rapprochement between audiovisual arts and game studies to experiment with storyworlds as an alternative mode of storytelling (Ryan & Thon, 2014). We use the comprehensive term XR to reference a group of emerging technologies and media which in some way manipulate our perception of physical reality. These include virtual reality (VR), augmented reality (AR), mixed reality (MR), and other digital tools and applications (Rauschnabel et al., 2022).

Moving from traditional narrative and timeline-based film towards an experience that calls for an active participant rather than a viewer, XR holds the potential to unveil new territories for storytelling just as cinema did 120 years ago. This is even more apparent when engaging in interactive, free-roam, 6 DoF (six degrees of freedom) performative installations in public spaces (Ceuterick & Ingraham, 2021).

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Our multi-disciplinary inquiry uses artistic practice research to explore the storytelling possibilities in the burgeoning field of animated XR, which now offers increasingly complex immersive and participatory animated XR worlds, both for individuals and for groups (Lukas, 2012).

Methodology

Our research methodology aligns with the term 'practice research', which encompasses all forms of research that incorporate practice (Candy 2006). Practice research may be used to describe our body of work 'as a whole', combining practice-as-research (PaR) approaches in the development process with practice-based-research (PbR) analysis, including researcher practitioner reflection, and participant research. Described as a cycle or revisionary process (Gadamer, 2004), PaR is an iterative cycle of "doing – reflecting – reading – articulating – doing" (Nelson, 2013).

The cycle consists of making work, reading, researching as artists and complementing that with critical assessment and evaluation of other works. Producing new work and iterations of prototypes, presenting work, conducting workshops with students and collaborators from across disciplines perpetuates this cycle.

Our methodology of artistic practice research (Nelson, 2006) is anchored in the creative process and applied to our teaching practice. Among other opportunities, it is through our association with a higher education institution that we have access to the latest technology in our lab and studio. Reflective practice (Schön, 1983), an invaluable feature of our practitioner research, is also embedded in our teaching methods. Notably, our methods often employ the pedagogic lens of Project-based Learning (PjBL) (Mitchell & Tilley, 2024).

From Linear to Participatory

As a touchstone and primary case study, we offer a brief analysis of the project The Hangman at Home (2020). This multimedia work deliberately explores the crossover between the linear screen-based medium of animated film, and the technologically mediated immersive experience of VR (Kranot, 2021). Thus, in the following section, we chart the milestones which led to this innovative work and the technological achievements it later enabled. These are organised as a six-stage framework.

Situating the case study

The Hangman at Home is an animated short film and a single-user VR experience. It is also a multiuser co-location experience and a performance installation. Though all the components of this multimedia project deal with the overarching theme of acknowledgement, the two XR experiences are separate and independent from The Hangman at Home animated short film. These investigate interactivity as a call for participation (Biocca, 2002), examining this through the lens of a non-linear user-led journey through changing environments.

In 2020, the project The Hangman at Home was awarded the grand jury prize for best VR immersive work at the 77th Venice Biennale Film Festival. Notable titles released in this same period include Finding pandora x by Kiira Benzing (USA) and Sha si da ming xing (killing a superstar) by Fan Fan (China), (La Biennale, 2020). The Hangman at Home is uniquely innovative among its contemporaries in its use of fully interactive story elements. Interaction is a term that is more common in discussions of multimedia and digital art forms than in participatory theatre (Machon, 2013). Yet it is knowledge transferred from the field of participatory theater and installation art (Biggin, 2017) which positions The Hangman at Home as unique in the XR landscape at the time.

The development and production process of this large-scale project, co-produced in Denmark, France and Canada, was lengthy and incremental. Beginning with drawing, painting, sculpture, and sketches, the narrative progressively built upon each iteration and in conversation with the distinct media platform. Our objective was to explore the diverse possibilities offered by each platform: the screen-based film adheres to a linear structure adopting a strict formalist approach to cinematography and editing. It features only five repeating shots, with no camera movements. As an XR experience, we introduce user mobility and interactivity, inviting users to make choices and take on an active role as an avatar in the story. In its multi-user form, the project enables participants to communicate and make decisions collaboratively within a virtual world.

Stage One: Performative Immersion

We describe the first stage of our six-stage framework as 'performative immersion'. Some game and VR researchers regard immersion as a technical construct, while others regard immersion more as a psychological state (Bareisyte et al., 2024). Our definition builds upon our own earlier work, preceding the introduction of XR technology into our creative process. This earlier work investigates multiuser experiences in expanded animation (Hagler et al., 2019), embedded within participatory theatre (White, 2013). Gareth White defines theatre as participatory when active audience participation is an integral aesthetic and structural feature of the participatory performance (White, 2013).

Figure 1: Photo from The Hollow Land Experience

We refer to the example of The Hollow Land Experience (2013), which was the first in a series of collaborations with theatre practitioners Sara Topsøe Jensen and Sarah John. Together we designed a sensorial participatory theatre experience where the audience wears masks and is immersed in the visual world of Hollow Land (2013), which was first released as a traditional stopmotion animated film on the theme of displacement. The film is a love story about resentment, immigration, and hope.

Figure 2: Still from Hollow Land

As a theatrical experience, it is a poetic and moving social experiment with light and projections, and is motivated by curiosity and playfulness. By placing masks on people, audiences are invited into the story – making them active participants in the characterless landscapes of the Hollow Land visual universe. We consider this our first step towards interdisciplinary and participatory storytelling (Machon, 2013), leading to further research on the technologically mediated notion of 'presence'. Lee defines the term 'presence' in communication theory as "a psychological state in which virtual objects are experienced as actual objects in either sensory or nonsensory ways" (Lee, 2004).

Stage Two: Passive Witnessing

Following 'performative immersion', we propose 'passive witnessing' as the second stage in the framework. To exemplify this progression, we can trace the leap from The Hollow Land Experience, as a theatrical offshoot of the animated film Hollow Land, to the next milestone project – Nothing Happens (2017). Nothing Happens began as an animated film about spectatorship. The project is about watching and being watched, and it was simultaneously developed into an XR experience on the same theme.

Figure 3: Still from Nothing Happens

Examined through multiple perspectives, Nothing Happens offers a new way of looking and questions our accountability as viewers, spectators, and artists. The project depicts a crowd of people assembling to witness a spectacle. The assembly of characters is mirrored by a murder of crows in the tree tops: a snowy forest, time and location unspecified. Nothing Happens is an animated observation on the nuances of interaction and passive witnessing.

The adaptation from a screen-based film to VR allowed us to deconstruct the narrative and put it back together in a new way. We were compelled to place the viewer inside the painted scenes, inviting the spectator to become part of the collective spectacle itself. Nothing Happens VR, in line with its theme, offers the user a multi-layered, yet passive experience.

Figure 4: Photo from Nothing Happens VR installation

Though many VR works address the notion of togetherness, in most early VR works, the user is passive (Durlach & Slater, 2000). This may have to do with the limitations of the technology at the time. Developing the technology which later allowed for interactive shared experience demonstrated in The Hangman at Home, demanded a substantial financial investment, and was still out of our reach. Our investigation into the innovative interactive components of a VR experience was thus broken down into smaller, cumulative building blocks.

Stage Three: Immersion Through Interaction

Succeeding the notion of 'passive witnessing', is stage three which we label 'immersion through interaction'.
Shortly after the successful launch of Nothing Happens, we were approached by The Guardian Virtual Reality team to collaborate on Songbird (2019). Described as 'a fairytale with a dark heart', Songbird transports you to the island of Kauai in 1984 and into a painted replica of a lush cloud forest filled with colourful birds. Here you are invited to search for the last known 'ō'ō, an iconic black bird with yellow leg feathers and a beautiful song, a bird whose existence has been threatened to the point of extinction.

Figure 5: Still from Songbird

Songbird challenged us to develop a new storytelling toolkit and vocabulary for interactive spatial narrative (Jenkins 2004). Our response was to position ourselves in the role of the user and anchor the progressional storytelling process in a series of questions. These questions, though listed here as a first-person internal monologue, are offered as a broadly applicable model for developing immersive stories:

"Where am I?"

Our most primal need: we want to feel safe. As we are transported into a new environment, we will most likely make a quick 360-degree scan of it, making sure there are no dangers around us. In terms of storytelling, this initial orientation requires more time for an introduction, allowing the user to adjust to their surroundings.

"Who am I?"

Once we familiarize ourselves with the environment, we might ask ourselves how are connected to this place. Or in other words, in what state do we exist? Are we ourselves or have we been put in 'someone else's shoes'? Is our existence represented physically? Do we have a body? Hands? Are we a ghost?

"Why am I here?"

We propose that once it has been established that one exists, the next logical question would be to ask why.

As opposed to traditional screen-based viewing, in interactive media, it is imperative to define the role of the person engaged in the media experience. As authors and creators, we may refer to our audience as users or participants. We may refer to them as guests or players, considering that each characterization implies a different position and varying degrees of agency.

"What can I do?"

Can I move around? Can I touch it? Can I interact with my surroundings?

At this point, the user would most likely be developing expectations which demand to be addressed: if the experience is interactive, what are the rules? What are the parameters? Which actions are rewarded, and how?

The work poured into Songbird finally afforded us the tools, applications, and production opportunities to begin the development of The Hangman at Home.

Stage Four: Immersion Through Being

We situate The Hangman at Home as an example of the fourth stage of the framework called "immersion through being".

Figure 6: Still from The Hangman at Home

"What does the hangman think about when he goes home at night from work?"

Inspired by the 1922 Carl Sandburg poem of the same title, The Hangman at Home (2020) is a multi-media project exploring participation across mediums, it became an opportunity to investigate the position and the role of the of the user more deeply.

A guest?
A ghost?
An observer?
A participant?
A character?
A player?

Both the single-user VR experience of The Hangman at Home and the multi-user XR installation titled We Are at Home (2022), present a captivating, poetic habitat that prompts users to question the consequences of their actions and inaction. The experience expands on the notion of witnessing and observation posed in Nothing Happens, by going further to ask about implication and responsibility through interaction and bifurcating storylines (Ryan, 2001, Murray, 1997).

Figure 7: Still from The Hangman at Home VR

As in our previous works, the animation is hand-painted frame-by-frame with acrylic, a technique that allows for a rich though subtle examination of characters, gestures, and behaviours. The series of 'living paintings' highlights private, domestic spaces, which are positioned within a formalistic, fragmented narrative.

When expanded and presented as an immersive scenography and installation for a larger group of participants, the project was showcased in the context of a theatrical event. This leads to stage five: where audience members are invited into a shared immersive experience - to meet each other both in the VR headset, as avatars, and outside it - engaging with multiple layers of narrative and imagery.

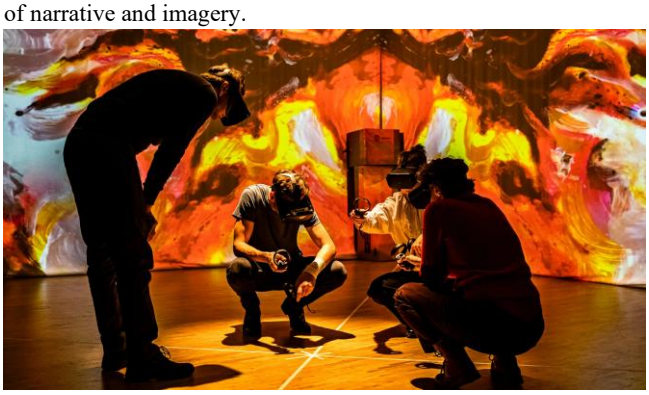

Figure 8: Photo from The Hangman at Home VR installation

Stage Five: Immersion Through Shared Experience

'Immersion through shared experience' is stage five in the framework. The investigation into the collective and shared experience of The Hangman at Home became a highly relevant case study for applying immersive storytelling research and introducing XR into the educational sphere, as well as the cultural sector.

Prototyping workshops with students emerged as a novel and integral tool in realizing the project, serving as a meeting point with bachelor students. We organized periodical showings where students tested our latest prototypes. We closely observed and documented their behaviour, in combination with interviews. By observing users' behaviour, we were able to assess their navigation skills, comprehension levels, and their ability to actively engage with and progress through an interactive narrative. We paid close attention to how much time was spent in each of the virtual spaces, variations in attention, in focus, and how these impact the perceived experience. In addition, students actively participated in the production process, through internships and workshops. Students could take on various positions, from visual development to programming, which fostered a valuable exchange of knowledge.

Stage Six: Real-Time Narratives

The sixth stage of the framework proposes the notion of 'real-time narratives' as the most powerful storytelling tool we have developed as of now. Our current project, "The Garden Says…" (2025) is born from the lessons of The Hangman at Home. Specifically, we were spurred to expand on the notion of collective experience and explore a shared virtual space in a more authentic and sensorial setting (Bucher, 2017).

Figure 9: Still from The Garden Says...

"The Garden Says…" is a virtual world. It is an interactive audiovisual and tactile multi-user mixed reality experience: a dynamic, shared playground where music, hand-painted animation, and dramaturgical scenography unite. The garden serves as an active and sensual space for emergent behaviour, exploring human encounters as an ecological act, through an immersive experience of the sublime.

In "The Garden Says…" different types of meetings take place simultaneously: a meeting in VR for four to eight people at a time, alongside different invitations to analogue (not digital) meetings in the room. The performance hosts of "The Garden Says…" are a team of three performers who, by way of inviting, meeting, and asking questions of the participants, make these questions come alive. We describe these experiments with dialogical structures as a 'meeting laboratory', where performers and participants share the responsibility for the experience (Breel 2017).

Figure 10: Photo from The Garden Says... installation

In the expansion from the individual to collective experience, The Hangman at Home opened new opportunities for working collaboratively. Thus, "The Garden Says…" not only builds on the technical accomplishments of The Hangman at Home, but also on the teamwork, the talents, and the network that allow us to push the boundaries of the medium. Prototyping workshops with practitioners from the fields of games, theatre, educational sciences and communication design, emerged as an integral tool in realizing the project. This valuable exchange of knowledge made it possible to develop a complex networked system using mixed reality headsets (Quest3), projection mapping, and directional sound into a seemingly effortless habitat.

Conclusions

The evolution of our storytelling methods goes hand in hand with innovation in emerging media. By using XR technology, we transcended our linear screen-based practice to explore multisensory space: visual, tactile, and haptic all at once. We find that the integration of performance, animation, and XR offers a rich and meaningful outcome.

Our learnings allow us to further explore how digital artwork might relate intimately to a specific spatial and sonic setting and how it might take up a physical, visual, and emotional relationship with the audience. We argue that, as opposed to traditional screen-based viewing, in interactive media it is imperative to define the role of the person engaged in the media experience.

We conclude that, whereas XR is an excellent tool for scenography or visual dramaturgy, we feel very strongly that it is not the technology that is driving the experience. The element of engagement in public spaces and the interconnected themes of presence and participation are the thread that ties together all the works represented here – rather than the technology or the medium through which the artwork is expressed. That said, we

believe that a discerning choice of medium is at the core of any work of art.

This account serves as a foundation for the further investigation of audience experiences in virtual worlds. In our research, we argue for the conceptual framework of 'Expanded Worldbuilding' to describe a system for emergent storytelling which combines visual, immersive, and participatory strategies (Crois, 2022). In continuing our research endeavour, we propose that 'Expanded Worldbuilding' enables the audience to engage in an increasingly complex, emerging narrative as they experience and participate in a shared meaning-making process.

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Preservation of Web-Animation in a Post-Flash Era

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ABSTRACT

At the beginning of 2021, Adobe ended support for Flash Player. The software had been a popular mode of accessing and displaying web-based multimedia content for decades, and its discontinuation has led to a shift in the way amateur and short-form animation can be hosted online.

Flash allowed amateur creatives to share animated videos, playable video games, and other multimedia content with audiences over the web. After the announcement that Adobe would no longer be supporting the software, websites and creatives alike who relied on Flash turned to alternative means of disseminating animated works. In the absence of this software, creators and publishers alike have turned to alternative solutions, such as integrating new third-party software, or converting the media to embedded video– without support for interactive elements. Some Flash animations have been taken offline altogether, or have become lost media.

The impact of this discontinuation is wide and varied. This paper aims to focus on the impact it has had on the largest web-based visual narrative to date: Andrew Hussie's cult-classic, multimedia comic Homestuck. During the webcomic's seven year run, Homestuck amassed over 8000 pages, with a sizable percentage containing Flash animation. The purpose of this case study therefore is to discuss the solutions brought forward by VIZ Media, who had acquired the publishing rights to the comic in 2018, and by volunteer archivists to preserve the original medium of the comic. In using Homestuck as a case study, where multiple forms of preservation and archiving have been attempted, preliminary hypotheses about the effect that Flash Player's discontinuation has had on amateur web animation can be drawn.

CCS CONCEPTS

• Applied computing→ Arts and humanities→ Media Arts; • Computer systems organization → Real-time operating systems; • Human-centered computing→ Interactive systems and tools; • Computing methodologies → Computer graphics → Animation.

1 Introduction

Adobe Flash Player was a computer program that was typically run on web browsers as a plug-in component. It allowed users to view a variety of multimedia content through their web browsers, including but not limited to animation, click-and-point games, Rich Internet Applications, and audio streaming. The program switched hands a lot, ultimately becoming part of Adobe's arsenal after their acquiring of Macromedia in 2005, an acquisition that also allowed them to obtain Adobe Animate, formerly known as Adobe Flash.

These digital advances allowed a culture of web-animation to develop on the early internet, with Spümcø debuting the first animated series made solely for the internet in 1997.[1] YouTube, launched in 2005, took the lead as the principal video hosting and sharing website from there on out. But prior to the mass availability of video streaming and high speed internet, Flash animation persevered. As Flash could compress video and audio files to a fraction of their size and could preload this data over even a dial-up modem, it was a convenient and almost universally accessible way of sharing and hosting video files.

Digital technologies had been increasingly used in mainstream animation since developments in the 1980s[2], but wider access to technologies for amateurs helped a culture of web-animation to develop. The popularity of free and widely used platforms on which to display video content was also key. Newgrounds, and other similar platforms, were built to host Flash-based animation and games from amateur creators which could then be easily accessed and shared by others online. Digital tools for animation made the creation and distribution of web-animation easier– with no formal training, an artist could access professional tools and a large audience.

2 EOL of Flash

In 2010, then-Apple CEO Steve Jobs penned an open letter criticising Adobe.[3] As Flash was not available on iOS, Adobe claimed that Apple products such as the iPhone could not view 75% of video material on the internet at the time. In Jobs's rebuttal, he claimed there were security risks associated with Flash and that the majority of video content was available in formats that negate the need for Flash; at this point, he claimed approximately 40% of the internet's video material was hosted on YouTube alone. Despite pushback from Adobe, this was

considered the turning point for Flash Player. Adobe began pushing HTML5 as an alternative for web-animation, rebranding Adobe Flash Professional as Adobe Animate and ending future developments for Flash Player. In 2017, Adobe officially announced the EOL plans for Flash Player, declaring the software would cease to be supported from the end of 2020.

Despite this, by January 2021 there were a number of facilities worldwide that still relied on Flash Player, including many international government bodies.[4] Many news websites in the United States had hosted their coverage of events such as 9/11 in Flash and the graphics became defunct.[5] There was a fallout for those relying on old flash animation content too, specifically schools who had been using the wide array of educational animation videos and games available online as part of their core curriculum. While many creatives themselves had made the switch to either video hosting platforms or HTML-5 in the years leading up to Flash's EOL, many users and audiences had not and were left stuck or lacking.

Websites that utilised Flash animation, or were used to host Flash animation, had to either cease operation or come up with innovative ways to continue. Many old, often unmonitored, websites became defunct. However, websites such as Newgrounds, one of the primary sites for hosting Flash based media from amateur creatives, have turned to Flash emulators. Ruffle, an open-source Flash Player emulator, is currently used by Newgrounds and various Flash-based online gaming sites, such as Neopets and Armor Games. Developer Mike Welsh, who has previously worked for Newgrounds, developed Ruffle as the last of a series of software developments to preserve Flash content. As it's developed in Rust, Ruffle's developers claim it is protected from many of the security issues concerning Adobe Flash Player. From websites dedicated to Flash content, such as Newgrounds, to the archives of organisations such as The New York Times, the utilisation of Ruffle has saved a sizable portion of Flash works from becoming lost media.[6]

However, this preservation is an ongoing effort. Large amounts of Flash animation is still inaccessible. Many smaller or personal websites have gone dark, and some creatives have opted to removing or abandoning their work. While multiple news websites recreated or republished their coverage of 9/11, for example, that had become defunct, many others chose not to– causing their coverage of the event to become lost media.[7]

Ongoing initiatives are vital for ensuring the preservation of Flash media hosted elsewhere. Sites such as The Internet Archive, responsible for The Wayback Machine and other archival initiatives online, have utilised Ruffle in their archives of Flash media.[8] Perhaps the most sizable archive of Flash material is Flashpoint; an archive run by approximately 200 volunteers that has a library of approximately 79,000 Flash games, totalling 500 GB. Flashpoint founder Ben Latimore began the archive in 2017 when Adobe announced EOL plans for Flash. Without Ruffle or similar emulator software at the time, Latimore created Flashpoint as what he referred to as a "fake internet," where the programme tricks the computer into believing it is on the internet.[9] This allows the games to be played unedited in their original format.

3 Case Study: Homestuck

One can use Andrew Hussie's webcomic Homestuck as a case study of the ways in which flash animation has been preserved. Homestuck was a cult classic, multimedia web-narrative, updated in its initial form over the time period 2009 to 2016, before continuing in official and semi-official capacities. During the webcomic's seven year run, Homestuck amassed over 8000 pages, with a sizable percentage containing Flash animation.

It makes use of the internet as both a medium and a host, utilising Flash technology to incorporate animation, sound, and mini-games into its sprawling narrative where necessary. These Flashes are called [S] pages; where [S] stands for "sound," and signals to the reader that the following page will autoplay with sound. The idea of the webpage as a medium is an important framing device in Homestuck. Frequently animation and characters "break out" of the visual frame of the comic, emphasising the use of the narrative and website itself as a liminal space the characters are metaphorically trapped in. The utilisation of Flash allowed the visuals of Homestuck to break out of the standard resolution, at times switching the visual appearance of the website mid-animation; such as with [S] Game Over.

3.1 Official Approaches to Preservation

In 2018, publishing company VIZ Media acquired the rights to publish Homestuck in physical form; a difficult feat due to the vast amounts of animated and gameplay content that remains incomplete today. The complexity of converting Homestuck from its digital format with interactivity to print– a format with little to none in this case– has been documented and referred to as a form of remediation.[10] VIZ Media's physical publication attempts came with the additional responsibility of navigating compatibility issues in advance of Flash Player's discontinuation for the original digital publication. Solutions were brainstormed behind the scenes on solutions to file hosting on Homestuck's parent website mspaintadventures.com, later rebranded to Homestuck.com. VIZ Media and Hussie worked on a solution to convert Flash files to HTML-based files, or convert them into video files, as announced in a news post by Hussie in April 2018.[11]

Although video files were supposed to be largely a temporary solution they became the primary solution for longform Flash animation on the site. At the time of writing, major [S] pages such as [S] Cascade and [S] Game Over still direct the viewer to an embedded YouTube video file. Much of the interactivity is lost by this approach. Homestuck utilised Flash animation as a means to break the physical boundaries of the comic, allowing objects and characters to break out of the perceived visual confinements of the comic's canvas and move across the side panels, and allowing the animation to bluff 3D and perspective by moving objects towards the viewer. At times, the website interface itself would change mid animation as a visual effect. These effects have limited influence on the audience when presented in the form of a video file that acts as a screen-recording of the initial material. Installing Ruffle on a desktop browser briefly reverts these longer animations to their original Flash form. They are, however, unable to direct the reader to the next page, something that has to be manually edited in the address bar.

One of the primary concerns in 2018 was making the comic accessible to mobile devices. Both Apple and Android had limited support for Flash animation anyway, and Homestuck was unable to be read by those accessing from a mobile device due to the heavy Flash content. Initial solutions were lacking. Previously interactive games were unplayable. In some shorter cases, visual comics were made out of the original Flash.[12] Longer games, such as the Openbound games which have several hours of gameplay, were prioritised for conversion into HTML using the Sburb game engine, which was later released publicly to allow fans to create their own HTML games. Openbound games now play on web browsers, but are still inaccessible on mobile. Users are prompted instead to view on a supported browser and are linked to a walkthrough and map of the game; solutions that are insufficient for the audience to gain narrative-pertinent information that exists in the gameplay.

3.2 Unofficial Approaches to Preservation

After Adobe's EOL announcement, there was initially confusion and fear among fans of the comic as to its future. Archival work among the fanbase started almost immediately, with YouTube channels dedicated to converting the Flash files into video files popping up. While some fears were quashed by the announcement that VIZ Media and Hussie were looking for solutions, some fans found the application of these measures to be unsatisfactory or unsuccessful. This encouraged projects such as the The Unofficial Homestuck Collection to form.

The Unofficial Homestuck Collection is a fan initiative started by a fan under the name "Bambosh" and maintained currently by "GiovanH" to restore Homestuck to its original user experience. It allows the audience to emulate the experience of reading the comic in real time, undoing retcons until the appropriate milestones are reached and blocking off potential spoilers for new readers. The initiative however is largely credited with preserving the original Flash format of various pages and for preserving other elements of Homestuck, such as bonus content and externally hosted media such as Paradox Space. Their mission statement claims that "with Flash finally being phased out at the end of 2020, Homestuck is in a precarious state. While there have been official attempts to preserve aspects of the original experience…the results have been mixed."[13]

The Collection works similarly to Flashpoint. The user installs the application and its assets on their desktop, and the application functions somewhat like a browser where the user can then read Homestuck. The application runs Flash natively, but as it is self-contained it does not need to connect to the internet and does not pose a security risk. The vast majority of Flash animation from the original comic has been preserved, with the exception of the lengthy [S] Collide and [S] Act 7, which were both hosted externally through a YouTube mirror originally in 2016 due to fears that the website would crash, as it had in 2011 with the release of [S] Cascade. Interaction with these animations within the app directly simulates the original audience experience reading or watching Homestuck when it was originally published. However, much like its Flash-based origins, the collection does not function on mobile either so the increasing number of mobile-dependent users remain locked out from the authentic experience.

Moving forward in an official, or semi-official capacity, Homestuck's officially sanctioned, yet non-canon, sequel Homestuck 2: Beyond Canon has continued publishing media reminiscent of its namesake without the defunct technology. Thus far, [S] pages in the sequel have been limited, largely due to a multi-year hiatus that stalled the comic's development. These [S] pages are however embedded into the website using HTML-5 and, more recently, using the visual novel engine Ren'Py for gameplay content. Both these options emulate the original Flash style of the comic, without the reliance on the technology.

4 Conclusion

An often colloquially quoted sentiment about the digital age is that *once it's online, it's online forever.* Increasingly, it can be observed that this is not the case. As websites fail, crash, and fall victim to corporate monopolies on digital spheres, nowhere is the delicacy of online media preservation more visible than in places that were once filled with animation now instead reading that Flash Player is no longer supported.

While efforts have been made, nearly entirely by volunteers, to archive Flash media, it is not possible to say how many of these archives can persevere on volunteer enthusiasm alone, and how much is already lost or inaccessible. The influence of niche online creative media on popular and youth culture makes amateur Flash animation a legacy worth continuous research and preservation, like any artform. It can be concluded, perhaps belatedly, that the monopoly Adobe exerted over the entire production of online animated media for an entire era of creative output allowed a unilateral destruction of that media when they made the decision to cease supporting it. Similarly, the preservation of this material now relies on mostly volunteers, small applications like Ruffle, and entities like The Internet Archive that face the potential of being shut down. Reliance on amateur or singular archives may result in access to more material being lost in the future without further research and investment into the area.

It is also worth noting that while discourse around the eventual obsolescence of formats and technologies and the long-term cultural effects that might have has been brewing for decades[14], the cessation of Flash Player was not necessarily so easily envisioned by early creatives. The vast loss of video and animated material experienced here could, and likely will, occur again on unknown scales in ways we cannot necessarily imagine within the scope of this paper. Recently, the deterioration of many previously assumed stable online platforms and mass abandonment of them by creatives and audiences alike could result in more material being lost in the future. There are lessons for the future to be taken from the loss of Flash Player in the need to preserve work even in the seemingly permanent digital sphere.

To conclude, the impact Flash Player had on the ability to create and disseminate animation online, and the prevalence and perseverance of the medium in online amateur spaces cannot be understated. Animation is facing unique challenges and developments in this current cultural sphere, not limited to production queries, software developments, and the increasing utilisation of AI in creative spheres. As Henry Jenkins noted in 2006, the assumption of the digital age has been that new media will always replace old media, which becomes defunct and

irrelevant; an assumption that has never been that simple in a digital sphere where old and new media form a reflexive relationship. [15] While we navigate future challenges and pursue continuous development within the industry and practice, it is not possible to do so without an awareness of what came before and a willingness to take it with us.

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CONFLICT OF INTEREST

The author declares no applicable conflict of interest.

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Real-Time Animation, AI and Virtual Production: Opportunities and Challenges

- And how to build a low-budget ICVFX stage

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ABSTRACT

This paper explores the opportunities of utilizing real-time animation and AI in Virtual Production (VP) workflows. The investigation is based on insights from the ViZARTS project, where filmmakers, TV producers and animations are educated during hands-on workshops to utilize the potential of VP. The study will describe some of the challenges we have encountered and introduce a few innovative workflows, we have developed during the workshops, including how to build a low-budget sustainable VP training facility studio. Finally, we will look ahead and discuss the future of real-time animation and AI-driven workflows in Virtual Production.

CCS CONCEPTS

• Applied computing→ Arts and humanities; • Computer systems organization → Real-time operating systems; • Humancentered computing→ Interactive systems and tools;

KEYWORDS

Virtual Production, Real-Time Animation, Final Pixels in Camera, In-Camera Visual Effects, ICVFX, Rear-projection, Projector-based, DIY, low-budget, Unreal Engine, Unity 3D, Generative AI, DMX.

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1 Introduction

While there is a growing number of studies attempting to define and investigate the novel concept of Virtual Production, where real-time game engines and large display technologies are used in live-action film production, it seems like that there is limited research specifically detailing the potential of low-budget virtual production studios for educating filmmakers and content creators.

Several YouTube creators demonstrate how to build low-budget table-top or room-scale VP set-ups. However, many educational institutions often opt for expensive complicated solutions with LED walls and professional camera tracking systems. We argue that independent filmmakers and training facility studios can do more for less and start building VP set-ups with minimal financial resources.

In this paper we will thus explain how we have built a simple low-budget, sustainable, DIY-style projector-based VP training studio at Aalborg University's Medialogy education by using readily available technologies.

This studio is an integral part of the ViZARTS project, an initiative supported by Nordisk Film Fonden, which trains filmmakers, TV producers, game developers, and animators to harness the new opportunities that Virtual Production offers [1].

As our working definition of VP at ViZARTS (which will be introduced later) includes real-time animation as a fundamental element, this study will also describe how real-time animation and AI helps to address challenges and supports the various approaches for Virtual Production pipelines and workflows, we are working with at the ViZARTS project.

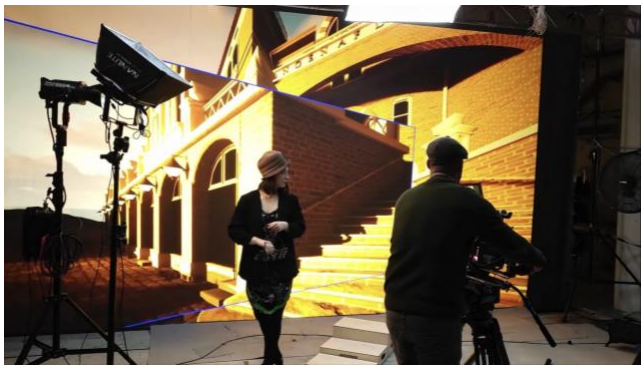

Figure 1: Filming at the Virtual Production Training Facility Studio

Finally, we will discuss advancements in our AI-driven VP workflows, which integrates automated 3D depth maps based on prompted images and examine AI's future role in virtual production workflows at ViZARTS.

2 Defining Virtual Production

In The VES Handbook of Virtual Production, S. Slade defines Virtual Production as "The augmentation or replacement of traditional visual effects or animation workflows by the use of real-time, digital technology." [2]. This encompasses a range of techniques, from live green screen replacement to the complete digital substitution of actors, environments, and cameras.

At Weta Digital, VP is described as an integration of physical and digital filmmaking techniques in real-time: "Virtual production is where the physical and digital worlds meet." [3].

The Moving Picture Company (MPC), describes VP as a collaborative and technology-driven approach to filmmaking that bridges the gap between pre-production, production, and post-production and that "VP combines virtual and augmented reality with CGI and game-engine technologies to enable production crews to see their scenes unfold as they are composed and captured on set." [3]. This is e.g. employed in Motion Capture productions, where performers are visualized with 3D models in virtual environments with game-engines for immediate live-reference and quality checking

These descriptions align with an overall understanding in the industry, which is emphasizing the use of tools like real-time rendering, CGI, game engines (e.g. Unreal Engine or Unity), motion capture, LED screens and virtual reality tools (VR) to create immersive environments and visualize complex scenes in real-time before or during filming.

Our working definition is thus that Virtual Production is an overarching term that covers the use of various real-time game- and media technologies in film, television, and animation production workflows.

3 Using Real-Time Animation in Virtual Production Workflows

Real-time animation is by definition a fundamental element integrated into many VP workflows during pre- and postproduction as well as on set. We have identified three primary virtual production workflows in our workshops:

- 100% Game Engine-Based Production
- Real-Time Live Compositing
- Final Pixels in Camera

3.1 100% Game Engine-Based Production

This workflow relies entirely on real-time animation enabled by game engines such as Unreal or Unity running on workstations with powerful GPUs. It leverages their ability to render photorealistic CGI at over 60 FPS. The workflow enables storytelling entirely in virtual scenery, eliminating the need to wait for individual image rendering to complete sequences. Modern CGI can produce fully computer-generated rendering films, as recently demonstrated by 'Mufasa: The Lion King' (2024). However, Animated TV shows and short 3D animations can now run in real-time, similar to in-game cinematics, with examples such as 'Time Ghost' [4] and 'Meerkat' [5].

This capability enhances creativity and efficiency throughout the production pipeline, enabling filmmakers to integrate various techniques to enhance planning, execution and finishing a production. At the ViZARTS project, we have identified and worked with several of the following real-time animation supported workflows in our workshops:

- Pitchvis – A process of visualizing key film scenes through real-time animation instead of written scripts, helping secure funding by previewing essential moments.
- Previs – Previsualization employs real-time animation with virtual cameras and motion capture to visualize scenes before shooting. It supports set construction, background creation for virtual production, and camera work planning, while allowing simulation of actor movements through rough motion capture.
- Techvis – Uses real-time animation to model scenes and integrate filming equipment like cranes and lights. This helps optimize equipment placement and predict spatial constraints before physical set construction.
- Stuntvis – Combines real-time animation and motion capture to visualize and plan stunts efficiently, reducing production time by simulating action sequences beforehand.
- Virtual Location Scouting – Directors and cinematographers use VR headsets to explore and modify virtual locations pre-filming, allowing real-time adjustments to camera angles, lighting, and set design.
- 3D Location Creation – Technologies like laser scanning, photogrammetry, and Neural Radiance Fields enable digitization of real-world locations for virtual production, creating photorealistic real-time animated backdrops for LED screen studios and rear-projection stages.
- Virtual Actor Creation – Scanning techniques and modeling pipelines, such as Unreal's MetaHumans, enable creation of photorealistic real-time animated virtual extras and effects like de-aging.
- Performance Capture – Tracks actors' movements and expressions to integrate them into real-time animated characters.
- Postvis – Combines green screen footage with preliminary low-quality virtual environments in post-production, enabling visual preview before final rendering.

3.2 Real-Time Live Compositing

The second virtual production method uses real-time animation for live compositing, merging live-action and green/bluescreen shots in real-time. This process, sometimes called Simulcam, traditionally combined live-action elements with low-resolution virtual sets. Directors and cinematographers could then preview scene composition, motion capture performances and lighting in real-time, enabling creative decisions before final rendering. Notable examples include 'Avatar' (2009) and 'The Jungle Book' (2016). While this technique does not traditionally produce final pixels in-camera scenes, it recently has become possible to do this process in real-time as well due to faster GPUs.

3.3 In-Camera Visual Effects or Final Pixels in Camera

The third and most advanced technique, "Final Pixels in Camera" or "In-Camera Visual Effects" (ICVFX), utilizes LED volumes or projector-based systems to display virtual set-extension as a backdrop for physical props and actors. With camera tracking controlling the animated backgrounds, the resulting parallax effect is creating a realistic illusion of being on location, when looking through the camera.

Instead of relying on green screens and "fix it in post", in-camera visual effects allow for a more interactive and immersive "what you shoot is what you get" experience, reducing the need for post-production. Notable examples include TV-Series such as 'Star Wars: The Mandalorian' (2019) and '1899' (2022)

While many ICVFX productions use simple video plates or photographs for backgrounds, a growing number of filmmakers employ fully 3D photorealistic environments. We have also at the ViZARTS project focused on working with 3D environments, as they are more flexible.

These real-time-animation-supported VP workflows optimize resources by shifting costs from post to pre-production. VP also has several sustainability benefits. VP reduces travel emissions, minimizes physical set construction, and enables asset reuse across platforms.

Figure 2: Shooting ICVFX with 3D virtual set extensions mixed with physical props in the foreground.

3.4 AI assisted Virtual Production

Generative AI and machine learning are furthermore becoming essential tools in virtual production by streamlining workflows and enhancing creativity. In previsualization, AI tools can e.g. assist the artists in generating concept art or storyboards. For asset creation, AI can help 3D artists with e.g. generating 3D models, textures and vehicle animations, reducing tedious manual work. During filming AI can support real-time cinematography through automated basic lighting, and virtual environment animated effects like dust particles or smoke. Performance capture can be improved with AI for facial/body tracking and digital doubles. 3D Virtual sets and textures benefits from AI upscaling which is boosting the image quality. In post-production, AI can aid the editor with e.g. organizing shots, color grading, digital effects and dialogue replacement.

In the ViZARTS project, we have experimented with using AI in order to discuss the possibilities, limitations, ethics and property rights. During the filmmaker workshops we have also utilized real-time animation pipelines and implemented many of the above VP workflows. Our recent focus on the Final Pixels in Camera approach necessitated a studio with a large screen setup.

Figure 3: Creating a "Final Pixels in Camera" Scene with AI enhanced backgrounds.

4 Case Study: Building a low-budget, Indie Virtual Production Training Studio

Educational institutions and independent studios seeking to explore virtual production opportunities often face budget constraints. Our experience building a low-budget virtual production studio at Aalborg University's Copenhagen campus began with the ViZARTS project, funded by the Nordisk Film Foundation, Samsung, and Aalborg University. Starting in 2017 at the Samsung Media Innovation Lab for Education (SMILE Lab), we experimented with game technologies for in-game rendered shorts using Rokoko motion-capture systems, before focusing on ICVFX workflows.

Originally, Samsung provided the SMILE Lab with a 4x2m LED wall comprising nine 55-inch screens with 0.64mm pixel pitch

(distance between pixels), enabling close to the screen video shooting. We began experimenting with matching physical and virtual lighting using large figurines and props, and in 2019, we implemented parallax effects with camera tracking by using a 360 Kinect through AutoDesk Motionbuilder, later upgrading to a Vive tracker implemented in the Unreal Engine [6].

In 2021, bachelor students developed a VP system using the Vive tracker in Unity with our LED wall. A master thesis supported this project with integrated DMX-controlled lights in the Unity pipeline [7]. The resulting short film adapted to viewers' attention using brainwave measurements, making it one of the first VP shorts of its kind [8]. However, visible bezels in the LED Wall setup required post-production fixes, necessitating a seamless screen solution.

So, we needed a larger screen without bezels, but with LED walls costing upwards of 200,000€ at the time, we chose to build a rear-projection set-up for its simplicity and affordability (approximately 1,000€ for a 6.6x3m screen plus projector costs).

The rear-projection approach is well-known; however, it is important to remember to reserve space behind the screen for the projectors [9]. We used the Gerriets Optiblack 2.2 specialized black rear-projection fabric to reduce reflections from physical lights in front of the screen and started out with recycled classroom projectors. Later additional funding made it possible to upgrade to two Epson PU2010B 3LCD Laser Projectors with 4K Enhancement, which we stacked for an output of 2 x 10.000 Lumens. With this simple setup, we only need one CGI workstation to project the virtual set-extensions, and over the years, our workstations evolved from Nvidia 1080ti GPUs to 3090s and recently we secured funding for a 5000 Ada Generation Nvidia workstation. The camera tracking system utilizes Unreal 5.5 and an HTC Vive tracking system featuring four base stations. Due to its relative simplicity, the rear- projection-based system provides an energy-efficient and more sustainable alternative to LED walls. Per shooting day, a projection-based screen like ours consume around 5 kWh. In contrast, a LED wall of similar size can use approximately 10-15 times more energy and thus emits much more CO_2 and costs more to use. However, while a rear-projection setup can also reduce moiré effects and maintain visual quality and sharpness in the virtual backgrounds, one should bear in mind that the LED wall is much brighter than the rear-projection screen, so we often use additional lights when filming.

The training facility studio today hosts the ViZARTS workshops and sessions with the Danish Filmworkshops and the Super16 Film school. Since 2022, we have conducted over 20 workshops and trained more than 200 filmmakers, animators, and game developers, bridging technical expertise and artistic talent through creative workflows. The feedback from the participants have always been that they learned a lot and several of them moved on to produce their own productions on professional LED stages in Denmark and abroad.

5 Novel Creative Opportunities with Real-Time animation and VP

Virtual Production workflows in combination with real-time animation unlocks new creative possibilities for exploration during pre-production and on set. We have thus experimented with many different approaches in the studio.

The virtual set-extensions can for example be dynamically altered with real-time animation - for example opening doors or fast-moving clouds. A character can also be placed atop a skyscraper, and the roof can be raised or lowered hundreds of meters in real time. In-camera visual effects can furthermore manipulate set elements, such as bulging walls or rotating stages, with synchronized lighting changes.

We have also often worked with in-camera VFX such as particles, fire, fog and clouds. We have even shot scenes with animated virtual vehicles, such as a train nearly running over a character. Virtual characters can also serve as background extras, and we can control creatures in real-time through puppeteering [10].

6 Overcoming Challenges

At our workshops, filmmakers work closely with technicians, so communication challenges naturally arise in all production phases, so we equip workshop participants with basic terminology used by both film crews and technicians to smoothen the processes.

Besides on-set communication, lighting remains the most significant technical challenge, requiring new approaches for realistic integration between virtual set-extensions and physical elements. We have set up pipelines with DMX controlled lights and experimented with KinoFlo's Mimik lights controlled by Unreal Engine to e.g. dynamically simulate rotating lights. In one case, an actor pulled a simulated moon down to earth, making it appear to increase in size and brightness as it approached, while the Mimik's intensity increased from zero to full power to support the weaker light from the growing virtual moon on the rear-projected background.

Figure 4: Controlling 'Mimik' lights in real-time via the Unreal Engine to enhance the brightness of the moon.

Camera tracking has been another major challenge. A team of Medialogy students therefore developed a smartphone-based

tracking system in Unity, providing affordable and effective solutions for real-time camera movements [11]. The solution included mounting an Android smartphone with inside-out tracking onto an ARRI Alexa camera, allowing movement tracking far away from the screen without loss of accuracy [12].

7 A Glimpse into the Future of Virtual Production at ViZARTS

At the ViZARTS project, we constantly develop novel VP workflows to enhance creativity and efficiency while disseminating knowledge to filmmakers and industry. One challenge we had in the first ICVFX workshops, was the time needed to build detailed 3D locations, such as recreating the historic "Hotel Kongen af Danmark" from Fanø Island, which took 10 weeks before we could use it in our ICVFX workshops [14]. To accelerate this process, we've now developed a generative AI solution, enabling us to go from prompt to image, then to 3D depth map and rear-projection in 20 minutes. The images can be generated by prompts or real location photos.

Recent research also includes AI-assisted hand-drawn sketching to 3D location conversion through the drawing software Krita. Furthermore, a master thesis project has aimed on automating light setups in the virtual background based on DMX controlled lights on a physical actor's face [13]. The goal is automated lighting setups covering 80% of light needed on stage.

We're now developing a new VP pipeline to insert augmented 3D props, creatures, extras, and particles in front of actors while filming them with real-time animated rear-projected 3D set-extensions in the background. This approach aims to achieve 'Final Pixels on Harddisk'. The setup could be enhanced by integrating real-time performance capture, enabling live-action actors to perform with virtual characters captured via mocap or real-time puppeteering.

8 Conclusion

Virtual Production workflows supported by real-time animation are transforming filmmaking processes across all production phases. Through our work at the ViZARTS project, we have demonstrated that VP is becoming increasingly accessible, even for independent filmmakers and educational institutions. Our DIY rear-projection-based VP studio proves that sustainable, cost-effective solutions can deliver professional results compared to expensive LED wall setups.

The integration of real-time animation in our three identified VP workflows - 100% Game Engine-Based Production, Real-Time Live Compositing, and Final Pixels in Camera - has shown significant potential for enhancing creative possibilities while reducing production costs and environmental impact. The challenges we've encountered in lighting integration and camera tracking have led to innovative solutions, including smartphone-based tracking systems and AI-driven automation. Examples of these productions can be seen on the ViZARTS YouTube channel [14] and readers are welcome to contact the authors for guidance to build their own low-budget VP Stages.

Looking ahead, the convergence of AI and VP technologies promises to streamline workflows further, particularly in rapid 3D environment creation, automated lighting setups, and real-time character animation. Our ongoing experiments with augmented VP pipelines, combining rear-projected backgrounds with integrated virtual elements in front of actors, suggests that we are moving toward more sophisticated "Final Pixels on Hard disk" solutions. These advancements, coupled with our commitment to knowledge dissemination through workshops, are helping to democratize Virtual Production technologies for the next generation of filmmakers.

ACKNOWLEDGMENTS

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On-Screen Prototypes:

Making speculative designs for and through animation

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ABSTRACT

This paper gives a short insight into the author's exhibition and book project Visual Music Design Fiction, a project that explores both adventurous and silly interconnections between sound and animation and simultaneously addresses problems within contemporary media technology. The text positions the project in relation to speculative design and design fiction, traditions that encompass design proposals that are made to critically explore technological or societal developments rather than to make commercially viable products. Further it draws lines between these and wider artist/inventor traditions. Based on experiences from the project it is being demonstrated how the craft of animation can be applied to model processes, and such work as an "expanded draughtsmanship" for the artist/inventor.

CCS CONCEPTS

Hardware ~ Emerging technologies ~ Analysis and design of emerging devices and systems ~ Emerging tools and methodologies • Human-centered computing ~ Visualization • Social and professional topics ~ Professional topics ~ Computing industry ~ Sustainability

KEYWORDS

Animation, design fiction, speculative design, draughtsmanship

1 Background

With pencil and paper humans have been able to imagine themselves as inventors. This has been done by professional artists and as part of the imaginary world children create while drawing. Among the more famous, Leonardo DaVinci's sketchbooks show both a refined draftsman and several plausible technical concepts [1]. The proposals of "the last renaissance man", Athanasius Kircher, are maybe less plausible than those of the "the original", but the singing statues and psalm composing machine that he and his illustrators presents in Musurgia Universalis (1650) are certainly inventive and amusing [2]. Fictitious machines presented mainly for amusement, have become a cartoon genre of its own rights. Among these are the elaborate chain reaction machines of Storm-P [3], Rube Goldberg [4] and Heath Robinson [5].

Figure 1: Office environment with sun-lit LCD screens

Speculative design distinguishes itself as a separate branch of the fictitious inventor tradition by adding a critical component. An early example of this critical turn is the 1960s Italian architect studios Superstudio and Archizoom Associati [6]. The latter did e.g. propose the No Stop City, a shopping centre you could live in, where all corridors looked the same, and each cubicle was as good as the other to sleep or shop in. The proposal takes traits from its contemporary architecture and drags them into absurdity, a strategy common in the critical design traditions [7]. The term design fiction has its origin in literature where it first described a

kind of science fiction that was just as much concerned with a convincing presentation of the fictional world and its props than as the narrative that went on within it [8]. Both design fiction and speculative design are today used beyond their original professional fields [7, 9], they are sometimes overlapping, and both are characterized by setting up fictional future scenarios to facilitate a critical discussion.

2 The Visual Music Design Fiction project

This project is a component of an artistic research PhD project in visual music film. It has until now been exhibited at Fredrikstad Animation Festival [8] and a book will be made as part of the final PhD submission. It originates from a document where ideas were uncritically noted down during the first part of the research. Partly inspired by being introduced to the concept of design fiction, and partly in search for some useful output of these, obviously too many, too expensive, sometimes impossible and other times just silly, ideas, it was decided to make them into a project of their own.

When taken a little bit more seriously the nature of the ideas suggested a critical perspective and could be used to bring forward some ethical discussions that should be part of the overall PhD project. Some core questions were later emphasized when editing and working on the presentation of the ideas:

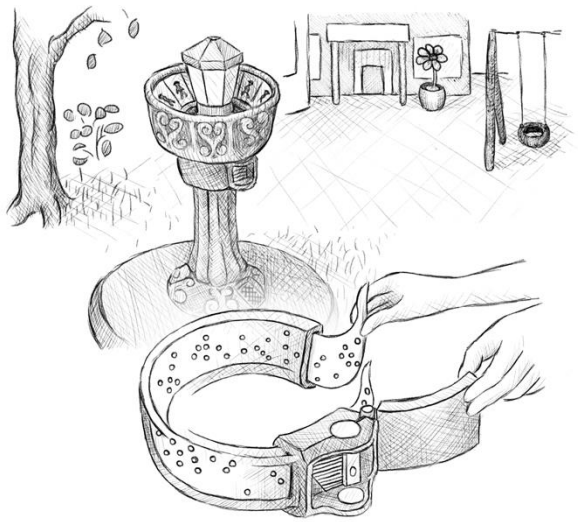

Figure 2: A combined praxinoscope and music-box

There is widespread public concern about the mode**s** of interaction we have with digital media devices, how smart phones, social media, etc. steal our time, can create an addiction like behaviour and affect cognitive functions. As animation makes up for a considerable part of the content on these devices and platforms, part of the metaphorical fuel in the machinery, it can be argued that animators share a responsibility for the eventual negative effects. How can animators then make an effort to stimulate or invent other modes of interaction with animated media?

The production and distribution of animated media is energy consuming in itself. In addition to this animated media is part of advertising financed platforms, or is in itself advertising, that stimulate energy consumption. To view the animations, you do also need devices produced through an energy consuming process and strategies in the different media and technological fields do stimulate a frequent replacement of these products. Can animated works be made in ways that to a lesser degree use non-renewable energy or provide ideas of how society and economy can be organized in less energy consuming ways?

Figure 1 shows a modern office environment where the employees work behind sun-lit LCD screens. As the back lighting typically makes up for the very most of an LCD-screen's power consumption this would reduce it considerably. Also, since the screening mechanism is weather dependent, it changes how you interact with it; it would raise your awareness of the weather, maybe also the general outdoor environment, as you would have to adapt a work rhythm closely dependent upon sunshine.

Figure 2 shows a praxinoscope – a precinematic device where animation frames are placed around the inside of a drum. An equal number of mirrors around a centre column do reflect the frames, and when the drum is rotated you can view the animation in these mirrors. Here the praxinoscope is combined with a music box mechanism underneath. As the drum is steadily rotated by a pedal, this also drives a punch card through the music box, and the composition written on the punch card is played. As the front part of the drawing shows, the punch cards are, like the animation frames, interchangeable. The device is here placed in a school yard, and both the drawing of animation frames and the composition of punch card melodies can be integrated in the school's teaching.

The different ideas presented in the project relate to many other topics than the two problems listed above. They are not presented very systematically and are seldom clearly polemic. A possible societal impact of the project must thus be viewed from another perspective: It is very hard to imagine a radically different world. It is e.g. very difficult to imagine a world where the computer, or very similar devices, do not play a massive role in the production, distribution and viewing of animation. Still, when the seminal exhibition Cybernetic Serendipity was held in 1968 the catalogue stated that computers do not yet play an important role in the arts [12]. This was stated in a highly developed culture, that already had lived through the "golden age of animation". Although alternatives certainly must exist, "the future of animation" is often imagined as a continuation of the computerization that has gone on since Cybernetic Serendipity, with e.g. the implementation of augmented reality and the application of artificial intelligence driven tools, not as shift of direction. A famous quote says: "it is easier to imagine an end to the world than an end to capitalism"

[13]. If one wants change, the obstacles are not just the practical implementations, but also the imagining of these changes. The aim of the Visual Music Design Fiction project is not the abolition of all computers, but one of its purposes is still that of disruptive utopianism; to push the viewer into a state where radically different ways of interacting with sound and animation can be imagined.

Animation, like the rest of society, is partly shaped by technological development. What media technology we will have in the future is not pre-destined. Still, taking part in the development is often not open to animators. It is rather a process exclusive to those who have the necessary knowledge, economic means or political influence. Speculative design can, as in this project, be a way for animators to take part in this conversation.

3 Animation as the modelling of a process

On screen representations of not yet existing technology in fiction film has been discussed as "diegetic prototypes" [14]. While this is a very useful term, the word diegetic points to an exclusively narrative context. We can imagine a wider term, "on-screen prototypes", that could also encompass representations of technology in other contexts, e.g. models made for studying and developing the technology.

Several definitions of animation do sit side by side without necessarily contradicting each other, such as “creating an illusion of life” and “frame by frame manipulation of film movement”. These two do emphasise respectively an experiential and a technical aspect. A definition that emphasises the qualities relevant here is “Animation is the visual modelling of a process”. A model should here be understood as something created to enable us to observe what does not yet exist, like and model that an architect makes of a non-existing building or like a mathematical model can anticipate certain qualities of a water wave caused by the impact of a certain falling rock. If such a model is made in a visual media and shows a process rather than a static situation it is animation. This definition might also be logically sound when used in the context of traditional narrative animation. One could e.g. speak about a scene where Wile E. Coyote runs off a cliff and first falls down when he realizes he does not have ground under his feet as “a model of consciousness activated gravity”. Still, the definition is probably more meaningful in a technical context.

When Leonardo DaVinci or Storm-P drew static prototypes of their inventions, we must assume that this helped them understand aspects of their different contraptions that were hard to grasp without visualization. Further on, it is easy to imagine that the drafting process must have revealed errors in their initial concepts, pipes that would obstruct the path of a pendulum or gears turning wheels in wrong directions, and that this led them into a continuous process of reimagination and revisualization. If so, the drawing process would not happen just in order to communicate the ideas, but closely integrated with the inventing process itself, and thus the inventor skills and the drawing skills could also be related. With the skills and tools of and animator this iterative process can be considerably expanded. Through animation one can visualize and help understand the evolvement of processes that are hard to make adequate mental or static representation of. Many animation tools do also provide the possibility of a 3d view of a model. With these expanded possibilities, such animation practices could be considered as an “expanded draughtsmanship” and provide the skilled artist-inventor with useful tools to develop their ideas.

In later exhibitions of the Visual Music Design Fiction project some ideas will also be presented through physical models. To prepare the development of these, animated modelling has been applied as a tool to optimize the designs. Figure 3 and figure 4 do both show devices that draw “musical epicycles”. An epicycle is a geometric figure drawn by a cyclic motion attached to another cyclic motion [15], e.g. as the figure we would get if we traced the movement of the moon as it cycled the earth while the earth cycles the sun. The pitch of a musical note is expressed in frequencies – the speed of the sound’s vibration. The relation between different musical pitches can be expressed as ratios (although in most scales and systems these numbers would only work as approximations), e.g. a fifth has a 3:2 relation and a major third a 5:4 [16]. The devices pictured here draw figures by having wheels rotate at speeds with similar ratios as those of a musical scale. With three or more wheels they can draw figures based on the same proportional relations as those present in musical chords, e.g. major and minor. Hence the naming - musical epicycles. The “bicycle spirograph” in figure 3 changes the ratio-relation through a gearing system. The spirograph does also have cardboard stuck

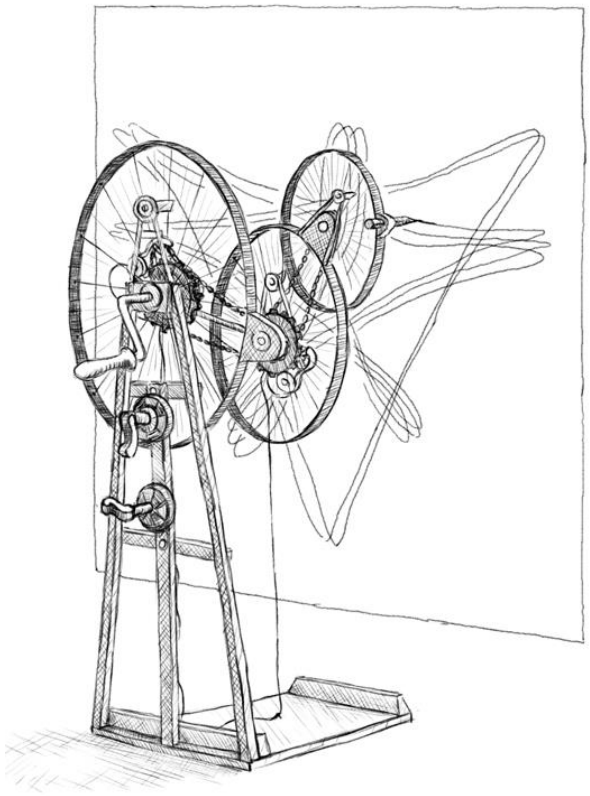

Figure 3: The Bicycle Spirograph drawing a major chord musical epicycle

between the spokes of the wheels, producing a pitched sound. Thus, both the drawn figure and the sounded musical chord will change depending on what gear ratios are set. The turntable spirograph of figure 4 has replaceable wheels that can change the ratio relation. The device does not produce a related sound, and the relation between the drawn figures and musical chords is a theoretical one. Setting up a physical model of these devices would involve a series of practical problems, some of which can be solved by animated modelling: Which combinations of wheel sizes, rotation directions and speeds result in aesthetically pleasing figures? What combinations result in figures that stays within the given frame? And what combinations will result in movements where the parts do not obstruct each other? In Adobe After Effects a circle was created and rotated around its own centre. Then a new circle was created, parented (attached) to the first and then rotated, so that it both rotated with the first circle and around its own centre. Then one more circle was created, parented and rotated. At the rim of the last circle a "pencil object" was attached, and by tracing that object one could see the resulting epicyclic figure. Depending on the sizes of circles and their rotation speed, an innumerable variation of figures could be produced. These were then aesthetically evaluated; one could observe if the pen object did move outside the frame and if the parts would obstruct each other.

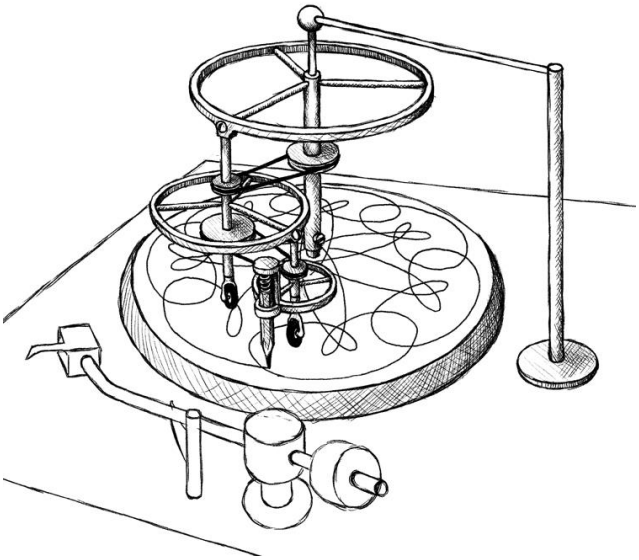

Figure 4: The Turntable Spirograph drawing a major 9 chord musical epicycle

The drawing of figure 4 was made before the animated model. It can be observed from the drawing that this design would not work, the pencil would move outside the paper, the pen would collide with a wheel etc. An animated model was needed to determine what could be possible solutions – what could be possible sizes of wheels and attachment of parts. Reiterations were done until the models did not any longer reveal flaws in the design and at the same time did draw visually interesting figures. Still on must expect that a physical model can reveal design flaws that could not be observed in the animated models, and that several reiterations must be done here too, or that one may have to return to the animated models or the drawing table. When making a physical model the typical animator skill of 3d modelling can be applied to make 3d printed prototypes.

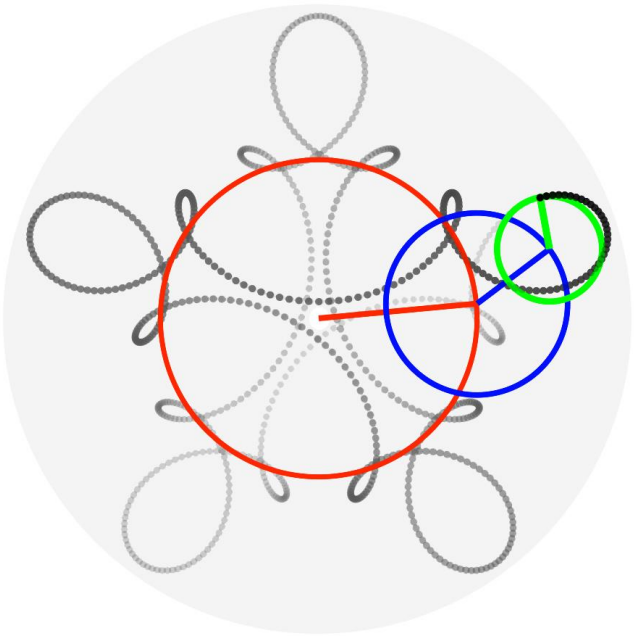

Figure 5: An animated model of the Turntable Spirograph

4 Conclusion

Traditions like design fiction and speculative design have inspired the particular art project featured in this paper to move beyond the realistically attainable and thus opened up for new ideas to solve problems within the field of animation. When making speculative design, or other kinds of artists inventions, the skill- and toolset of an animator can be used to make animated models of the designs. Such a process is here demonstrated by two devices from the featured project. Here geometric figures produced by the imagined machines first are drawn, then made by animated models, and further, through processes of reiterations developed towards the desired credible, or incredible, state. Speculative design can be a way for artists contribute to the conversation about technological and societal developments. These demonstrations shows that the skills- and toolset of an animator is suited to strengthen those contributions.

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Guiding Attention in a Virtual Reality Theater - A case study of the Virtual Reality Performance Symmetry

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Figure 1: The actors performing in Virtual Reality.

ABSTRACT

With comparatively new technologies such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Spatial Computing, the range of interaction possibilities for theatrical performances is expanding considerably. While classical user interfaces are based on predefined visual compositions, VR applications can create highly dynamic scenarios in which the impact of established attention-guiding techniques has an uncertain effect on the user. Users often have a great deal of freedom of movement, which can make established attention-guiding approaches less effective. This study examines the challenges and solutions associated with *attention-guiding* in VR environments, particularly in the context of digital theater productions. The study focuses on the development and implementation of attention-guiding techniques for the VR performance *Symmetry*. Combining expert interviews, systematic research, and practical implementation, this research aims to identify non-intrusive and intuitive methods to effectively guide users' attention. The results highlight the importance of visual cues, color saturation, and salience modulation to enhance user engagement and immersion while addressing the challenges posed by emerging technologies in the theatrical space.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**; **Collaborative and social computing**; • **Applied computing** → **Media arts**.

KEYWORDS

Theater, Digital Theater, Virtual Production, Virtual Reality, Metaverse

1 Introduction

Technical artists in digital theater productions have often experienced that viewers, whether participants or observers, are so distracted by the novelty of the technology or the technologically augmented objects themselves that they tend to miss essential plot elements or central messages from the actors and the story. This distraction emphasizes the need to develop methods that focus the user's attention without taking it away from the important content or being too restrictive and limiting.[12, 16] Combining this practical experience with my personal background in theater arts and video game development provides an opportunity to further develop established attention techniques and apply them specifically to the needs of VR environments, not just for theatrical purposes but commercial purposes as well. Furthermore, research on attention-guiding techniques employed in Augmented Reality (AR), Mixed Reality (MR), and Spatial Computing has the potential to inform a wide range of applications.

In the rapidly evolving field of digital theater, the integration of VR technologies has opened up new dimensions of storytelling and audience engagement.[19] However, these technological advances also present significant challenges, particularly with regard to directing attention without interrupting the narrative structure or overwhelming the user [15, 20]. This paper addresses the need for effective attention-guiding techniques in spatial computing environments, drawing on theoretical research and practical insights from the production of *Symmetry*[1], a sci-fi thriller performance in which the audience can actively participate in solving the murder case. This performance has been developed fully in VR, from coding to animation and performing.

[1]https://www.staatstheater-nuernberg.de/en/spielplan-23-24/symmetrie/02-02-2024/1915

2 State of the Art

The recent availability of technologies such as VR, AR, MR, and Spatial Computing has opened up new possibilities for immersive and interactive experiences [10, 24]. These technologies enable the creation of three-dimensional spaces in which users can interact naturally with digital content [23]. However, directing attention in these environments presents unique challenges due to the high degree of user freedom and interaction.

2.1 Attention Guidance in Mixed And Augmented Reality Scenarios

There are a multitude of promising studies that concern themselves with the topic of immersive, intuitive, and effective attention-guiding in AR and MR [1, 4]. A lot of these conducted studies also highlight areas where further research or more detailed studies are necessary, providing a facilitated entry point for conducting exemplary studies.

Guiding the user's attention in AR poses to be more difficult than in traditional 2D media, as the user is usually in full control of the device and can, therefore, look and rotate freely. In an uncontrolled environment, the user cannot be physically forced to look in the direction desired by the author of the application. This raises the need to find intuitive ways to guide the user's attention without being too intrusive with the means. When it comes to interacting with technology, it is very important to not disrupt the player experience and immersion for the performance to have a meaningful effect on the user.[6]

2.2 Cue-Categories

Existing literature tends to categorize certain *cues* which have distinct features and purposes [6]. These *cues* are typically sectioned into four groups. [13, 17] Each of these groups is also divided into two subcategories as illustrated in Figure 2 from the work of Lasse at al. [13]

Explicit *diegetic* cues : Explicit diegetic cues can limit user interaction, such as events that force focus shifts, e.g., a guided tour in a VR that directs attention to specific locations. Conversely, non-limiting cues include virtual characters that use dialogue or gestures to emphasize items or diegetic signs that perform the same function. A HUD can also be diegetic, such as a cockpit display that is visible only to the pilot but is still part of the virtual world.

Explicit *non-diegetic* cues : A Heads-up Display (HUD) can serve as an explicit non-diegetic cue without limiting interaction if it provides information unavailable to the embodied character, such as a widget showing non-participant positions. Similarly, spatialized non-diegetic arrows and signs can direct attention without restricting interactivity. In contrast, a non-diegetic cue that limits interaction could be a system preventing access to areas without narrative content, akin to safety measures such as the safety wall in Meta Quest systems.

Implicit *diegetic* cues : Implicit diegetic cues that limit interaction include environmental constraints, such as virtual objects or characters altering the user's path or vision. Any salient object that draws attention without explicitly directing focus qualifies as an implicit diegetic cue that does not restrict interaction.

Implicit *non-diegetic* cues : Non-diegetic cues can similarly be used to implicitly guide the user's attention. Examples of non-diegetic approaches that constrain the user's interaction are systems that assume control of the user's viewpoint in a manner that is not feasible in the Virtual Environment.

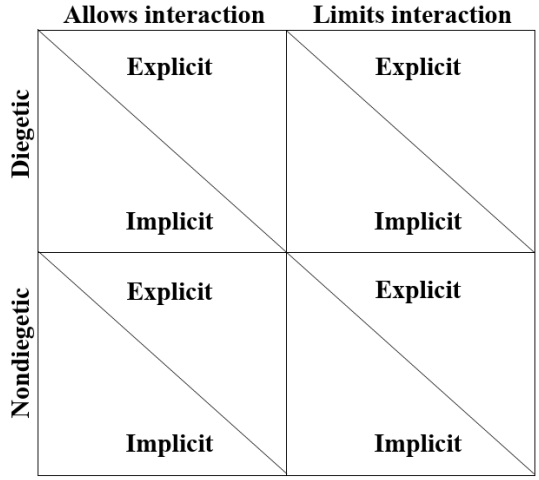

Figure 2: Taxonomy of cues for guiding the user's attention, as suggested by Nielsen et al. [13].

2.3 Attention Guidance in Virtual Reality Scenarios

Guiding attention in VR applications is a central research topic since an adequate focus on the main plot points, objects, or actors contributes significantly to the immersion of the user. There are visual methods that use contrasting colors, light accents, geometric shapes, or animated objects to specifically direct the user's attention, using the manipulation of depth of field and perspective as a means to generate focus [18].

Auditory cues play an important role, as spatially positioned sounds or specific acoustic signals act as directional indicators and thus support multisensory integration. This concept is complemented by haptic feedback, in which vibrations or tactile impulses are used in conjunction with visual and auditory stimuli to dynamically modulate attention. These haptic impulses are not only transferred via the controller or the VR device itself but can also be achieved by specific haptic equipment such as haptic vests, gloves, or face-pads.

The integration of these multimodal methods not only reduces cognitive load, but also optimizes immersion and situational awareness in virtual environments, which is highly relevant for educational applications as well as entertainment and training simulations. The research conducted in this field is relevant to Augmented Reality applications as well, as these technologies do not differ too much from each other.

2.4 Saliency Modulation

In addition to the different types of *cues*, existing literature examines *Saliency Modules* [21]. *Saliency Modulation* describes a method in which the focus subject is made distinct from the rest of the scene by applying different forms of alteration to it. There are a multitude of methods that can be applied to the hero object to make it stand out [14, 22, 26]. Based on existing literature, the following list and its description of the individual modules can not be taken as a complete overview of all the existing ways of performing saliency modulation. This list is much rather a broad overview of the most common methods used in video games.

Color and Contrast Manipulation: By deliberately altering color saturation and contrast, certain areas of an image are emphasized to draw visual attention to them. In a video game interface, interactive elements such as quest markers or collectibles can be emphasized by using higher saturation and contrast compared to their surroundings [2, 7].

Intensity and Brightness Control: Changing the brightness of an object or area relative to its surroundings changes its saliency. Bright objects in dark surroundings, or vice versa, attract the eye [9]. In a horror game, a door to the next section can be highlighted with a subtle light source while the rest of the scene remains in darkness [11].

Motion Salience: Moving objects or animations stand out due to the biological motion detection mechanism of the human eye. An enemy Non-Player Character (NPC) moving in the bushes is immediately noticeable, even if it is well camouflaged.

Peripheral Salience Direction: Subtle changes in the peripheral areas of the visual field subconsciously direct attention in a desired direction. In a narrative adventure game, a slight change in brightness in a side alley can direct the player's attention in that direction without the use of a direct cue.

Auditory Salience Modulation: Sudden or unusual changes in sound can serve as auditory salience mechanisms to control attention. The gradual increase of threatening background noise signals to the player that danger is approaching.

Space and Depth Composition: The strategic placement of objects in the virtual environment uses perspective, linearity, and depth of field to guide the eye [6]. A level designer might arrange pathways and architectural structures to guide the player's eye toward a goal naturally.

Reduction of extraneous sources of salience: By reducing the salience of irrelevant elements, attention can be focused on an important object or area. During a boss fight, the User Interface (UI) could be automatically minimized or hidden to make it easier to focus on the fight [5].

Dynamic Salience Control through Adaptivity: Salience can be dynamically adjusted for the player based on their behavior or current game state. A tutorial could provide increasingly intrusive visual cues when a player has trouble recognizing a new gameplay mechanic.

Cognitive Salience through Semantic Meaning: Objects with narrative or gameplay relevance are automatically more salient to the player because of their meaning. A glowing sword in a cut scene could be identified as a legendary weapon without the need for explicit markers.

These means of modulation are a handful of operations that ensure that the user is noticing the hero object. Almost all of these saliency modules can be separated or combined in the Cue-Categories elude before.

2.5 Diegetic Cues

Especially the work of Rothe et al. [18] focuses on *Cinematic Virtual Reality* and is therefore looking very closely at diegetic cues in this context. Diegetic cues are integral parts of a scene and have the potential to specifically direct the visual attention of the audience within an immersive environment. In contrast to non-diegetic cues, which exist outside the narrative (e.g., background music or a voice-over), diegetic cues are inherent elements of the cinematic world and can, therefore, be perceived as natural without affecting immersion. As with the list of methods for saliency modulation, this list and its cues are not an overview of each existing cue but were much rather chosen as the most relevant for the performance.

Acoustic cues: The role of sound in directing the viewer's attention is particularly important in both traditional cinematic contexts and VR environments [25]. Acoustic signals can draw attention to certain areas even if the viewer's gaze is currently directed elsewhere. The mechanism behind this effect is well established in psychology: people tend to localize the source of a new sound, especially if it implies narrative relevance. It turns out that not only sounds that are correctly localized in space have a directional function, but also sounds that originate outside the direct field of vision can trigger the impulse to turn around and identify the sound source [8].

Lighted objects: Light is a classic cinematic tool for focusing attention, but it has a different effect in a VR environment. As discussed in the pervious subchapter of Saliency Modulation, this suggests that light is less effective as an isolated fixed point and more effective in conjunction with motion. An example of this is a moving cone of light or a sudden change in light intensity that appeals to the viewer's peripheral vision and triggers a natural tendency to shift their gaze.

Scene transitions: Transitions between scenes pose a particular challenge for eye tracking in CVR. Unlike traditional movies, where hard cuts or montage techniques are used to direct the viewer's attention to a new element, the 360-degree environment lacks direct control over the field of view. Research has shown that it is particularly difficult to direct viewers at the beginning of a new scene because they are in an orientation phase and their line of sight does not necessarily correspond to the narrative focus.

3 Expert Interviews

To estimate upcoming challenges and opportunities of *attention-guiding* in these technologies within theatrical environments, six expert interviews were conducted with professionals in the fields of theater, technology, and interactive media. The purpose of these six interviews was to gain valuable insight into the practical aspects of

implementing *attention-guiding* techniques and to supplement theoretical findings with real-world experiences and perspectives. The experts were selected to provide perspectives from a wide range of production departments, including technology, dramaturgy, acting, and screenwriting. The interviews were conducted using a structured guide that included specific questions about the challenges and solutions associated with directing attention in MR environments. The experts were asked to share their experiences and opinions on various aspects of directing attention, including the use of visual and auditory cues, the integration of interactivity, and overcoming technological hurdles. The interviews were recorded and then transcribed for detailed analysis.

3.1 Technological Challenges and Distractions

A recurring theme in the interviews was the challenge of effectively directing user attention in MR environments without breaking immersion. Experts emphasized that technological difficulties, such as operational problems or interaction delays, can significantly affect immersion. One expert noted that even small technical glitches are often interpreted as "the technology not working", which can undermine user confidence in the technology. A key aspect to overcome these challenges, was the conduction of training and onboarding processes that help users become familiar with the technology before they are immersed in the immersive experience. Interactive learning environments in which users can experiment and make mistakes without fear of negative consequences are a important component of the onboarding process. These environments offer users the opportunity to explore the technology in a safe and controlled setting, which facilitates learning and reduces the fear of making mistakes later on during the performance. One expert emphasized the importance of feedback mechanisms in such learning environments. Real-time feedback can help users track their progress and understand which actions lead to the desired results.

3.2 Interactivity and Tactile Experiences

Another important aspect highlighted in the interviews was the importance of interactivity and user control in MR environments. Users who feel in control of their experience are more likely to engage more deeply and stay immersed significantly longer. Interactive elements, such as the ability to interact with objects in the virtual world or explore the environment, were seen as critical to maintaining user attention and interest. One expert pointed out that the balance between guidance and freedom is critical to creating an immersive yet navigable experience. Too much control can overwhelm users, while too little can lead to disinterest and distraction. The interviews emphasized the importance of considering the tactile and cultural experiences of users, as well as their tactile abilities, for *attention-guiding* in MR environments. They pointed out that younger users who have grown up with digital technologies are often able to interact with MR environments more quickly and intuitively than older users. Generational differences in technology acceptance and cultural differences in perception and interaction influence how users interact with technology and navigate the immersive environment. Ease of use and non-intuitiveness can significantly impact immersion, making adaptive technologies and personalized onboarding processes critical to ensuring a seamless and inclusive user experience. By adapting technology to the individual needs and abilities of users, MR applications can be made more immersive and accessible, resulting in greater audience retention and engagement.

Figure 3: The audience experiencing the performance.

4 Technical Implementation

Symmetry is a theatrical performance developed and performed entirely in VR. The application was developed on the *Resonite* platform, an established Metaverse platform that covers many of the basic requirements for such a production. The platform offers features such as multiplayer, voice chat, and integrated coding tools for creating complex game mechanics within the system. Building on this solid foundation, the technical team was able to program and create the necessary game mechanics for the users and stagehands directly in the VR within the application.

An important goal for the team was to keep the complexity of the system as low as possible for the user to ensure a seamless and immersive experience. This meant that all interactions had to be intuitive and self-explanatory so that users did not have to interact with additional user interfaces. The entire experience was designed to work without additional technical barriers, allowing users to focus on the action and explore the virtual world. To achieve this goal, the results of the research and interviews were analyzed and reduced to a few test cases. Discussions with experts in other fields and people outside the production provided an objective insight into the progress of the production and the intuitiveness of the system.

4.1 Worldbuilding

An integral part of *Symmetry* was the ability for users to freely explore the open world at certain stages of the game to find clues and hints to the story. The design of the world and the integration of *attention-guiding* techniques were based on insights gained from expert interviews and research on diegetic cues. Color saliency was used to direct users' attention to specific locations by highlighting important objects or places with targeted lighting. Important objects were also outlined when the user was nearby. Auditory cues

signaled proximity to points of interest, while NPC dialog provided subtle to obvious cues about important locations.

The saliency modulation techniques proved to be particularly helpful in the expansive sections of the open world. Users were usually able to find all of the hidden clues because the level structure was designed so that there were always lines of sight to important clues, and users could orient themselves within the level at any time. The deliberate placement of objects and use of directed lighting and color helped to effectively direct the user's attention without breaking immersion.

4.2 Chroma Salience

At certain points in the story, it was critical that users focus their attention on specific dialog or avatars. Chroma saliency was used here, a technique where only the important area is displayed in color while the rest of the scene is monochrome and completely desaturated. This method ensured that users were not distracted by the environment or other distractions and could focus on the central elements of the action. The use of chroma saliency was particularly effective in scenes where important information was being conveyed or the plot was taking a decisive turn. By reducing visual distractions and focusing on the relevant areas, the user's attention could be directed in a targeted manner, resulting in a more intense and immersive experience.

Symmetry demonstrates how important the integration of certain attention-guiding techniques and a focus on user experience is to create an intuitive and immersive theatrical performance in virtual reality. The use of color and chroma salience, combined with auditory cues and intuitive world design, allowed users to focus on the main plot points without being distracted by the technology or faults of the technology.

5 Conclusions and Shortcomings

The implementation of the attention-guiding system in *Symmetry* was successful, with most audience members remaining engaged throughout the performance and not feeling lost. Observations over the 10 performance days showed that the attention-guiding techniques were effective in directing the audience's attention to central narrative elements without being intrusive. Quantitative feedback, as well as critics' feedback, helped assess the success of the play and shed some light on the experience that users had with the system. Users were not only able to orient themselves in the virtual environment effortlessly but could also contribute to the plot by finding clues and hints within the open-world exploration parts of the play. Most users reported an increased confidence to engage with the system due to the tutorial that was provided directly before the performance.

However, some users experienced difficulties interacting with the technology due to some technical difficulties. Every user was briefed and was provided with a comprehensive onboarding tutorial. Nevertheless, some users experienced motion sickness or similar symptoms. This is likely due to inexperience with this kind of technology, and additionally, performance problems in the form of frame rate drops whenever *Resonite* or the VR Headset could not handle the demanding task. For users that did not cope well with Virtual Reality, the whole play was being shown on a big screen through the lens of a spectator camera within the virtual play. Being able to take a break or even experiencing the whole play this way proved to be a preferable option for a significant amount of people. Virtual Reality, in particular, is known for being polarizing when it comes to being affected by motion sickness [3]. The interviews and observations from the performance clearly show that the technical aspects of the performance did not pose as much of a problem after the introduction. Known issues such as motion sickness need to be addressed by future iterations and research.

6 Future Research Directions

Future research should focus on extending and refining these techniques, with a particular interest in integrating multimodal approaches that combine visual, auditory, and haptic stimuli. Implementation of such systems could not only further increase user immersion and engagement but also reduce cognitive load by engaging multiple senses simultaneously. Interdisciplinary collaboration between psychology, computer science, design and theater studies is crucial to develop innovative solutions that consider both technical and artistic aspects and thus contribute to a holistic user experience. The evaluation and validation of the developed techniques in real-life application scenarios using quantitative and qualitative methods will provide a comprehensive picture of the user experience.

Ethical and societal implications, such as privacy and user autonomy, should be considered to ensure responsible use of the techniques. Especially, when the performance is being held online. Future research should also consider other forms of mixed reality technology, such as augmented reality, as there are significant overlaps and similar challenges and solutions. The integration of accessibility features is also crucial to ensure that these technologies are accessible to all users, regardless of their physical or cognitive abilities. Further development and application of these techniques can significantly increase user engagement and immersion in digital theater productions and other MR applications, although ethical and societal aspects should always remain in focus.

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~~Black Pudding~~: A Speculative Visual Index

Representational limits of Generative AI during creative porn productions

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ABSTRACT

Funded by the GenAI Studio grant (Milieux Institute and Applied AI Institute), *~~Black Pudding~~* is a research-driven, AI-based project that revisits the lost pornographic animation film *Black Pudding* (1969) by Nancy Edell (1942-2005), a Canadian-American pioneer director in feminist animation. By using the tools available on generative AI porn platforms, this project speculates on how contemporary AI would represent *Black Pudding* today. This is done using surviving textual materials (critics, festival reviews, films encyclopedias) written about the film as prompts on contemporary AI-porn content generators. *~~Black Pudding~~* creates a space to explore the ethical and creative boundaries of generative AI in reconstituting feminist sexual representations.

CCS CONCEPTS

• Applied computing → Media arts • Human-centered computing → Cultural content • Computing methodologies → Generative AI • Human-centered computing → Collaborative content creation • Applied computing → Ethics

KEYWORDS

pornography, pornographic animation, generative AI, AI pornography, Nancy Edell, feminist animation

1 Introduction

The intersection of sexuality of generative artificial intelligence (referred to in this article as generative AI) has often centered the ethical concerns over its representational harms: how systems are trained on biased data that reflect the ideologies of their creators and reinforce harmful stereotypes [1], and how generative AI can exacerbate existing harms against marginalized communities using models, such as seen in the proliferation of deepfake pornography [2]. Prakash L. Kharvi [3] describes deepfakes as the "employment of manipulated digital content, such hyper realistic synthetic video, audio, images, or texts crafted using advanced Artificial intelligence (AI) techniques, to compromise targeted decision-making process," and reports that deepfakes related incidents increased from than 20,000 in 2019 to almost 100,000 in 2023. During this brief period, technologies on AI-content generator platforms that focus on the making and distribution of AI-based pornographic online content have grown increasingly more user-friendly, often offering fast services at no cost. These platforms have contributed to the proliferation of deepfake pornographic content potentially used to harm, bully, and produce nonconsensual pornography about existing people. Women have been the main targets of the misuses of generative AI. On platforms where users are encouraged to reduce them to "digital resources to be edited onto sexual bodies" without their consent [4], their faces are extracted from personal pictures and edited into pornographic media. This has led mainstream pornographic platforms, where most of this content circulates, to amend their policies [5].

Although deepfake pornography is admittedly the first form of fake porn to receive attention in the press, Chandell Burkell and Jacquelyn Gosse [6] explain that the production of nonconsensual sexual imagery of women exists in a long history of gendered abuse at the intersection of digital technologies and visual culture. A similar argument is made by Benjamin N. Jacobsen and Jill Simpson [7] who argue that deepfake pornography media that target women exist within a continuum of female objectification that is "always emerging and always have emerged," and by Kate Sinclaire [8] who explains that the policing of women's sexuality cannot be summarized to deepfake pornography. Centering deepfake pornography, as it has been commonly done by mainstream media, policymakers, and online commentators, risks isolating it from other forms of tech-enabled abuse and oppression towards marginalized communities, including the adult performers whose content is used without their consent as training data and weaponized to hurt and mock others. Additionally, this bias ignores other forms of AI-generated pornography, such as non-photorealistic content: illustration and animation, that do not answer to live-action logic and must be understood in their own rights. This aligns with a tendency from studies of pornography to not take into consideration the specificities of animation:

> "Porn animation challenges the application of traditional approaches that centre live-action content, such as emphasis on sex-worker rights and in-person productions. Hence, it calls for theoretical frameworks that intentionally medialize animation." [9]

In the context of AI pornography, it means leaving an important part of massively produced generative AI porn productions underexamined and unexplored, rendering us underprepared to fully understand its role, impact, and consequences if used during creative

porn productions. This short article addresses generative AI pornography beyond deepfake. This is done by exploring the tools currently available to creative porn producers on AI-porn content generators.

Unlike popular AI models that block (DeepAI) or paywall (Stable Diffusion) adult content, AI-porn content generators are online platforms that allow users to generate sexual content using machine learning. More than often, these platforms rely on a credit system and premium subscriptions, to quote Peter Alilunas: "Pornography will not merely exist in the coming world of AI, it will thrive." [10]. The majority of these platforms rely on marketing metaphors that advertise their easy accessibility and unrestricted capability to generate creative images or videos. Arman Chaudry, the co-founder of Unstable Diffusion, a platform and dataset of more than 30 million data photographs that grew out of the Stable Diffusion's online community, explains that the platform was made "for creativity to thrive without undue constraints … Our belief is that art, in its many forms, should be uncensored, and this philosophy guides our approach to AI tools and their usage" [11]. Yet, despite the marketing argument of unlimited generation that is often advertised on these platforms, these new AI tools come with their fair share of limitations, whether these be technical, financial, representational, or ethical. This project illustrates said limitations by critically and creatively investigating these platforms during a research-creation project titled *Black Pudding: A Speculative Visual Index* that creates a space to explore the ethical and creative boundaries of generative AI in reconstituting feminist sexual representations in animation.

2. The ethics of using AI-content generators

It should come to no surprise that using AI-content generators for the purposes of a research-creative project involving animation comes with its set of ethical concerns. The use of generative AI in the animation industry has been largely pushed against by its workers, and accused of impacted junior and intermediary roles [12]. The AI Task Force of The Animation Guild reports that 75% of 300 entertainment executives already expressed that generative AI had supported the elimination, reduction or consolidation of jobs in their business division, and that 90% foresaw that generative AI will play a larger role in future productions. The AI Task Force also anticipates that more than 20% of the 118,000 entertainment industry jobs in the U.S. will likely be affected by generative AI by 2026 [13]. In addition to the labor impact of generative AI, there exist other concerns regarding the ecological and copyright costs of the models used by AI generators. Said models are usually trained on powerful, energy-costly computers and with data acquired without their authors' consent. Moreover, the proliferation of AI-generated pornography might limit opportunities and viewership for creative porn workers as platform capitalism depend on fast produced user-generated content, as well as endangering their labor and rights to anonymity by pushing regulators to create all-encompassing policies against pornography that do not answer to live-action governance logical.

These concerns justify in themselves the urgency to better understand AI-generated pornography, but the very use of AI-porn content generators in an academic setting must be guided by labor, ethical and ecological concerns. While not a perfect answer, *Black Pudding: A Speculative Visual Index* attempts to address these by transgressively using AI-content generators to investigate a lost experimental feminist short animation film, Nancy Edell's *Black Pudding* [14], the first known pornographic animation directed by a woman. Designed as a platform to reclaim Edell's overlooked contribution to the study of pornographic animation history dominated by male directors, this research is conducted outside of the capitalist and extractive logic that inhabits much of the current AI porn industry. Funded by a research-creation grant from the GenAI Studio grant (Milieux Institute and Applied AI Institute) and first shown to the public during the MUTEK Forum 2024, *Black Pudding: A Speculative Visual Index* shifts away from mainstream pornography, commercial uses, and platform-restricted distribution by instead producing a series of experimental AI-generated images based on a lost feminist animated media.

Black Pudding: A Speculative Visual Index is informed by feminist historiography and speculative media studies: which history about pornographic animation emerges when women are not positioned as either subjects or opposition forces? This project is as much a tribute to Edell's contribution to animation history as it is an interrogation of AI's evolving role in reshaping visual adult culture.

3. Black Pudding: A Speculative Visual Index

Black Pudding: A Speculative Visual Index is a research-driven, AI-based project that revisits the lost pornographic animation film *Black Pudding* (1969) by Nancy Edell (1942-2005), a Canadian-American pioneer director in feminist animation. Edell made two other films throughout her career, *Charley Company* [15] and *Lunch* [16]. Made in the late 1960s during her studies at Bristol University (UK), *Black Pudding* is one of the oldest known animated representations of sexual imagery made by a woman, ten years before Suzan Pitt's *Asparagus* [17], often cited as a pioneer of this genre. At the time of its release, many adult-oriented films were produced across Europe, as these were not subjected to the Hays Code, however many of them are now considered lost, and not much is left of *Black Pudding*. The film is considered a lost media: copies are no longer available, exemplifying the lack of film preservation for 1) adult animated films, 2) feminist media made by women, and 3) experimental films that exist outside of traditional film institutions. By using tools available on generative AI porn platforms, this project speculates on how contemporary AI would represent *Black Pudding* nowadays. Using surviving textual materials (critics, festival reviews, films encyclopedias) written about the film as prompts, *Black Pudding: A Speculative Visual Index* [18] takes the form of an online platform to explore the ethical and creative boundaries of generative AI in reconstituting feminist sexual representations by speculating on how AI would imagine a lost animation film. The "disappearance" of *Black Pudding* guides the method that motivates this project: to explore both the history of pornographic animation, and the new creative AI tools that seized its industry by creating images based on a lost pornographic animated film using AI-porn content generators.

If we do not have access to *Black Pudding* today, many did in the past: film critics, academics, feminist collectives. This means that information about the film exists, such as short summaries and graphic depictions. These surviving texts were found in archival media using the "text content" search tool available on the Internet Archive–now an official US government document library not without its own preservation challenges against publishers [19]. Nine bibliographic sources were then identified on the Internet Archive, dating from 1972 to 2002, to which additional entries on *Black Pudding* were added from two repositories: the British Film Institute (BFI) and the Lost Media Wiki. Each of these eleven sources mention and describe to some extent *Black Pudding*:

1. Maryse Holder (1972) "First International Festival of Women' Films in New York City" in *Off Our Backs*: "The least uptight of the erotic films was "Black Pudding," an animated film by Nancy Edell. In it a giant vagina belches out strange, surrealistic, creatures in an endless stream." (p. 17)
2. Women's History Research Center (1972) *Films by and/or About Women*: "Black comedy surrealistic cartoon of Hieronymus Bosch's world." (p. 18)
3. Ralph Stephenson (1973) *The Animated Film*: "Black Pudding, a modern erotic fantasy in the vein of Bosch or Bruegel." (p. 95)
4. Amos Vogel (1974) *Film as a Subversive Art*: "The violent pornographic surrealism of American underground cartoon magazines finally invades film animation. In an unfathomable universe, huge vaginas and penises are protagonists of bizarre, violent, and pornographic events: the mixture of monsters and sexuality, the perverse and the apocalyptic are reminiscent of Bosch." (p. 221)
5. Julie Lesage (1974) "The Personal Film" in *Films by Women, Chicago '74*: "Dark and ominous creatures pour out of a Boschian vagina in an inexhaustible frenzy of animation. Edell is expert at summoning up the at-once comic and erotic personae of woman's nightmares." (p. 31)
6. Brian Clancey (1976) "Of Black Pudding and Pink Ladies" in *Cinema Canada*: "The vacuum cleaner is chasing the food around; the food is coming out of this sphinx. So, I was drawing all the food for that scene and I drew this little black pudding. Women give birth to black pudding humanity." (p. 39)
7. Kaye Sullivan (1980) *Films for, by, and about women*: "A Black comedy surrealistic cartoon film reminiscent of the world of odyssey; with caricatures fornicating and excreting as they go." (p. 37)
8. David Clandfield (1987) *Canadian Film*, Oxford University Press: "an extension of her eccentric drawings." (p. 120)
9. William Beard and Jerry White (2002) *North of everything: English Canadian cinema since 1980*: "dark, surrealist fantasy full of bizarre, often erotic imagery and feminist themes." (p. 80)
10. Lost Media Wiki (2021) *Black Pudding (lost pornographic animated short film 1969)*: "Released in 1969, it is said to be a seven-minute animated short with sexual imagery and representations of household items."
11. British Film Institute, *Black Pudding*: "Animated lithographic characters: a group of surreal beings take a startling journey through the inner recesses of an enormous nude female."

The eleven sources were used to convey prompts to be used on three AI-porn content generators that were not limited to photorealistic imagery: Unstable Diffusion, Civitai, and Promptchan. To maintain coherence between image generation, each prompt was introduced by a description of *Black Pudding* I wrote based on the sources:

> "Animate a scene from 'Black Pudding' (1969) by Nancy Edell, featuring a giant vagina belching out strange and surreal creatures in a Bosch and Bruegel-inspired style described as [insert the quote extracted]."

The project resulted in the generation of 90 images, in three distinctive styles and formats shaped by the tools available on each generator platform as exemplified below.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 1 and 2: Images generated on Unstable Diffusion using the Clancy (1976) and Beard and White (2002)'s based-prompts.

Figure 3 and 4: Images generated on Promptchan using the Bear and White (2002) and Lesage (1974)'s based-prompts.

Figure 5 and 6: Images generated on Civitai using the Stephenson (1973) and the BFI's based-prompts.

These images compose a speculative visual index: these do not attempt to reconstitute the lost *Black Pudding*, but rather to open a process of speculation on what it might have looked like, and of reflection on the limits of AI-porn content generators during creative porn productions. The image generation process of this project was limited by the technological affordances on each platform: the number of images possible to generate at one time, the cost of credits for generation, the format of the images, the art styles available, the rules over content generation, and which content the initial data used was trained on. Despite the relatively neutral tone of the prompts used, the image generation process was always limited by the representational politics of these platforms, including the predominance of whiteness, gendered stereotypes, and uniformed body types. For example, all the women represented using the Unstable Diffusion tools had pale skin colors and answered to outdated Western beauty standards, reinforcing rather than expanding upon common tropes in pornographic media.

Since this project started, one additional source in French has been discovered from Quebecois journal *Virus Magazine* and will be added in future iterations of the project:

1. Virus Montréal (1978) "Le cinéma parallèle" in *Virus Magazine*: "L'Empocheur, le Pilote de la RAF, l'Aspirateur, le Trieur de Nez, l'Oiseau Plein d'Marde et d'autres font un voyage, rencontrent le Roi et vont voir une vue." (p. 30)

Conclusion

In the chapter "Hacking Metaphors in Anticipatory Governance of Emerging Technology," Meg Leta Jones and Jason Millar [20] argue that we must move beyond simply anticipating metaphors used by designers and users of new technologies, and must rather engage in a process of "hacking" said metaphors (p. 600). On AI-porn content generators, generative AI is advertised as "unlimited," a tool of endless possibilities for its (paying) consumers. On Promptchan, users are invited to bring their "spiciest sexual fantasies to life," and Civitai describes itself as "a virtual canvas where [users] can unleash [their] creativity." But not only these metaphors describe generative AI as something that anyone should be legitimately scared of (what if someone's "spiciest sexual fantasies" involved, for example, children? [21]), these are also unfairly describing what is actually a quite limited creative process [22]. If *~~Black Pudding~~: A Speculative Visual Index* provides a more accurate understanding of what AI-porn content generators can, and cannot, really do, it also points towards the need to hack these metaphors of unlimitedness. AI-porn content generators are governed spaces informed by platform capitalism, and contain many financial, legal, and creative limitations that are dependent on the dominant narrative of AI tied to extraction.

While the intent of this project was never to "recreate" *Black Pudding*–an enterprise that would have had its own layers of ethical and legal concerns, this project hints that other tools might need to be used. What might AI look like if we slowed it down, made it smaller, and used it to make art together instead?

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Brosch AI - Distorted Dreams:

Expanding and Animating an Archive With AI

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Figure 1: Insight into the six-minute animated film *Brosch AI - Distorted Dreams* [10] .

ABSTRACT

Brosch AI - Distorted Dreams explores the intersection of artificial intelligence, art, archives, and animation. The project transforms the archive of Upper Austrian artist Klemens Brosch (1894– 1926) into an AI-animated film. While AI image-generation tools typically rely on online archives, museum collections often provide only low-quality digital reproductions. By utilizing high-resolution images from Brosch's archive, this project investigates the potential of AI-driven animation while addressing challenges related to stylistic control, and creative authenticity. The findings demonstrate that while AI can produce high-quality outputs, extensive refinement and iterative adjustments are necessary to preserve the essence of Brosch's work. The project sparks critical discussions on authorship, originality, and the evolving role of technology in artistic creation.

CCS CONCEPTS

• **Computing methodologies** → **Animation**; **Artificial intelligence**; **Machine learning**; • **Applied computing** → **Media arts**.

KEYWORDS

AI, AI and ethics, animation, media archive

1 Introduction

Since the emergence of AI tools for generating images and animations, numerous discussions have arisen regarding copyright issues, biases, stereotypical outputs, and clichés in AI-generated artworks. AI-based image generation tools rely on online-available images as training data, enabling them to create images and animations based on user prompts. However, image archives from museums and collections are often only partially available online and frequently in low quality. To achieve high-quality outputs, a well-curated image database with high-resolution digital reproductions is essential.

In this study, we demonstrate how the image archive of Upper Austrian artist Klemens Brosch can be transformed into an animated film using AI tools. The project *Brosch AI - Distorted Dreams* [10] explores how AI-based tools can animate and expand Brosch's artistic legacy, while also highlighting the limits of cultural heritage interpretation [11]. We examine the potential of current AI tools to enhance historical artworks and create added value through digital augmentation.

The results reveal that while AI tools can generate high-quality outputs quickly, the process lacks control over specific artistic styles and details. The final animation exemplifies the fine balance between what is currently achievable with AI tools and the limitations that still exist in this context.

2 AI tools in Animation

The origins of AI-driven image generation are traced back to early experiments in computer graphics and algorithmic art in the 1960s [1, 13]. A pivotal moment in this field was the emergence of Convolutional Neural Networks (CNNs) [2] and, in particular, the introduction of Generative Adversarial Networks (GANs) in 2014 [3]. A significant milestone in this evolution was Glenn Marshall's AI-generated short film *The Crow* (2022) [7]. In this project, Marshall utilized style transfer and various AI techniques to morph a dancer's movements into the fluid and dynamic form of a crow,

showcasing how machine learning models can manipulate and reinterpret visual aesthetics. Similarly, Sujin Kim's animated short films *Dissolution* (2023) and *Cunabula* (2023) [5] showcased how artists can harness AI-driven Style Transfer to reinforce a specific artistic vision. In these works, AI was used not merely as a tool for digital enhancement but as an integral part of the creative process, guiding the transformation of imagery in a way that aligned with the conceptual and aesthetic goals of the project [5]. These films exemplify the growing potential of AI-assisted art in crafting unique and immersive visual narratives. The continuous advancement of AI-driven image generation, particularly in the realms of deep learning and neural style transfer, marks a transformative shift in digital art. These technologies extend the creative toolkit of artists and designers, providing new methods for reinterpreting traditional artistic styles, generating novel compositions, and automating complex visual effects. More importantly, they redefine the role of AI as a collaborative partner in artistic expression, where human intuition and machine intelligence interact to produce new works. As AI continues to evolve, its integration into the creative process is expected to further blur the boundaries between technology and artistry. The synergy between human creativity and machine learning algorithms opens up unprecedented opportunities for aesthetic exploration, offering artists new ways to experiment with form, texture, and motion. This ongoing convergence of AI and art signifies not only a technical advancement but also a philosophical shift, challenging traditional notions of authorship, originality, and the very nature of artistic creation.

3 Methodology

Based on Klemens Brosch's archive, we produced a six-minute animated film *Brosch AI - Distorted Dreams* [10]. The animated short explores how AI tools and workflows that include style transfer can be used to stage and expand Brosch's creative period (see Figure 1). It examines how art, described as a "psychogram of self-destruction" [8], can be reinterpreted through AI while integrating current insights and expertise from art history. Additionally, it considers how AI can provide an expanded perspective on Brosch's dark yet romantic visual worlds and what insights this approach can offer for contemporary art historical analysis. Another central theme of this experiment is a creative and self-reflective approach to AI tools.

3.1 Klemens Brosch Archive

Klemens Brosch (1894–1926) was an Austrian artist, whose work is characterized by extraordinary precision and a dark, often surreal visual language. Born into a middle-class family in Linz, Brosch displayed an exceptional talent for drawing from an early age. Recognizing his abilities, he was encouraged to study at the Academy of Fine Arts in Vienna. There, he co-founded the artists' association MAERZ and quickly gained recognition for his precise and atmospheric drawings. His works, often depicting landscapes or fantastical visions, were distinguished by meticulous line work and a melancholic undertone. A profound turning point in his life was World War I. Drafted into the military, Brosch was soon discharged due to health issues. The war left an indelible mark on his art, as he documented its horrors in stark, evocative drawings. During this time, he also began using morphine, initially prescribed for medical reasons. This addiction would become the defining struggle of his life and had a lasting impact on his artistic output. After the war, Brosch returned to the Academy, but his career took an increasingly tragic course. His addiction led to social isolation and mounting financial difficulties. Despite occasional successes, including significant exhibitions and recognition in art circles, he fell deeper into dependency. His later works grew darker, often dominated by apocalyptic visions and a morbid fascination with death. In 1926, at just 32 years old, Klemens Brosch took his own life. Though his work was long forgotten, it is now recognized as a significant contribution to Austrian art of the early 20th century. Elisabeth Nowak-Thaller published a comprehensive study on Klemens Brosch in 2016; other relevant publications include Kastner [4] and [15].

> Brosch's fantastic, meticulously detailed drawings—anticipating both New Objectivity and Surrealism—are timeless and existential. Early on, the artist dedicated himself radically to pressing issues such as the mass destruction of World War I or drug addiction, while also engaging with themes of landscape, transience, and death [8, 11].

Figure 2: Klemens Brosch – a selection of works from the final creative period: *Ride in a Gloomy Moonlit Night* (1922), *The Plague* (1922), *The Hermit at the Cross* (1922).

His images are both dark and romantic; Brosch employs strong contrasts, and extreme perspectives, and explores themes such as illness and death, as seen in works like *Ride in a Gloomy Moonlit Night* (1922), *The Plague* (1922) and *The Hermit at the Cross* (1922) (see Figure 2).

The OÖ Landes-Kultur GmbH[1] and the LENTOS Kunstmuseum[2] supported the project. The initial idea of working with the Alfred Kubin Archive had to be abandoned due to the estate's refusal to grant image rights. After further discussions, Klemens Brosch's works were chosen as an excellent alternative starting point. The association ANIMA PLUS serves as the producer, and the project got funding from the City of Linz, the State of Upper Austria, and the Federal Ministry for Arts, Culture, the Civil Service. The image and usage rights were clarified with the OÖ Landes-Kultur GmbH and LENTOS Kunstmuseum in December 2023. In January 2024, the graphic collection of the Landesmuseum Linz provided 250 digital reproductions of Klemens Brosch's works for the project.

[1] https://www.ooekultur.at/
[2] https://www.lentos.at/

Moreover, the photographer Norbert Artner provided a Gigapixel of the artwork *Observatory* (1926) which allows further experiments with AI tools.

3.2 Expanding and animating an archive with AI tools

In this chapter, we demonstrate how the images from the archive were expanded and animated. The workflow builds upon the expertise of *LUCID* [9] by Celine Pham, enhancing it with AI video tools like *Runway, Luma Dream Machine, Haiper or KlingAI* [12]. The production workflow used for *Brosch AI - Distorted Dreams* is illustrated in Figure 3.

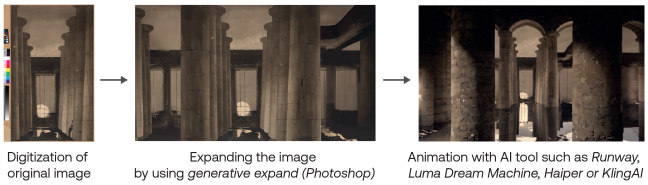

Figure 3: Insight into the used production workflow of *Brosch AI - Distorted Dreams* through the example *In the ruins* (1922).

3.2.1 Expanding. The pictures were edited in Photoshop. In particular, they got cropped at first, getting rid of all the unnecessary sides of the pictures. Then, the canvas size was extended to a ratio of 16:9. In some cases, certain motives were cut out with a mask to have an isolated picture with only that object. Finally, the AI-process starts. Working with the AI tool provided by Photoshop, usually no prompt was used, due to the fact that in that case, the AI will refer to the neighbored parts of the image to get a smooth transition. Hence, the final image was more determined by decision making rather than the input. The only way to steer the generation in a certain direction was to change the mask size and positioning. This limited the sphere of influence of the environment.

3.2.2 Animating. Throughout the process, three different pipelines were explored, but only one was actually used to create most of the content. One workflow included *ComfyUI* and projection mapping in Blender. After the 3D structuring, multiple render passes are generated, including outlines, depth maps, and multi-matte layers, which provide crucial data for subsequent AI-driven transformations. These rendered passes were then processed in *ComfyUI* and used as conditioning inputs in *Stable Diffusion*, guiding the image generation process similarly to how *ControlNet* refines AI outputs based on structured input data. This setup enabled an organized prompting approach: a main prompt defined the overall visual direction, while different elements within the scene were refined through sub-prompts corresponding to specific render layers. By leveraging these layers, the workflow allowed for precise control over individual components, ensuring context-aware and coherent visual enhancements. The graphic in Figure 4 offers a detailed visualization of this production workflow. However, none of its outcome was used in the final video.

Another experiment involved training a *LoRA* model to capture the visual style of Brosch's paintings. This model was then used

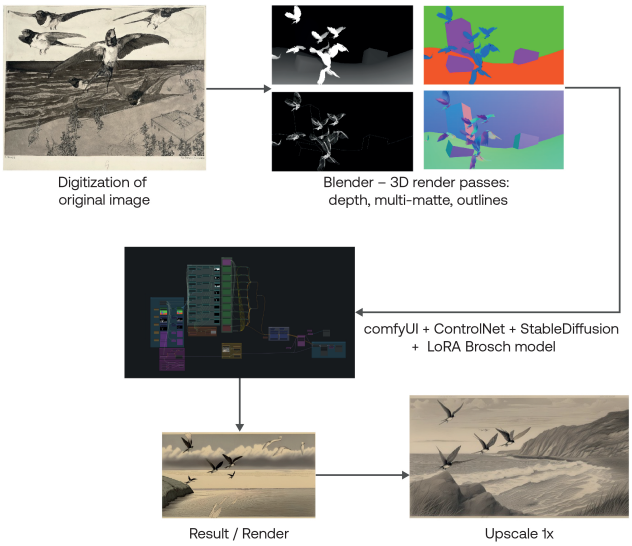

Figure 4: This workflow, based on the image *By the Seashore* (1913), involved using *ComfyUI* and *Blender* projection mapping to generate 3D render passes, which were then processed in *ComfyUI* to create text prompts for *Stable Diffusion*, enabling refined AI-driven enhancements. However, none of its results were used in the final video.

in the *ComfyUI* workflow for style transfer, applying the painterly characteristics to AI-generated videos and blending them with real footage.

The most fruitful workflow used online AI tools like *Runway, Luma Dream Machine, Haiper or KlingAI*. Almost every part of the final video was produced with these online tools. At first, the picture was analyzed, and the animation was determined. Then, the picture was put into every tool to see, which AI was grasping the motive the best, without any additional information. This step also led to an intuitive knowledge, which AI tool could work the best with certain images. After choosing one tool to continue working with, the different AI models of this tool, if available, were tested, the same way as before. In case with Runway, the models *Gen-3 Alpha Turbo, Gen-3 Alpha and Gen-2* were tested, including their key features like the motion brush. After this process, the best working model for one picture was found. Depending on what should happen in the animation, the pictures were used as a startframe and endframe or startframe and middleframe and endframe. This made it possible to run the generated animation with fixed start, middle or end images. For this operation, pictures were sometimes edited in layers to make for example appearances possible. Prompting plays a crucial role in AI-driven creative tools, influencing the quality and precision of generated content. Whether using platforms like *ComfyUI*, *Runway*, or *Haiper*, the way instructions are formulated significantly impacts the output. Each tool has its own syntax and "language" for interpreting prompts, meaning that an effective command in one application may not yield the same results in another. Additionally, factors such as image size, format, and video length further affect how prompts are processed and how the model interprets the input.

Understanding the specific requirements and nuances of each tool is therefore essential to achieving optimal results in AI-assisted media production [6].

The following features influence the generated animation: pictures, length, prompt, seed and additional settings like camera movements, motion brush and resolution. If a generated animation fulfills the requirements, it can either gets expanded by a few seconds or exported for the final steps. Some tools offer an enhancement – meaning upscaling the footage to a greater resolution – or a slow motion generator.

4 Discussion

The described AI tools streamline complex processes, improving efficiency and automation by reducing the time required for tasks such as image expansion, morphing, and animation. With the ability to upscale and refine images, AI can add detail to low-resolution artworks without manual intervention, ensuring high-resolution output. Furthermore, AI opens the door to experimentation and new perspectives, allowing for alternative artistic interpretations and offering fresh insights into historical artworks and visual storytelling.

In expanding and animating an artist's imagery using AI, several ethical and technical challenges arise. Ethical concerns include the risk of distorting the artist's original intent, potential copyright issues, and the broader implications of AI-generated modifications that may misrepresent historical works. Morphing problems and weak animation can further complicate the authenticity of the artistic vision, leading to unintended aesthetic shifts or the dilution of expressive depth. Additionally, experimental approaches often introduce unpredictability, requiring careful curation to balance creative expansion with respect for the source material and cultural heritage. Addressing these issues critically is essential to ensure that AI serves as a meaningful extension of artistic exploration rather than a tool for arbitrary alteration. This topic is discussed in many communities such as the *Digital Arts Community ACM SIGGRAPH* [14].

5 Conclusion

The result of the art project shows that AI can serve as a tool for expanding and animating historical artworks when guided by a carefully constructed workflow. By combining manual image editing with context-aware AI expansion and multiple animation pipelines, it was possible to generate results that remained visually coherent with Klemens Brosch's original style. The process demonstrated that while technical experimentation—such as 3D projection mapping or custom-trained models—offers valuable insights, the most effective outcomes were achieved through intuitive, prompt-driven workflows using accessible online tools. The success of the project hinged not on complex automation alone but on human decision-making, artistic sensitivity, and a deep understanding of each tool's limitations and strengths.

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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]

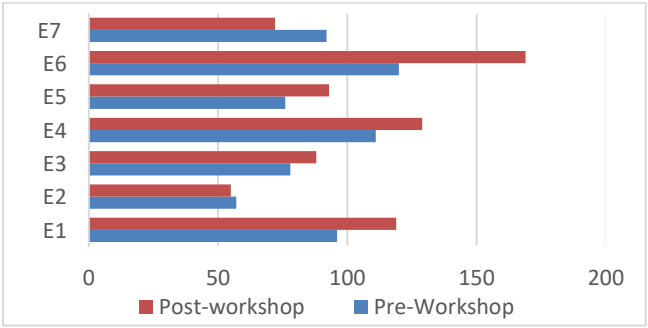

Figure 2: Graph depicting the educators' competency growth before and after their training workshop in 2024.

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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Leading the Future: Exploring Transformational Leadership in the European Animation, Games, and VFX Industries

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ABSTRACT

This study offers an in-depth analysis of how transformational leadership is currently understood and enacted within the European animation, games, and VFX sectors. Through qualitative insights gathered from 75 professionals across European studios and educational institutions, the research identifies both the promise and the practical limitations of the leadership model that centers on emotional intelligence, mentorship, and shared team ownership. While these principles are widely endorsed in the industries, the study finds that their consistent application is hindered by industry-specific challenges, most notably: the prioritization of technical expertise over leadership capabilities in promotion decisions, a lack of industry-specific leadership training, generational differences, and pressures stemming from intense production demands. Additionally, issues such as blurred boundaries between work and personal life and imbalanced workloads between leaders and teams further complicate leadership in the industries. The findings point to a need for clearer leadership frameworks tailored to the industry's demands and greater institutional support to equip both current and future leaders with the skills needed to foster sustainable, high-performing teams for the evolving demands of these creative industries.

CCS CONCEPTS

• Social and professional topics • Professional topics • Computing profession

KEYWORDS

Transformational Leadership, Creative Industries, Animation, Games, and VFX, Leadership Development

1 Introduction

The work environment in the animation, games, and VFX industries has been gradually evolving away from 'crunch' cultures centered on 'rockstars', though the pace of change varies across regions and studios. While these 'rockstars', exceptionally skilled and independently driven employees, have made significant contributions to their fields, their intense work habits have often resulted in challenging work-life balances and unhealthy environments [3]. In response, a nascent trend within the industry is emerging, with an increasing focus on fostering more positive, sustainable work environments that prioritize work-life balance, adaptability, and collaboration [7, 12]. This shift also recognizes that modern productions are complex team efforts that require cohesive, well-supported teams, ensuring a sustainable workforce that retains talent instead of losing it to burnout [7]. As the move toward a more collaborative and balanced work environment progresses, a critical challenge remains: maintaining a highly skilled, innovative, and competitive workforce in a fast-paced, ever-evolving field while avoiding a return to unsustainable practices. Striking the right balance between competitiveness and long-term sustainability requires strong and effective leadership [5, 14].

Transformational leadership has emerged as a potential solution to address such challenges [5] and is widely used for *"facilitating organizational change and driving success in an increasingly dynamic business environment [4]"*At its core, this leadership model emphasizes inspiration over pressure: leaders motivate their teams to pursue ambitious goals and consistently exceed

expectations [13]. Most research describes transformational leadership through the framework of the four I's: *Inspirational Motivation, Idealized Influence, Intellectual Stimulation,* and *Individualized Consideration* [13]. Transformational leaders are described *"as 'change agents' who influence others through visioning activities, role modeling, or appeals to emotions, morals, and standards, thereby 'transforming' individuals and/or organizations in broadly positive ways [2]"*. It prioritizes both professional growth and personal development of team members. While being one of the most practiced and researched leadership models [13], its practical application remains largely unexplored [9]. Research in the creative industries suggests that transformational leadership is *"critical to increasing employee performance in the creative industry [9]"*. First research in the animation, games, and VFX industry specifically suggests that transformational leadership is the leading approach in the games industry in Indonesia and positively impacts organizational climate, creativity, productivity, and innovation [10]. However, no significant practical studies on this topic have been identified within the European industry.

This paper, as part of the PANEURAMA project (www.paneurama.eu), contributes to the growing body of research by investigating to what extent and how transformational leadership is applied and developed in real workplace environments within the European animation, games, and VFX industries. By examining the practical challenges companies face in implementing these leadership strategies, this study seeks to bridge the gap between theory and real-world practice. It further explores how (future) leaders are trained and supported within companies and educational institutions. Understanding industry expectations for leadership and their alignment with educational offerings is crucial for ensuring that (future) leaders are equipped to meet the evolving demands of the industry. It also ensures that educational programs remain relevant and responsive to the sector's changing dynamics, preparing graduates for real-world challenges.

2 Methodology

This study is part of a broader qualitative research project involving unstructured and semi-structured interviews, focus groups, panel discussions, and informal conversations from January to September 2024. 75 participants joined interviews online via Teams and participated in offline focus groups, including industry experts, educational specialists, and students from 12 European countries (see Figure 1 and 2). Additional contributions came through panel discussions and informal conversations at key industry events following PANEURAMA presentations, including FMX 2024 in Germany, the Annecy International Animation Film Festival in France, and the Viborg Animation Festival in Denmark. A member of the research team was present in the audience at these events and took handwritten notes of the discussions, which were incorporated into the analysis. Informal conversations with individuals fitting the sampling criteria were also used for triangulation, helping to validate and refine preliminary findings. However, the exact number of contributors from these settings is unknown.

All participants provided written informed consent. The sample was balanced for diversity in professional experience, academic year, and industry expertise, and participants were recruited through a combination of direct outreach and snowball sampling to ensure a broad representation across sectors. Sociodemographic factors such as gender, ethnicity, and neurodiversity were not explicitly collected, because they were not within the scope of this study. Given that literature highlights the impact of gender, ethnicity, and neurodiversity on experiences in the industry [1, 6, 8, 11], exploring these factors more directly in future research could provide valuable insights into how they shape leadership dynamics and inform more inclusive practices.

Regional diversity was also considered, but most participants were based in Northern and Central Europe. Despite efforts, it proved difficult to recruit participants from Southern and Eastern Europe, which limited broader regional representation. Nevertheless, individual voices from these regions were included, and all perspectives were equally weighted in the analysis to ensure a balanced view. A follow-up study with stronger representation from these regions could help uncover potential regional differences and deepen understanding of leadership and work experiences across Europe.

The data was analyzed using thematic analysis to identify prominent themes. The outcomes aim to inform policy debates and contribute to future large-scale research and data-driven initiatives.

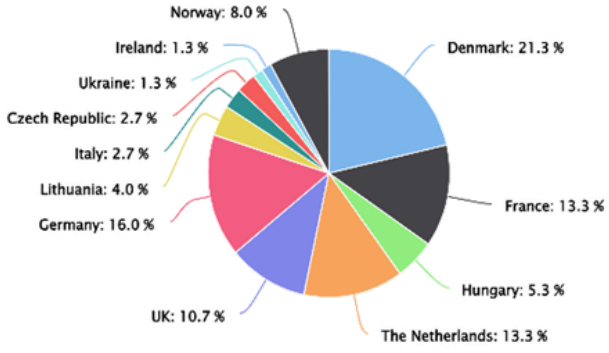

Figure 1: Percentage of Participants by Country of Residence

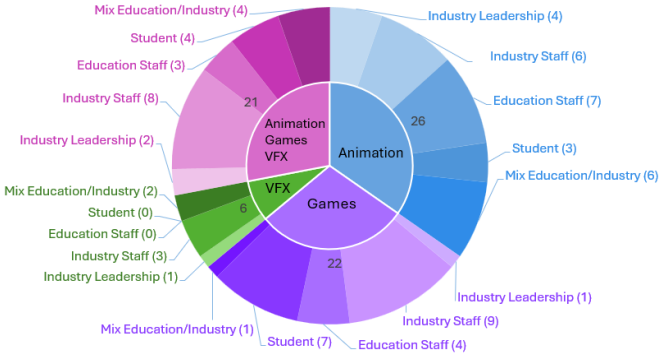

Figure 2: Professional Background Study Participants

3 Findings

3.1 From Managers to Mentors: Evolving Leadership in Creative Industries

The study indicates that while the term 'transformational leadership' is rarely explicitly used, its principles are generally appreciated across the industry, though not universally adopted. Participants noted that leadership in the animation, games, and VFX industries is evolving rapidly, requiring more than just technical expertise and project management skills. Emotional intelligence, empathy, and effective communication were identified as crucial for supporting and inspiring teams. Leaders are now expected to serve as role models who motivate through enthusiasm, shared vision, and intellectual stimulation, while also taking on coaching and mentoring responsibilities. This shift reflects a broader expectation that leaders guide teams through both professional and personal challenges, not just tasks and workflows.

Due to long work hours, often spanning days and nights, participants stated that they perceive their workplace as their second home, forming deep personal connections beyond professional interactions with colleagues. They emphasized that this unique environment needs to be understood and embraced by leaders, as the boundaries between professional and personal issues often blur. One participant described their leadership role as *"almost like a coach, a father figure, or even like a psychologist at the company,"* highlighting the importance of the personal touch. *"If you're only concentrating on the project, you're really missing the point,"* they noted, stressing that understanding individual struggles and fostering open communication is central to leadership in this context.

The psychological demands of creative work were emphasized, especially for junior talents encountering high-pressure situations for the first time. One participant highlighted the importance of approachable and supportive leadership, where employees feel safe to voice concerns and seek help. *"When work gets really stressful, I can vent to my lead, and my lead will listen and ask, 'Hey, what can I do to make it a bit better for you?'"* In these moments, participants shared that they often don't need more than the conversation itself, as it makes them feel seen and understood. In contrast, participants spoke about colleagues who lack this supportive leadership and often feel isolated, struggling alone without reassurance. This can lead to feelings of inadequacy, even when the issue may not relate to their abilities. Participants noted that, in industries like animation, games, and VFX, work is often tied to personal identity and the absence of an empathetic leader can foster self-doubt, lower motivation, and lead to overwork or people leaving the industry. These outcomes pose risks to individual well-being, team success, and workforce retention.

Furthermore, participants emphasized the importance of fostering an environment where all voices are encouraged, particularly when suggesting improvements to workflows or products. However, given the high-pressure nature of the industry, they also emphasized the need for leaders to ensure that concerns are voiced at the appropriate time. As one participant put it, *"A fast-moving train cannot just all of a sudden stop, but it must be constantly evaluated and improved."* For innovative workplace cultures, it is important that innovation is not only driven by a few individuals. Leaders must create a culture where diverse voices feel safe to contribute, ensuring that every team member's input is valued and considered.

3.2 Redefining Leadership: Generational Tensions and Work Imbalances

While there have been positive developments in redefining leadership within the industry and more leaders experimenting with new styles, the process is not without challenges. Participants highlighted struggles, including generational tensions and work imbalances between employees and leadership.

An example of a challenge was managing blurred boundaries, where the lines between professional and personal responsibilities become harder to maintain. Leaders balance their teams' emotional demands with their own workload, while employees benefit from flexible arrangements without facing the same pressure. Additionally, leaders experience unrealistic expectations, and employees pushing boundaries too far, placing them in uncomfortable positions and leading to criticism for not being seen as a good leader, despite already pushing their own limits. As one participant described, adopting more people-centered leadership styles can feel overwhelming: *"I was spending a lot of my energy just being this motherly/fatherly figure for these people and trying to get into their minds and their life... it was just a very unproductive period."* This highlights the delicate balance leaders must strike between meeting their teams' emotional needs and maintaining their own well-being and productivity within a high-pressure context.

Participants also discussed the challenges of managing differing perspectives across generations, noting that older generations

tended to hold on to traditional work habits, while younger generations advocate for new approaches. One participant explained, "*The older and younger ones have some tension sometimes, because of old habits... they [the older generation] say, 'But when I was young, I was here... working really hard to deliver the project on time,'"* while younger employees are often less willing to accept these intense work demands. As younger employees become the majority in studios, there is growing pressure on leadership to adapt, creating a more complex dynamic. Leaders must balance traditional and new approaches while ensuring effective collaboration across generations.

According to participants, the struggles leaders experience often push them to revert to leadership styles they are familiar with. However, this return to old methods presents a paradox: while these approaches may offer temporary relief, they are increasingly viewed as ineffective in meeting the industry's evolving needs.

3.3 Growing Need for Leadership Development for Current and Future Leaders

According to participants, companies urgently recognize the need for leadership training to accelerate the development of effective leadership within their studios. Leadership roles have traditionally been awarded based on technical expertise rather than leadership skills, leaving many leaders unprepared for the demands of their roles. As one participant explained, *"Some of them really like to manage, but they were not trained to be a manager... Many are not feeling comfortable because they are not trained."* This *"natural promotion style,"* as participants named it, perpetuates outdated leadership approaches ill-suited for the industry's evolving needs. One participant shared, *"We proposed management training for the team, but it was a little too late. We should have done this a few years before... It's our [HR] responsibility to give them the skills."* Despite recognizing this need, many studios struggle to afford such opportunities. As one professional put it, *"The industry is so tight... they can't afford losing one person for a day. It could be like hell for them."* These operational and financial challenges create significant barriers to leadership development.

In response to the challenge of leadership training, participants emphasized efforts to collaborate with educational institutions to bridge the gap in leadership development. Their goal is not only to create appropriate workshops for current leaders, but also to nurture future leaders. However, participants pointed out that this initiative faces obstacles. To meet the demanding skill requirements of the industry, young talents are often expected to work beyond 40 hours a week during their studies just to be considered for entry-level positions. This extreme workload leaves little room for developing leadership skills, and confirms findings of the previous PANEURAMA report [7].

This issue extends to educational settings, where students are often assigned dual roles in group projects that simulate real-world production scenarios. In these cases, students are expected to, for example, fulfill both their creative responsibilities as artists and the leadership duties of team leads. While teachers and mentors are specialists in the creative disciplines, they rarely have the expertise to support students in navigating the complexities of managing team dynamics. As a result, students in leadership roles are left to manage these challenges on their own, without specialized guidance.

"We barely interfere unless there's truly people wanting to strangle each other. Then we interfere for sure. […] But coming to resolutions in a 20 plus man team is an incredibly valuable experience. That is also the reason the companies say your students are ready to work the moment they move into our company. Is that a pleasant experience? No. Is that the best teaching methodology? No. Does it work? For some of them, and that's the problem: it doesn't work for all of them. And I'm not sure how to solve it. Because it's exactly that tension: they need to be tough as nails to survive in this industry. But by making them tough as nails, we are continuing the problem."

While participants acknowledge that such experiences can build resilience, they also recognize that they may not fully prepare students to become effective leaders in a collaborative work environment. Additionally, the traditional skill-based education model tends to prioritize technical excellence, which may inadvertently overlook individuals with leadership potential. One participant shared an example of a student initially rejected from the program but later thrived as a lead: *"We had a student that applied several times and he was not accepted. And he improved and came back. And followed all the advice and finally he got in and he turned out to be a star student that ended as one of the directors. Now, he was not a genius at drawing, but he was a genius at supervising. He was a genius at talking. He was a genius at creating a great mood in the group."* While participants from industry, educators, and students all recognize the importance of rethinking leadership skills in the curriculum and adapting the admissions process to better spot future leaders, educators face challenges implementing these changes within an already packed curriculum.

4 Conclusion and Future Studies

This study highlights a shift in leadership approaches within the animation, games, and VFX industries, moving away from toxic, high-pressure work cultures and towards more supportive environments. Studios increasingly recognize the importance of emotional intelligence and mentorship in leadership, reflecting transformational leadership principles, and the opportunity to foster healthier, sustainable workplaces. Some companies have already taken practical steps, but this transition is still in its early stages, with participants yet to adopt specific terminology for the leadership styles they envision. No industry-specific approach has been identified to meet the evolving needs of teams and leadership. Participants emphasized the urgent need for change and formal training support from educational institutions, given the challenges they face without expert guidance.

Challenges include promotions based on technical expertise rather than leadership skills, leaving leaders insecure when adopting new, collaborative approaches. Additionally, generational complexities, blurred lines between professional and personal roles, and overworked leaders have caused some to revert to outdated leadership styles that prioritize control over support.

While there is growing awareness of the need for structured leadership development, implementing such programs within the constraints of time, budget, and production demands remains difficult. Moreover, leadership programs tailored to senior staff are rare, and leadership development is rarely incorporated into undergraduate curricula. This gap in formal leadership training makes it challenging to align leadership practices with the fast-paced, project-driven nature of these industries, posing an obstacle for both studios and educational institutions.

Further research is needed to explore how leadership training can be integrated into industry practices without disrupting workflows. Studies on the long-term impact of different leadership styles on team performance, retention, and innovation would provide valuable insights.

5 ACKNOWLEDGEMENTS

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From Carbon Footprint to Social Justice: Rethinking Sustainability in Television Production and Virtual Studios

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ABSTRACT

The environmental and social impacts of television drama productions are staggering, with a single hour-long episode generating an average carbon footprint of 77 metric tonnes, equivalent to driving a car around the world six times. Key contributors include extensive fuel consumption (58% of emissions), air travel, energy use, and accommodation. This research explores the integration of environmental and social sustainability practices across diverse filming contexts, addressing the absence of clear, adaptable guidelines for production teams.

There is clear evidence for pushing the integration of sustainability practices in the entertainment industry. However, the lack of research in this field is a challenge. What is the climate impact of the various production operations? What are the greener choices? And what about diversity, health and safety, and workers' unions? When every production is unique, how does one know the best option for sustainability?

This research aims to advance environmental and social sustainability integration across various departments and production locations. This research project addresses the lack of concise and clear sustainability guidelines tailored to each filming department and adaptable to multinational productions. A multinational project team of academics and practitioners from five countries simulated the monetary and environmental costs of filming a six-episode television period drama set in both Denmark and Argentina. The simulations assessed the effectiveness of the proposed environmental and social sustainability guidelines across the different production methodologies.

Some early adopters and industry experts suggest that virtual production could enhance crew diversity and mitigate biodiversity loss within the entertainment sector. This belief has driven significant investment in costly virtual production studios across Europe. However, these claims remain largely theoretical, lacking robust empirical validation. To bridge this gap, this project undertakes the world's first large-scale investigation to quantify and qualify the environmental and social impacts of virtual production, providing data-driven insights into its true potential for sustainable filmmaking.

DISCLAIMER: At the time of writing this text, final results have not yet been obtained from the research.

CCS CONCEPTS

• Applied computing→ Arts and humanities→ Media Arts; • Computer systems organization → Real-time operating systems; • Human-centered computing→ Interactive systems and tools; • Computing methodologies → Computer graphics → Animation.

KEYWORDS

Sustainability, Virtual production, Environmental and Social sustainability, Television

1 Climate impact from television production

Studies reveal that producing a typical drama production has the same carbon footprint as driving a car around the world six times [1], highlighting the significant impact of small-screen productions on society and the environment. A recent report noted that a single episode of an hour-long drama production results in a carbon footprint of 77 metric tonnes; with filming taking place in multiple locations, 58% of emissions came from fuel usage [2]. Air travel in a single production equates to 75 return flights from America to Europe, and its energy consumption could power Times Square for 5 days [3]. The primary contributors to the carbon footprint in television production include utilities, fuel, air travel, and accommodation. The CO2 emissions from crew hotels alone equal those of 34 households over a year (ibid). The average screened content typically has a carbon footprint of 16.6 tCO2e/hr (a UK resident's emissions over 18 months). On the other hand, drama productions have almost triple the footprint [1]. Over half (51%) of these emissions are from travel and transport alone, with air travel as the dominant contributor (ibid). Drama productions typically have a larger carbon footprint due to longer shoots, increased on-location filming, additional travel requirements, bigger budgets, and larger crews. Productions with higher budgets and well-known talent will likely buy new materials and use business-class flights, furthering their carbon impact.

2 Social dilemmas

Only 1 out of every ten crew members describe the entertainment industry as a mentally healthy workplace. Moreover, a significant portion of British film crew members—over a third—reported working more than 50 hours per week, and a quarter of respondents

acknowledged experiencing thoughts of suicide [4]. Similarly, the #metoo movement originated from the entertainment sector and has since spread throughout society, prompting conversations and changing social norms. Actors often discuss the work of intimacy coordinators as part of press tours today. The role of nudity riders has been normalised, and more actors request green riders detailing green set procedures.

Social sustainability issues in the film and television industry present a complex social dilemma. On one hand, the industry plays a vital role in entertainment, education, and cultural expression, bringing joy and meaning to millions worldwide. The industry also employs hundreds of thousands of workers, providing economic opportunities and livelihoods [7]. However, the industry also bears witness to severe safety issues, mental health challenges, and inequitable power dynamics.

3 Research methodology

This research employs a **comparative case study methodology** combined with **simulation modelling** to evaluate the environmental and social impacts of different production concepts. The case study for this project is based on a fictional web series. The simulation involves applying environmental and social guidelines to different production concepts.

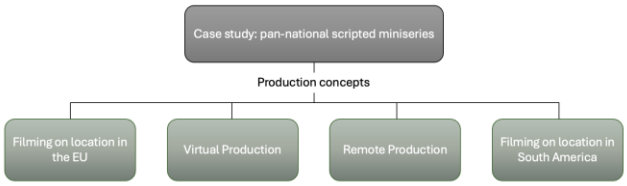

Figure 1: Case Study

Figure 1 illustrates the case study framework, detailing the production processes and how sustainability practices are integrated at various stages. These guidelines serve as a practical tool for industry professionals, aiming to bridge the gap between theoretical sustainability goals and actionable production strategies. Combining case study methodology with a simulation model provides a holistic approach to studying the application of the social and environmental sustainability guidelines to the production concepts.

Each production concept works with environmental and social sustainability practices to provide different solutions to doing a holistically sustainable production. The sustainability practices are gathered in guidelines with the purpose of supporting production decisions that will result in more environmentally and socially sustainable approaches.

3.1 Environmental guidelines

The environmental sustainability guidelines provide a tiered framework of green practices, developed through a comprehensive review of existing practices and industry standards. These guidelines are organised and tailored to address the specific needs of each production department, ensuring that sustainability is integrated across all facets of production. One key objective is to broaden the responsibility for sustainability beyond a single "green manager" by involving all relevant departments in the decision-making process.

For each production department, the guidelines present a series of options, ranked according to environmental sustainability. Option 1 represents the most sustainable choice, followed by Option 2, and subsequent options with progressively lower levels of environmental impact. This tiered approach allows for flexibility, enabling production teams to select sustainability practices based on their available budget and capabilities. In addition to department-specific guidelines, a separate set of general environmentally friendly practices is compiled, applicable to all individuals involved in the production process. This ensures that sustainability becomes an integral part of the entire production team's responsibilities, promoting a shared commitment to environmental stewardship.

The guidelines are designed to accommodate a wide range of production scales and resources, making them adaptable for use in both large-budget and smaller-scale projects. This flexible framework aims to facilitate the adoption of sustainable practices in diverse production environments, aligning with both environmental goals and practical constraints. The guidelines reflect recommendations for filmmaking based on existing advancements in technology. Therefore, the guidelines serve as a work-in-progress open to further development and addition of new knowledge.

3.2 Social guidelines

The social sustainability guidelines provide a range of approaches addressing multiple social dimensions, such as labour rights, mental health, diversity, and community engagement. These guidelines are informed by research into existing social sustainability practices across various industries, as well as by internal knowledge and expertise within the entertainment sector. Each approach is assigned a weighted score based on its value, the required efforts for implementation, and the associated budgetary considerations. This scoring system allows production teams to evaluate and select the most appropriate social sustainability practices according to their specific capabilities, resources, and objectives. The guidelines aim to foster a more equitable and inclusive production environment while balancing practical constraints.

4. Magnifying the virtual production concept

In the ever-evolving landscape of filmmaking and content creation, the emergence of virtual production has sparked a compelling discourse around its potential as a more sustainable alternative to traditional production methods.

Virtual production, a blend of live-action cinematography and computer-generated imagery, has gained significant traction in recent years. The virtual production concept is believed to entail various benefits for both the environmental and social aspects of film and television production.

In an environmental context, virtual production has the potential to significantly reduce transportation and travel-related emissions, as well as mitigate biodiversity destruction. By shifting filming and set construction from outdoor locations to controlled indoor studios, virtual production reduces the need for extensive travel to remote or environmentally sensitive areas, thereby minimising the production's ecological footprint. Additionally, this approach reduces the environmental impact associated with on-location set building and the disruption of natural habitats.

From a social sustainability perspective, the ability to control lighting and environmental conditions within a virtual studio offers several benefits. By eliminating the dependency on natural light and weather conditions, virtual production reduces the need for night shoots. It minimises the likelihood of prolonged working hours or last-minute schedule changes. This control over production conditions can lead to more predictable work hours, improving crew well-being and mitigating the risks associated with overwork, fatigue, and disrupted schedules. These factors contribute to a more stable and healthier working environment for the production team.

This research project will investigate whether virtual production truly offers sustainable benefits, both environmentally and socially. It will assess the environmental impact of virtual production by analysing its potential to reduce travel-related emissions, minimise resource use, and protect biodiversity. These aspects will be compared with areas of environmental impact within virtual production techniques, such as power consumption. In terms of social sustainability, the study will examine how virtual production can improve working conditions by offering greater control over schedules and work hours, potentially reducing the need for night shoots and overtime. Through a comprehensive analysis, the project aims to provide empirical evidence on whether virtual production can deliver on its sustainability claims across both environmental and social dimensions.

5. Constraints from technological development

Television production is an industry that is intrinsically linked to broader patterns of technological advancement. The creative sector is continually seeking to enhance production methods and adopt state-of-the-art technology for content creation. However, this constant cycle of innovation raises significant concerns regarding the generation of electronic waste and the broader sustainability of production practices. When exploring technology updates, it is highly relevant to consider the environmental sustainability impact of the frequent replacement of technological equipment and materials.

Despite increasing awareness, current studies and industry guidelines addressing the environmental impact of virtual production technologies remain incomplete and lack comprehensive scientific validation, such as life cycle assessments for individual components. This gap in empirical data complicates the evaluation of whether replacing older, functional equipment with newer, more energy-efficient alternatives result in a net environmental benefit. While this study and guidelines do not have scientific support from a lifecycle assessment on the individual options for up-and-coming technology within television production, however, the guidelines mentioned are a work-in-progress with the scope for further additions in the future. Future research is needed to rigorously assess these trade-offs and to support the development of sustainable technology transition strategies. While the acceleration of technological development undoubtedly opens new creative possibilities, it must also be critically examined through the lens of environmental responsibility.

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South African hacked animation methodologies:

A conceptual foundation to studying animation in local production practices post-2020

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ABSTRACT

South African animation studies have historically been constrained by outdated frameworks that fail to reflect current local production realities. This paper argues that contemporary South African animation must be analysed through locally adapted production methodologies, digital distribution strategies, and shifting intellectual property (IP) structures. The discourse around "authentic" African animation remains problematic, as outsourced productions are dismissed as "odourless," while local content is critiqued for not being "native" enough. These views overlook how studios creatively adapt to economic, political, and infrastructural challenges through "hacked" production techniques—innovative, resourceful strategies that work around systemic limitations.

With the rise of platforms like YouTube and Netflix, studios are bypassing traditional distribution barriers but still face algorithmic biases reinforcing dominant Western norms. This study calls for an updated and decolonised framework that addresses both Web 4.0 technologies and culturally situated analysis. Drawing on case studies of Rams Comics and Cabblow Studios, the paper highlights how animators assert creative agency and IP control.

CCS CONCEPTS

• Computing methodologies → Computer graphics → Animation • Social and professional → User characteristics → Cultural characteristics.

KEYWORDS

South African Animation; Decolonial Animation Studies; Creative Hacking; Adapted Animation Production Methods; Internet Distribution; Intellectual Property (IP) Ownership; Web 4.0 Technologies; Animation; Internet; Jonas Lekganyane; Kabelo Maaka.

1 Introduction

South African animation studies are outdated and too restrictive in their discourse and must be updated to reflect current local modes of animation practice. Furthermore, local animation practices have changed due to internet-based technologies and in response to local constraints. For example, animation studios are self-publishing online because of the lack of a local distribution supply chain [23]. Additionally, the discourse around South African animation studies is restrictive in what is considered "authentic" animation [6]. For example, international outsourcing to local animation studios is often considered to be "odourless" in terms of cultural representation [6]. Lu, quoted in Callus [2012], notes that racial and cultural ambiguity in the production design and is often attributed as a "commercial tactic to maintain non-Caucasian audiences while expanding in the Western media market". However, this perspective dismisses how outsourcing provides income, networks, and exposure to local South African animation studios. Conversely, African productions are often critiqued by Western scholars as not being "native" enough, as Enwezor notes (quoted in Callus [2012]).

These constrained viewpoints on "authentic" African animation are problematic in the current context where demand for video-based media [24] and African-centred film [9] is growing. Current South African animation practices – including adaptations to economic, political, skills, and infrastructure challenges – are not fully reflected in existing scholarship. Many studios are producing international content while creatively adapting their pipelines to the unique constraints to the local animation ecosystem [24].

In response to the constraints, South African animators employ "hacked" production methods to enable production. This study borrows the term "hack" from the term "creative hacking", meaning a "creative, resourceful approach that uses innovative, often unconventional strategies" [12]. These hacks are evidenced by the adaptations found in local production methods. For example, Rams Comics studios utilises a limited animation style to reduce production time while leveraging the internet to create and retain audiences to the studio [23]. Sidogi

[2021] also notes in his study that local comic and animation artists' "slapstick, edgy, and canny short stories" have gained popularity despite remaining under-researched.

International and South African animation partnerships have increased [24], but global interest does not necessarily translate to locally owned content. For example, *Kizazi Moto: Generation Fire* [2023] is an animation anthology distributed globally by Disney+ and is a collaborative project with South African animation studio Triggerfish [19]. All eight episodes were written and directed by creators from across the African continent, including Kenya, South Africa, Nigeria, and Zimbabwe. Each episode features visuals and stories that deeply incorporate folklore, characters, and production design from the culture of the country represented. However, Disney+ owns the intellectual property (IP) of these stories, and thus retains the revenue of the franchise. Ownership structures like this are critical to how South African animation should be discussed in academic discourse. As international demand for African content rises, it is essential to interrogate how hacked production methods democratise production and expand local critical frameworks.

This leads to the core line of discussion in this study:

1. How do South African animators adapt to their unique challenges to produce animation?

This paper employs literary analysis and case studies to frame a conceptual discussion on indigenous methods of animation production in South Africa. It begins with a short overview of South African animation history and then discusses current scholarship on South African animation. Two case studies are examined with particular attention paid to issues of intellectual property ownership, technology and their roles in shaping local production practices. Following that is a discussion on the study impact and limitations. This paper aims to establish a conceptual foundation for future empirical research into how hacked methods influence the metamorphic qualities of animation as a medium. By documenting indigenous animation practices, this study advocates for developing of local analytic frameworks that may operate outside of established institutional paradigms in animation studies.

2 Background: History and Structure of South African Animation

This section provides a brief overview on how the history of the South African animation industry and provides context on how it is organised in terms of income and commission. Historically, much of South African animation has focused on advertising and visual effects [22]. In the 1940s, studios produced animated advertisements and short films screened before cinema features, often emulating American and European studio models due to foreign trainers [22]. Many studios adapted their own methods to achieve effects comparable to Hollywood, as they could not afford modern equipment [22]. Television broadcasting through the South African Broadcasting Corporation (SABC) began in 1976, under the Apartheid regime, where programming served a "patriotic agenda" to influence the masses through commissioned documentaries, advertisements, and children's shows [22].

Post-Apartheid, government strategies in the 1990's aimed to grow the economy, promote employment, and support social cohesion through creative industries [14]. Funding opportunities were expanded to promote local film productions for South African audiences [14]. However, due to the high costs of animation, the local industry remained small, with most studios operating as outsourced service providers for international IP, and a continued dominance of advertising work [24]. The 2008/2009 Global Financial Crisis is cited as a major turning point for South African industry growth as the budget cuts to international productions allowed for local companies to lobby to produce animated commercials [24]. South Africa remains a popular outsourcing destination due to its time zone proximity to Europe and the UK, and favourable currency exchange rates [24][20]. Notable South African feature film animation productions distributed internationally include Triggerfish Animation's *Adventures in Zambezia* [2012][25] and *Khumba* [2013][25]. Studios like Mind's Eye Creative and Triggerfish have worked on international projects such as *F is for Family* [2017][2][16], and *Revolting Rhymes* [2019] [21], with *Revolting Rhymes* winning a BAFTA in 2017 and an International Emmy in 2018 [25].

Meanwhile, local broadcasters largely do not commission animations [24], although platforms like YouTube and Netflix are beginning to disrupt traditional distribution models. However, there are challenges to the local industry to get these opportunities, which are outlined below. These figures are sourced from the latest report from the South African Cultural Observatory, titled "SA's Animation Industry: Ecosystem Analysis" [2022]. The report is a multi-institutional collaboration to determine the state of the animation industry of South Africa:

Economic Challenges in South African Animation

- Securing funding or partnerships to actualise original animated content. Government funding is limited for the sector, accounting for only 28% of total funding for animation. 58% is provided by the private sector or self-funded by the animation studio.
- South Africa's tax exemption policies are only supportive to the investors involved in production, not to investment in film marketing and distribution,

which further hinders audiences being able to access the films.

Political and Policy Challenges

- The incentives created by The Department of Trade, Industry and Competition (DTIC) for the film industry were cited as a means of catalytic growth in industry. However, in 2018 those incentives became difficult to qualify for as they were exclusionary on racial and citizenship grounds. There is anecdotal evidence that BBBEE policies aimed to address racial transformation of the industry have impeded its growth and have further forced some market leaders to base some of their operations outside the country.
- The Copyright Amendment Bill (CAB) and the Performers' Protection Amendment Bill (PPAB) are two linked legislative bills in which the fair use provisions are too broad and thus would not protect domestic authors and would undermine the copyright market discouraging foreign investment in original content due to the current climate of legal uncertainty in copyright ownership.

Skills and Infrastructure Challenges

- There is a shortage of highly experienced animators in South Africa – and elsewhere in the world, e.g. Ireland [11] and the United Kingdom [13]. Additionally, is the general sentiment from local animation studios that the large influx of animation graduates are not prepared for integration into a studio pipeline. SETA grants that previously bridged education institutions and industry, currently have late approvals and limited eligibility. This results in a widening gap between graduate competence and the animation industry's needs.
- Animation studios' use of time and capital is impacted by large-scale scheduled power disruptions – known as Loadshedding in South Africa. Some studios opt to purchase equipment to allow them to continue to work during power cuts. Which hinders investment back into animation equipment, IP, and business development.

3 Hacked Production Methods

Despite all these challenges to the pipeline and distribution of animation, several animation studios, incubators and artists are leveraging the internet and opensource tools to release content [7] [24], using "hacks" to adapt their pipelines around these challenges. These hacks, and the differences in production approaches they produce, are of central to this study, as they reveal distinctive characteristics of South African animation processes and their impact on productions' stylistic qualities. In other words, economic strains, and an under-developed supply chain for South African animation (e.g., distributors, producers, film marketers) have created circumstances where South African animators adapt pipelines and build their own supply chain solutions – or hacks. Most of these hacks utilise the internet in modes not accounted for in recent South African animation studies.

Paula Callus's doctoral thesis "Animation in Sub-Saharan Africa: trajectories of ideas and practice" [2016], provides a valuable foundation on the impact of ICT technologies upon sub-Saharan animation, though it predates developments like web 4.0 and the mass proliferation of generative AI for public use. This study also draws on Callus's article "Reading animation through the eyes of anthropology: a case study of sub-Saharan African animation" [2012] as theoretical underpinning. She argues that applying interdisciplinary studies – like anthropology – to animation studies, can open more nuanced readings of global animation practices. She treats local animation as a rich site for cultural expression and ethnographic insight, especially within postcolonial identity formation. This reframing of animation theory offers tools for analysing hybrid, local, and resistant productions outside dominant Western models.

However, while Callus [2012] critiques Western-centric frameworks, the paper focuses on Western academic and festival gatekeeping, with limited attention to African audiences' own interpretative or reception studies. It relies on heavily on qualitative interpretation, without empirical audience studies, or interviews from a wider sample of animators. Callus [2016] addresses this partially with semi-structured interviews and sub-Saharan animation residencies in its methodology. However, her research, conducted between 2005 – 2012, does not address the technological shifts shaping current South African animation production, like mobile-first consumption or YouTube distribution.

Furthermore, while proposing anthropological approaches, Callus [2012] does not sufficiently address the colonial baggage of the anthropological approach – a historically Western discipline. This risks perpetuating "Othering" of African animation even within postcolonial frameworks. These two gaps – the technological and theoretical limitations – are what this study seeks to address, focusing specifically on the contemporary South African context.

In response, this study now turns to two specific case studies that illustrate how South African animators creatively adapt to local challenges. These examples of "hacked" production methods demonstrate how internet technologies and alternative pipelines are reshaping contemporary animation practices in South Africa.

Hack 1: Internet as a Tool for Self-Publishing and Distribution

Pfunzo Sidogi [2021] suggests that the internet "has created the ideal public and virtual museum for animated African comics to exist" both for its economic opportunities for African creatives, and "the transgressive power of the internet to unsettle unrepentant hegemonies". Opensource streaming sites like YouTube bypass traditional publication and distribution barriers. This democratising of publication empowers local animators by hacking a system that provides minimal support for South African animation distribution [23][24]. Online distribution is also suited to a context where, in 2023, 96.5% of South African internet users aged 16 to 64 streamed video content weekly [11], and YouTube had 25.80 million users [11].

There is also more creative freedom with self-publication, allowing creators to curate content for specific audiences, and inject it with cultural representation with South African appeal [23]. An example of this model is Rams Comics Studios. Owner Jonas Lekganyane gained success by posting his animated shorts, *The Adventures of Noko Mashaba* [2013 –] on YouTube [13]. The studio creates content for clients using their characters Noko and Malome Dons, but retains their IP by licensing the produced media for a stipulated period [23]. When licenses expire, the content, e.g. an animated advertisement, is uploaded onto the studio's social platforms for monetised views [23]. The motion comics style of the animation is quick to produce, emphasising dialogue and story over fluid animation. *The Adventures of Noko Mashaba* is also recognisably South African, using of vernacular and local signifiers to satirise South African popular culture [23]. The character Noko also has verified social media platforms to promote the studio, engage audiences, and participate in internet trends like the TikTok "Bottle Flip Challenge" shown in Figure 1.

Figure 1: Noko Mashaba challenges his uncle to the bottle flip challenge. TikTok: *You play stupid games, you win stupid prizes* (2023), [18]. Used with Permission: Rams Comics Studios.

Hack 2: Merchandise-Driven Preproduction Strategies

Many South African animation studios adopt business models focused on international collaboration to strengthen global distribution relationships and expands the reach of local representation [1]. However, ownership of IP remains a point of contention, especially when projects are funded externally. Retaining IP rights allows studios to control creative output and long-term revenue generated through licensing and merchandise, while maintaining agency over how local stories and identities are represented [23]. By controlling narratives, studios can challenge colonial stereotypes that historically depict African storytelling as primitive or uncivilised [23]. As [23] notes, "these animated narratives [offer] an outlet for the 'virtual African public' to consume their own myths, narratives, and iconography". Thus, IP ownership preserves both cultural agency and economic benefits within the local creative economy.

However, because an African context is external to the West, some narratives may be deemed "chaotic" and international intervention often seeks to "correct" stories for perceived marketability [10]. For example, Rorisang and the Gurlz, is an original animated series and Webtoon by South Africa's Cabblow Studios. The show follows a group of friends forming an Afropop band at their conservative Christian high school. Studio owner Kabelo Maaka explained challenges faced when pitching their show internationally, as the setting – a common South African experience – was misunderstood. On the authenticity of her experience as an African: "one of those realities is that we do have Christian schools, and we grew up in those contexts…that maybe people are not so aware of. When we would have discussions with potential distributors, that would be the thing they would just get stuck on, the faith bit. But that's most of the schools in South Africa" [8].

Resistance from funders led Cabblow to first publish the property as a Webtoon, testing audience reception to Rorisang's content and proving market interest [3][8]. To finance the TV pilot, Cabblow created and marketed branded merchandise, promoted through their social media channels [5]. Their main character Rorisang also maintains active social media profiles, posting playlist updates to Spotify and engaging fans, further expanding audience reach [3]. This strategy, marketing before full production, exemplifies a hack to production scheduling. It allows the studio to retain IP ownership and grow independently [8].

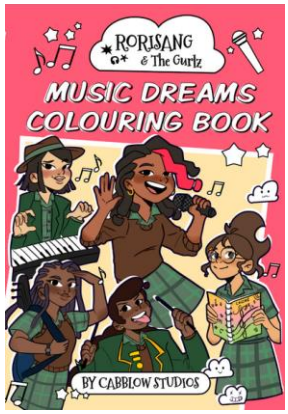

Figure 2: The *Rorisang and the Gurlz* colouring book merchandise sold by Cabblow Studios on cabblowstudios.com [4]. Used with Permission: Cabblow Studios

Both above examples illustrate the democratising power of technology, and the importance of hacks for creators' IP control. However, online publication presents disadvantages: the overwhelming and continuous generation of new content. It is "a contracting space whereby the visibility and access to this data diminishes" [7]. Algorithms reinforce dominant ideas of popular animation, limiting the recognition of diverse forms of animation and reinforcing Western standards [23].

4 Impact on South African Animation Studies

To account for the impact of hacks upon local animation studies, this study proposes two calls to action:

1. *Update existing research on South African animation, particularly regarding its relationship to the internet and streaming services post-2020.*

   Callus's research into the qualities of sub-Saharan animation and its relationship to the internet remains seminal to this study. However, in the decade since its publication the nature of the internet and AI have changed the face of technology drastically. Animation study must be updated to reflect these changes. Although the internet offers opportunity, algorithmic searches can further marginalise already underrepresented voices in South African animation. Future research must address how evolving technologies impact both animation production and artistic practice.

2. *Decolonise the gaze in both South African and international analysis.*

   As discussed, current South African animation studies constrain definitions of "authentic" South African animation. African productions are often critiqued by Western scholars as not being "native" enough, and from their own territories as not being "authentic" enough [6]. The restrictive views frustrate artists that must "navigate minefields of discourses on authenticity, exoticisation, myth and identity" [6]. Outsourced "odourless" animation improves international networks, and proves South African studios' high-quality animation capabilities and international relevance [6]. The hacked methods used by local animation studios also call for changes in how animation is taught and analysed in academic institutions [26]. Since the form has been "radically altered… [in] its context and in its changing roster of practitioners" [26]. Developing culturally specific critical questions in animation studies would foster local analytic frameworks that incorporate these hacked production methods.

5 Limitations and Areas for Future Research

The study is limited to a theoretical analysis based upon scholastic observations. This theoretical basis is intended for the study of South African animation production pipeline. Further research could apply updated and decolonialised lenses to specific local productions. Additionally, the study has remained limited to changing internet technologies but does not examine the impact of generative AI. Further research should investigate the impact of generative AI on animation production pipelines. Comparative studies across North, West, and East African regions are also needed. Further research includes the gathering of qualitative data from local animators on their production practices. Additionally, these interviews would provide insights into how adapted pipelines shape the final animation production.

6 Conclusion

The changing technologies of animation and the use of hacks democratises the animated medium. They enable South African animators to create and distribute their productions, while adapting to their unique circumstances and challenges. Social media and opensource streaming platforms enable animators to reach and maintain audiences with culturally specific South African stories and retain their IP. However, the expansive and algorithmic nature of the internet does hinder animation visibility, which further entrenches dominant modes of animation recognition from the West. The study proposes updating South African animation studies to incorporate local internet practices and decolonise rigid definitions of authenticity. These changes in the local discipline would, therefore, invite changes in how animation is taught and received in academic institutions.

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