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REVIEW ARTICLE

The Impact of Virtual Production Technology on Film Directors' Creative Practice: A Qualitative Integrative Literature Review

Feng Jing Jing1*, Zhong Xin Wei2*, Zhang Yue3*

[1] Faculty of Art, Sustainability And Creative Industry, Universiti Pendidikan Sultan Idris. nicolynlife@gmail.com

[2] Faculty of Art and Social Sciences, The University of Sydney.iamZ_45449@outlook.com

[3] Winchester School of Art, University of Southampton, Winchester School of Art.

Corresponding author: Zhang Yue (e-mail: zhanghappy72@gmail.com)

Abstract: This article examines the impact of Virtual Production Technology on Film Directors' Creative Practice through a Qualitative Integrative Literature Review. Against the broader context of art–technology integration, Virtual Production is no longer understood merely as a technical assemblage of LED Volume, Real-time Rendering, Game Engine, Camera Tracking, and In-camera Visual Effects. Instead, it is increasingly conceptualised as a new creative environment that reorganises the Film Production Pipeline and reshapes Directorial Creativity. Drawing on recent Web of Science and Scopus indexed literature, this review adopts Thematic Synthesis to examine how Virtual Production influences directors' creative workflow, spatial imagination, real-time visual decision-making, cross-departmental collaboration, and Directorial Authorship. The review identifies three major findings. First, Virtual Production front-loads creative decision-making by shifting key visual judgments from Post-production to Pre-production and Production. Second, it enhances directors' Visual Decision-making through real-time visualisation and collaborative on-set feedback. Third, it transforms Directorial Authorship from a text-centred model of personal style into Workflow Authorship, in which directors sustain creative intention through the coordination of digital assets, technical systems, and collaborative production processes. The article argues that the future Film Director should be understood not only as an On-set Director, but also as a Creative Organizer, Workflow Coordinator, and Real-time Image System Coordinator. This review contributes to Virtual Production studies by shifting attention from technical application and industrial efficiency to the transformation of directorial creativity and authorship.

Keywords: Virtual Production; Film Directing; Directorial Creativity; Workflow Authorship; Thematic Synthesis; Real-time Rendering

1. Introduction

1.1 Transformation of Film Directing in the Context of Art–Technology Integration

Film directing has always been shaped by the interaction between artistic judgment, technological media, and industrial workflow. From sound, colour, digital editing, CGI, VFX, and motion capture to contemporary Virtual Production, each major technological shift has changed how directors imagine, organize, and realize cinematic images. In recent years, Virtual Production has become one of the most visible forms of art–technology integration in film and television production. It combines real-time rendering, game engines, LED Volume, camera tracking, virtual cameras, motion capture, XR environments, and in-camera visual effects into a hybrid production system. Swords and Willment (2024) note that although many of these components are not entirely new, their integration into the production pipeline is producing a new paradigm for screen production. The significance of Virtual Production therefore lies not only in technical innovation, but also in its ability to reshape image production through real-time visualization and digital environment control (Swords & Willment, 2024).

This shift has direct implications for film directing. In conventional production, directors often make creative decisions through script interpretation, mise-en-scène, performance direction, camera blocking, and on-set coordination, while many digital visual elements are completed later in post-production. With Virtual Production, this linear workflow becomes more iterative. LED Volume, real-time game engines, and virtual scouting allow directors, cinematographers, production designers, and VFX supervisors to view and adjust images that approximate the final visual form during pre-production and shooting. Silva Jasaui et al. (2024) argue that real-time rendering pipelines enable filmmakers to organize visual solutions within more parallel and flexible workflows, rather than relying only on the traditional sequence of pre-production, shooting, and post-production (Silva Jasaui et al., 2024).

Virtual Production should therefore not be understood only as a tool for efficiency, cost reduction, or visual spectacle. It changes how directors conduct spatial imagination, visual judgment, aesthetic coordination, and cross-departmental collaboration. Studies on immersive production and location scouting show that Virtual Production supports early creative validation and reshapes collaborative workflows during pre-production (Bodini et al., 2023, 2024). This suggests that Virtual Production should be examined as a creative environment that reorganizes the director's role.

Despite the growing body of research on Virtual Production, existing studies remain fragmented in their explanation of directorial creativity. Much of the literature discusses production pipelines, LED Volume, game engine workflows, digital assets, industry organization, and cross-departmental collaboration. These studies clarify how Virtual Production improves production efficiency, expands visual possibilities, and restructures professional practices. However, the film director is often treated as a user of technical systems or as one participant within a larger workflow. Less attention has been paid to how the director's creative agency is reorganized within real-time, hybrid, and technologically mediated production environments.

This gap is important because Virtual Production does not only change technical procedures. It also changes how directors imagine scenes, test visual decisions, communicate with production departments, and maintain aesthetic continuity across production stages. Swords and Willment (2024) show that Virtual Production involves changes in working practices, skills, labour relations, and production networks. This indicates that the central question should move beyond what the technology can achieve and should ask how it reconfigures creative practice and directorial agency (Swords & Willment, 2024).

A second gap concerns the theorization of Directorial Creativity. Virtual Production enables directors to conduct virtual scouting, scene visualization, camera exploration, and previsualization in digital environments. However, existing studies often focus on user requirements, technical frameworks, or production support. They provide less explanation of how directors form aesthetic judgment in visualized environments, how cinematic language is reorganized, and how real-time feedback changes collaboration with cinematographers, actors, production designers, VFX supervisors, and technical teams.

A third gap concerns Directorial Authorship. Classical understandings of authorship often locate the director's creative identity in the completed film text, especially through theme, style, narrative form, and audiovisual expression. In Virtual Production, however, image-making increasingly depends on real-time engines, digital assets, LED volumes, Virtual Art Departments, camera tracking, and cross-departmental workflow. As a result, authorship is not located only in the final image. It is also embedded in the director's ability to organize workflow, coordinate technical mediation, guide team communication, and sustain aesthetic continuity across production stages. Research on Virtual Production education also shows that this transformation affects film training, because students and educators must respond to disruptive technologies, changing skill sets, and new creative workflows (Boutellier & Raptis, 2023).

Therefore, the problem addressed in this review is not the absence of research on Virtual Production, but the lack of a systematic account of how Virtual Production reshapes film directors' creative agency, visual decision-making, and authorship. This article responds to that gap through a qualitative integrative literature review and proposes Workflow Authorship as an explanatory concept for understanding directorial creativity in Virtual Production environments..

Based on the above problem statement, this review is guided by the following research questions:

RQ1: How does Virtual Production front-load and visualize film directors' creative decision-making across pre-development and pre-production workflows?

RQ2: How does Virtual Production transform film directors' real-time visual decision-making and cross-departmental collaboration during production

RQ3: How does Virtual Production reconfigure Directorial Authorship into Workflow Authorship through technical mediation, pipeline coordination, and aesthetic continuity?

Together, these questions structure the thematic synthesis of this review. RQ1 examines the front-loading and visualization of directorial creativity. RQ2 addresses real-time and collaborative visual decision-making. RQ3 explores the workflow turn of Directorial Authorship.

1.2 Research Contributions

This article makes two main contributions. First, it repositions the relationship between Virtual Production and film directing. Existing research often treats Virtual Production as a technology that improves efficiency, reduces costs, enhances visual expressiveness, reduces reliance on location shooting, and optimizes production pipelines. Swords and Willment (2024) show that Virtual Production integrates game engines, VR, AR, motion capture, camera tracking, LED screens, and in-camera visual effects, and has become an important paradigm in film and television production (Swords & Willment, 2024). However, when it is examined only as a technological assemblage or industrial-efficiency mechanism, its impact on directors' creative agency may be overlooked. This article therefore shifts attention from Virtual Production as technology to directors' creative practice, and proposes Workflow Authorship as an explanatory concept. The concept does not reject traditional directorial authorship, but argues that authorship is increasingly reflected in the director's capacity to organize digital assets, real-time visualization, technical mediation, collaborative pipelines, and aesthetic decision-making. In this way, the article extends Swords and Willment's (2024) research agenda from working practices, skills, and industry relations to the reconfiguration of directorial authorship (Swords & Willment, 2024).

Second, this article contributes methodologically by adopting a qualitative integrative literature review with thematic synthesis. Since Virtual Production research spans film studies, media studies, creative industries, digital media, XR research, HCI, and VFX studies, the existing literature is diverse in research objects, theoretical perspectives, and methods. This article therefore uses qualitative integration rather than meta-analysis or bibliometric review to identify core themes, conceptual pathways, and theoretical gaps. Bodini et al. (2024) show that Virtual Production research should consider the experiences, needs, and collaborative patterns of audiovisual professionals across production stages, which supports a review focused on creative workflow and production culture rather than technical indicators alone (Bodini et al., 2024). The article also provides a basis for future empirical research. Bennett et al. (2023) argue that Virtual Production education requires learners to understand the pipeline from pre-production to real-time production rather than mastering isolated tools (Bennett et al., 2023). Dober et al. (2024) further show that core Virtual Production concepts can be introduced through low-cost approaches, even without expensive LED volumes or high-end tracking hardware. This suggests the need to extend future research to independent film, small and medium-sized productions, film education, and non-Western creative contexts (Dober et al., 2024).

2. Methodology of the Literature Review

2.1 Review Design

This study adopts a qualitative integrative literature review supported by thematic synthesis. This design is appropriate because the article examines how Virtual Production transforms directorial workflow, visual judgment, collaboration, and authorship, rather than measuring technical performance or statistical effect sizes. Therefore, the study does not use meta-analysis or bibliometric review, but adopts qualitative synthesis for conceptual integration and theory development.

A literature review should clearly specify its review type, focus, methodological process, and contribution (Kraus et al., 2022). This article therefore positions itself as a qualitative integrative review rather than a general narrative review. Its transparency is strengthened through database searching, screening criteria, a data extraction matrix, and thematic synthesis. Since Virtual Production research spans film studies, media studies, creative industries, HCI, XR research, VFX studies, and digital production studies, an integrative review is suitable for synthesizing evidence from different disciplines (Dhollande et al., 2021). High-quality reviews also need to balance rigor, scope, transparency, and generativity (Fan et al., 2022).

The study also draws on the logic of Qualitative Evidence Synthesis, which develops deeper understanding through interpretive synthesis rather than simple aggregation (Flemming & Noyes, 2021; Moser et al., 2023). Although this article is not a systematic review in the strict sense, it follows PRISMA 2020 principles to report literature identification, screening, and inclusion clearly (Page et al., 2021a, 2021b). In summary, this review is qualitative, integrative, and theory-oriented. Its aim is to explain how Virtual Production reorganizes the creative conditions and authorship structure of film directing.

2.2 Search Strategy, Selection Criteria and Screening Results

The literature search in this study followed three principles: transparency, relevance, and replicability. Transparency means that researchers need to clearly report the database sources, keyword combinations, time span, and screening criteria. Relevance means that the included literature must be directly related to the research questions of this article. Replicability means that other researchers should be able to review or revise the literature identification process based on the search strategy provided in this study. Standardized reporting guidelines can improve the completeness and comprehensibility of review studies, enabling readers to assess how researchers identify, screen, and synthesize the literature (Sohrabi et al., 2021). Based on this requirement, this article reports the search strategy, inclusion and exclusion criteria, screening numbers, and final analytical sample together.

The search period of this study was set as 2021–2026. This time span is internally consistent with the research topic. On the one hand, Virtual Production has become an important issue in the film and television industry and in academic research over the past five years, along with the rapid application of LED volumes, real-time rendering, and game engines. On the other hand, as a review article intended for submission to an international journal, this study needs to reflect the frontier nature of the research field. The core databases included Web of Science Core Collection and Scopus, in order to ensure that the included literature had a relatively high level of international academic visibility. Considering the art–technology intersectional nature of Virtual Production, this article also searched ACM Digital Library, IEEE Xplore, Taylor & Francis Online, SAGE Journals, SpringerLink, and ScienceDirect. Among these databases, ACM Digital Library and IEEE Xplore were mainly used to identify studies related to game engines, real-time rendering, XR production, human–computer interaction, and virtual cinematography, while the other databases were mainly used to identify research on film, media, creative industries, and production practice.

The search keywords were divided into three groups. The first group consisted of technical keywords, including "virtual production," "LED volume," "real-time rendering," "virtual cinematography," "game engine filmmaking," "XR production," "in-camera visual effects," and "motion capture." The second group consisted of creative-agent keywords, including "film director," "directing," "filmmaker," "auteur," "creative agency," "creative control," and "creative decision-making." The third group consisted of creative-process keywords, including "creative process," "filmmaking workflow," "previsualization," "production pipeline," "collaboration," "cinematic authorship," and "workflow authorship." In the actual search process, Boolean operators were used to combine the terms, such as "virtual production" AND "film director," "virtual production" AND "creative process," "LED volume" AND "filmmaking workflow," and "virtual production" AND "cinematic authorship."

The inclusion criteria consisted of five items. First, the literature had to directly address Virtual Production or its key technological components, such as real-time rendering, LED volume, virtual cinematography, game engine, XR production, camera tracking, motion capture, or in-camera visual effects. Second, the literature had to be related to film or audiovisual creative practice, rather than merely discussing hardware performance, algorithmic parameters, or engineering optimization. Third, the literature had to be able to respond to at least one review question, that is, it needed to involve film directing, creative workflow, collaborative practice, production pipeline, or authorship. Fourth, the literature had to be published between 2021 and 2026. Fifth, the literature was prioritized if it came from peer-reviewed journal articles, conference papers, or academic book sections, and, wherever possible, from sources indexed by Web of Science or Scopus.

The exclusion criteria also consisted of five items. First, studies that discussed only traditional CGI or general post-production VFX without involving the Virtual Production pipeline were excluded. Second, purely engineering-oriented studies that focused only on rendering algorithms, display devices, computational performance, or software parameters, without discussing film creative workflows or creative agents, were excluded. Third, news reports, vendor promotional materials, commercial advertising materials, anonymous blogs, and non-peer-reviewed online sources were excluded. Fourth, materials for which the full text could not be accessed or whose bibliographic information was incomplete were excluded. Fifth, studies with weak relevance to film directing, the creative process, or authorship were excluded.

The literature screening process was divided into six stages: initial search, duplicate removal, title and abstract screening, full-text assessment, relevance appraisal, and final inclusion. This article draws on certain methodological principles of scoping review in order to regulate the research scope and screening procedure. Scoping review is suitable for identifying and mapping the scope of evidence in developing fields, especially those in which the types of literature are dispersed and the research boundaries have not yet fully stabilized (Peters et al., 2021). At the same time, review studies should define their research questions, inclusion criteria, and data extraction methods in advance, and clearly explain the research purpose, evidence sources, screening process, and mode of presenting findings (Mak & Thomas, 2022; Peters et al., 2022). This article does not define itself as a full scoping review, because its aim is not merely to map the research landscape, but to develop interpretive themes and a theoretical framework through qualitative integration.

Table 1 presents the actual search and screening results. The initial search identified 356 records. After 92 duplicate records were removed, 264 records remained for title and abstract screening. During the title and abstract screening stage, 168 records were excluded, mainly because they focused on purely technical rendering research, general VFX studies, non-film applications, or topics weakly related to directorial creative workflows. Subsequently, 96 full-text articles entered eligibility assessment, of which 42 were excluded because they did not sufficiently address Virtual Production workflow, film directing, directorial creativity, or authorship. After relevance appraisal, 37 core studies were finally retained for thematic synthesis. In addition, 24 methodological or contextual sources were used to support the review design, reporting transparency, and methodological justification. Therefore, the final reference list of this article contains 61 sources in total, among which 37 constitute the core analytical sample.

Table 1. Literature Search and Screening Results

Screening stage	Records / sources	Number retained	Number excluded	Notes
Web of Science Core Collection	78	—	—	Main indexed journal database
Scopus	112	—	—	Main multidisciplinary database
ACM Digital Library	46	—	—	HCI, XR, AI and interactive media studies
IEEE Xplore	29	—	—	Technical studies on XR, real-time rendering and virtual cinematography
Taylor & Francis Online	18	—	—	Film, media and creative industries studies
SAGE Journals	21	—	—	Media, communication and creative industries literature
SpringerLink	17	—	—	Digital media, arts and technology studies
ScienceDirect	24	—	—	Film technology and digital media studies
Citation chasing and manual checking	11	—	—	Added from reference lists and publisher pages
Initial records identified	356	356	—	Total before duplicate removal
Duplicate removal	—	264	92	Duplicates across databases removed
Title and abstract screening	—	96	168	Excluded irrelevant, purely technical or non-film records
Full-text assessment	—	54	42	Excluded weakly relevant records

Relevance appraisal	—	37	17	Retained studies directly answering RQ1–RQ3
Final core studies included in thematic synthesis	—	37	—	Core analytical sample
Methodological and contextual references retained	—	24	—	Used for methodology and contextual framing
Total references in final manuscript	—	61	—	37 core studies + 24 methodological/contextual sources

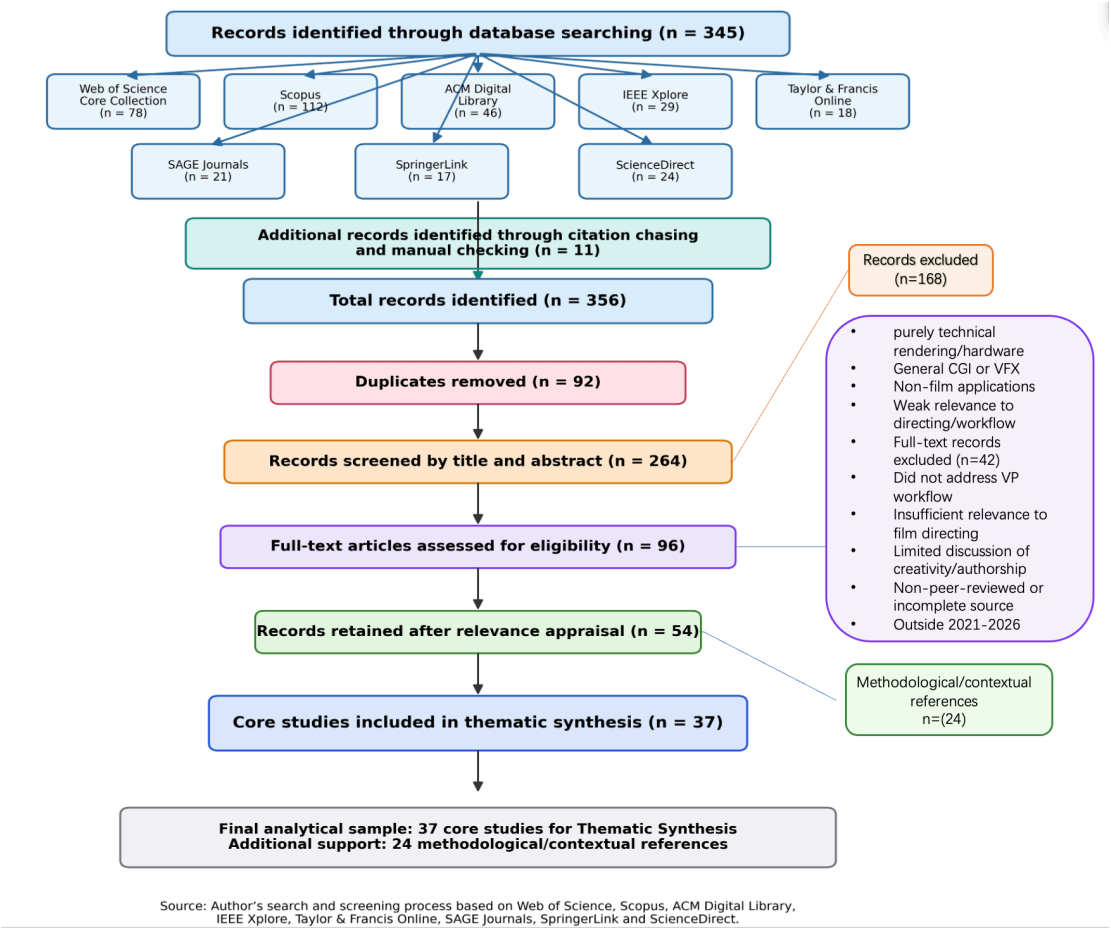

Figure 1. Literature Search and Screening Flow Diagram

The final core analytical sample is categorized by analytical focus and presented in Table 2. This table is not intended to replace the reference list; rather, it clarifies which studies were directly included in the thematic synthesis and which sources were used for methodological or contextual support. Flow diagrams and visual reporting can enhance the transparency and openness of synthesis in review studies. At the same time, in evidence synthesis, data extraction, analysis, and presentation of findings should remain aligned with one another (Haddaway et al., 2022; Pollock et al., 2023).

Table 2. Final Core Studies Included in Thematic Synthesis

Analytical focus	Core studies included
Virtual Production concept and production environment	Ronfard (2021); Cremona and Kavakli (2023); Helzle (2023); Silva Jasaui et al. (2024); Swords and Willment (2024a, 2024b); Méndez-Fernández et al. (2025)
Pre-production, virtual scouting and workflow front-loading	Bodini et al. (2023); Bodini et al. (2024); Chanpum (2023); Kerr et al. (2024); Dean et al. (2026); Jia et al. (2025); Leininger et al. (2025)
Real-time decision-making and collaborative production	Wei et al. (2024); Wei et al. (2025); Xu et al. (2024); Song et al. (2025); Park et al. (2026); Willment et al. (2025)

Directorial creativity, authorship and creative agency	Beak (2026); Chaurasia and Majhi (2026); Tsiavos and Kitsios (2025); Azzarelli et al. (2025); Sun (2025)
Education, training, accessibility and production scale	Bennett et al. (2023); Boutellier and Raptis (2023); Dober et al. (2024); Silveira et al. (2026); Bugahhoos et al. (2026); Hoare et al. (2026)
AI, immersive technologies and emerging VP tools	Hilal (2025); Jamil and Brennan (2025); Lee and Luk (2025); Zhao and Zhao (2024); Xu et al. (2025); Nebeling et al. (2021)

2.3 Data Extraction and Thematic Synthesis

This study used thematic synthesis to interpret the selected literature. Since the included studies came from different fields and used different research designs, their findings could not be statistically combined. The analysis therefore focused on concepts, arguments, cases, and theoretical claims related to Virtual Production, directorial creativity, and authorship. Thematic synthesis was suitable because it allows dispersed literature to be organised into conceptual categories and developed into an explanatory framework (Naeem et al., 2023, 2024).

Data extraction was conducted through a structured matrix. The matrix focused on source, analytical focus, technology or workflow, production stage, directorial dimension, key argument, and relevance to the review questions. These items were selected to connect individual studies with the three concerns of this review: front-loaded decision-making, real-time collaboration, and the reconfiguration of authorship (Pollock et al., 2023). Table 3 presents representative extraction examples rather than all details from the 37 core studies. The thematic synthesis proceeded through open coding, theme development, and interpretive synthesis. Initial codes included front-loaded workflow, virtual scouting, digital asset planning, real-time visual feedback, multi-role collaboration, technical mediation, workflow literacy, and shared creative agency. These codes were then grouped into three analytical themes: front-loading and visualization of directorial creativity, real-time and collaborative transformation of visual decision-making, and the workflow turn of directorial authorship. Table 4 shows how literature evidence was connected to codes, descriptive categories, analytical themes, and research questions.

Table 3. Condensed Data Extraction Matrix for Representative Core Studies

Representative sources	Analytical focus	Extracted evidence	Relevance to review questions
Ronfard (2021); Cremona and Kavakli (2023)	Virtual directing and hybrid production environment	Virtual environments reorganise camera, lighting, character, montage, studio space, real-time rendering, and interactive control.	Supports RQ1 and RQ3 by linking Virtual Production to computational mediation, hybrid image-making, and expanded directorial authorship.
Bodini et al. (2023); Bodini et al. (2024); Kerr et al. (2024)	Pre-production, virtual scouting, and spatial planning	Immersive scouting and tangible interfaces allow creators to assess locations, test camera positions, and visualise scenes before physical shooting.	Supports RQ1 by showing how spatial judgment and camera exploration are front-loaded into pre-production.
Swords and Willment (2024a); Jia et al. (2025); Silva Jasaui et al. (2024)	Workflow transformation and real-time production pipeline	Virtual Production shifts work from "fix-it in post-production" to "fix-it in pre-production" and supports non-linear, real-time convergence workflows.	Supports RQ1 and RQ2 by explaining front-loaded workflow, real-time iteration, and changing production networks.
Dean et al. (2026); Wei et al. (2025); Park et al. (2026)	On-set collaboration and shared visual communication	LED Virtual Production and collaborative 3D scene editing require shared interfaces, common ground, and communication across creative and technical teams.	Supports RQ2 and RQ3 by linking real-time decision-making, team coordination, and workflow-based authorship.
Xu et al. (2024); Wei et al. (2024); Song et al. (2025)	AI-assisted and multi-role virtual production workflows	Multi-agent systems, VR training, and AI-driven workflows simulate or support script interpretation, role coordination, scene generation, and production planning.	Supports RQ2 and RQ3 by showing how AI and multi-role systems reshape collaboration and creative agency.
Leininger et al. (2025); Azzarelli et al. (2025); Hilal (2025); Lee and Luk (2025); Zhao and Zhao (2024)	AI, intelligent cinematography, and digital environment generation	AI-generated environments, automated lighting, intelligent cinematography, and computational image-making expand previsualization, set design, and visual decision support.	Supports RQ1, RQ2, and RQ3 by connecting AI-assisted visualisation with technical mediation and directorial judgment.
Silveira et al. (2026); Bennett et al. (2023);	Education, training, and workflow literacy	Virtual Production education requires learners to understand pipeline logic, narrative-driven design, AI-assisted	Supports RQ2 and RQ3 by linking workflow authorship to training,

Dober et al. (2024); Sun (2025)		visualisation, and workflow literacy rather than isolated tool operation.	curriculum design, and future skills.
Bugahhoos et al. (2026); Hoare et al. (2026); Méndez-Fernández et al. (2025)	Production scale, accessibility, and contextual variation	Small studios, educational systems, cloud-based tools, and inclusive filmmaking contexts show that Virtual Production workflows vary by resources, access, and production conditions.	Supports RQ3 and the practical implications by showing that workflow authorship is context-sensitive rather than limited to high-end LED Volume production.
Beak (2026); Chaurasia and Majhi (2026); Tsiavos and Kitsios (2025)	Scenographic practice, immersive media, and digital transformation	LED Volume, immersive sound-space relations, and digital transformation reshape how directors negotiate space, perception, movement, and audiovisual meaning.	Supports RQ3 by extending authorship from final textual style to spatial, sensory, and technologically mediated creative coordination.

Table 4. Condensed Coding Path from Literature Evidence to Analytical Themes

Literature evidence	Representative sources	Open codes	Descriptive category	Analytical theme	Related RQ
Virtual Production moves visual planning, technical testing, and problem-solving into earlier production stages.	Swords and Willment (2024a, 2024b); Dean et al. (2026)	Fix-it in pre-production; early technical rehearsal; pipeline planning	Front-loaded workflow	Front-loading and visualization of directorial creativity	RQ1
Immersive scouting, virtual cameras, and tangible interfaces allow filmmakers to assess space, camera movement, and scene feasibility before shooting.	Bodini et al. (2023, 2024); Kerr et al. (2024); Ronfard (2021)	Virtual scouting; camera exploration; spatial pre-assessment	Spatial previsualization	Front-loading and visualization of directorial creativity	RQ1
AI-generated environments and digital assets support concept exploration, scene variation, and rapid visual testing.	Leininger et al. (2025); Song et al. (2025); Hilal (2025)	AI-generated environments; digital asset planning; visual testing	AI-assisted previsualization	Front-loading and visualization of directorial creativity	RQ1
Real-time rendering and convergence workflows connect creative judgment, technical execution, and visual verification across production stages.	Jia et al. (2025); Silva Jasaui et al. (2024)	Non-linear workflow; real-time iteration; convergence pipeline	Iterative production logic	Front-loading and visualization of directorial creativity; real-time and collaborative transformation of visual decision-making	RQ1; RQ2
LED Virtual Production requires directors	Dean et al. (2026); Wei et al. (2025);	On-set visualization; communication	Collaborative on-set decision-making	Real-time and collaborative transformation	RQ2

and departments to coordinate around shared real-time image systems.	Cremona and Kavakli (2023); Helzle (2023)	interface; hybrid image system		of visual decision-making	
VR training, AI multi-agent systems, and professional skills research show that VP competence depends on role coordination and workflow literacy.	Wei et al. (2024); Xu et al. (2024); Silveira et al. (2026); Willment et al. (2025)	Multi-role collaboration; AI-assisted workflow; professional skills	Skill-based collaborative competence	Real-time and collaborative transformation of visual decision-making	RQ2
Virtual environments, LED Volume, and computational systems reorganise camera, lighting, space, performance, and montage.	Ronfard (2021); Beak (2026); Chaurasia and Majhi (2026)	Computational staging; scenographic mediation; immersive audiovisual design	Technical mediation of directing	Workflow turn of directorial authorship	RQ3
Collaborative 3D scene editing and team communication require preservation of creative intent, tacit knowledge, and shared understanding.	Park et al. (2026)	Common ground; creative intent; shared decision context	Shared creative agency	Workflow turn of directorial authorship	RQ3
AI, automated lighting, intelligent cinematography, and generative image tools reshape set design, lighting, spatial capture, and production decision chains.	Azzarelli et al. (2025); Lee and Luk (2025); Zhao and Zhao (2024)	Automated lighting; intelligent cinematography; computational image-making	Computationally mediated authorship	Workflow turn of directorial authorship	RQ3
Small studios, educational contexts, cloud-based systems, and inclusive filmmaking show that VP workflows vary across resources, access, and production scale.	Bugahhoos et al. (2026); Hoare et al. (2026); Méndez-Fernández et al. (2025); Sun (2025)	Scalable workflow; accessibility; workflow training; production constraint	Context-sensitive workflow authorship	Workflow turn of directorial authorship	RQ3

3. Conceptualising Virtual Production in Film Directing

As the conceptual background of this article, this section primarily defines the core meaning, technological boundaries, and analytical premises of Virtual Production in the context of film directing, without pre-emptively presenting the thematic findings that will be developed in Section 4. Building on the preceding methodology of the literature review, the function of this section is not to conduct a full thematic synthesis, but to provide the necessary conceptual foundation for the subsequent thematic findings. In other words, this section addresses how Virtual Production is understood in this article, whereas Section 4 examines how the synthesis of existing literature shows that Virtual Production influences directorial creativity.

3.1 Defining Virtual Production as a Real-time Hybrid Production Environment

In this article, Virtual Production is defined as a real-time hybrid production environment composed of Real-time Rendering, Game Engine, Camera Tracking, Motion Capture, Virtual Camera, LED Volume, Digital Assets, and In-camera Visual Effects. It is not a single device, a single software package, or a single shooting technique, but a production environment that connects virtual spaces, physical sets, and real-time image systems. Compared with traditional CGI or post-production VFX, the key distinction of Virtual Production lies in the fact that certain digital visual elements are no longer primarily deferred to post-production. Instead, they enter the processes of creative judgment and on-set collaboration during pre-production and production.

In terms of its conceptual origins, Virtual Production is closely related to practices such as virtual cinematography, previsualization, motion capture, game engine filmmaking, and XR production. Ronfard (2021) points out that when the camera, character, lighting, and montage in virtual environments can be reorganized through algorithmic and interactive systems, traditional theories of directing concerning shots, mise-en-scène, and editing need to be reconsidered. This view suggests that virtual environments do not merely provide background imagery, but alter the fundamental conditions of image organization. Cremona and Kavakli (2023) also note that the Virtual Production studio integrates the physical studio, virtual scene, real-time rendering, and interactive control into a new production system. Its significance, therefore, lies not only in technological upgrading, but also in the reconfiguration of the studio system and filmmaking workflow.

In this sense, this article does not narrowly equate Virtual Production with LED Volume. LED Volume is currently one of the most visible forms of Virtual Production, but it is only one component of the broader virtual production system. Helzle's (2023) study of light fields and Virtual Production LED walls shows that LED walls do not merely provide background display; they also participate in the formation of on-set lighting, reflection, spatial perception, and actors' sense of orientation. Therefore, the function of LED Volume is not simply to replace green screen, but to enable digital environments to participate directly in the visual composition of the shooting site. From the perspectives of usability and democratization, Méndez-Fernández et al. (2025) further point out that Virtual Production is expanding from high-cost professional systems to educational, cloud-based, and lower-complexity solutions. This indicates that the understanding of Virtual Production in this article should not be limited to large-scale industrial studios, but should treat it as a creative infrastructure that can operate across different production scales and educational contexts.

Accordingly, this article conceptualizes Virtual Production as a real-time, hybrid, and workflow-based filmmaking environment. Here, real-time means that the director and creative team can immediately view, adjust, and evaluate images during shooting or simulation. Hybrid means that physical settings, actors, cameras, and lighting jointly construct the image space together with virtual scenes, digital assets, rendering systems, and tracking systems. Workflow-based means that creative judgment is no longer concentrated solely on the shooting site, but is distributed across continuous processes such as asset preparation, virtual scouting, previsualization, on-set visualization, and post-production integration (Cremona & Kavakli, 2023; Helzle, 2023; Méndez-Fernández et al., 2025; Ronfard, 2021). This definition provides the conceptual boundaries for the thematic synthesis in Section 4, while the specific mechanisms of influence will be developed in that section.

3.2 Distinguishing Virtual Production from Conventional Film Production Workflows

To avoid reducing Virtual Production to a "shooting method that uses virtual backgrounds," it is necessary to briefly clarify its fundamental differences from conventional film production workflows. Traditional workflows usually follow the stage-based logic of pre-production, production, and post-production. In pre-production, the director conducts script analysis, storyboard design, scene planning, and actor preparation. During production, the director completes on-set coordination, performance direction, and shot organization. In post-production, the final image is completed through editing, colour grading, sound, and VFX. Although feedback and adjustment also exist in practice within this workflow, it generally retains a relatively linear stage structure.

The emergence of Virtual Production has made this stage structure more intersecting and iterative. Kerr et al.'s (2024) study on tracked tangible interfaces for virtual film pre-production shows that virtual pre-production tools enable creators to conduct camera exploration and scene planning through trackable tangible interactive interfaces. This indicates that some spatial judgments that previously depended on paper-based storyboards or on-set test shooting can now be tested in advance within virtual environments. Wei et al.'s (2025) study of MetaCineMoji further points out that complex LED Virtual Production workflows require visual interfaces to improve on-set communication, because virtual production sites involve real-time communication among multiple roles, professional domains, and interfaces. Thus, the difference between Virtual Production and conventional workflows is not merely a matter of "when images are generated," but also concerns the closer collaborative relationships formed among different departments around the same real-time image system (Kerr et al., 2024; Wei et al., 2025).

At the same time, Virtual Production also changes the professional knowledge structure required of directors. Nebeling et al.'s (2021) study of XRStudio demonstrates that virtual production and real-time streaming systems can support immersive teaching and remote creative experiences, indicating that similar technologies affect not only professional industrial production, but also educational and

training contexts. Xu et al.'s (2025) study of cinematography lighting education in the metaverse similarly shows that virtual environments can be used to simulate lighting setups and help learners understand lighting realism, presence, agency, and collaboration. Taken together, these studies suggest that future directors do not need to become software engineers, but they do need to develop workflow literacy in order to understand digital assets, virtual cameras, real-time lighting, tracking systems, and collaborative production processes (Nebeling et al., 2021; Xu et al., 2025).

Therefore, this study summarizes the differences between Virtual Production and conventional filmmaking in terms of three conceptual premises. First, Virtual Production shifts image generation from post-production completion to cross-stage generation. Second, it expands the film set from a physical space into a physical–virtual hybrid space. Third, it extends the director's work from single-point on-set coordination to the integrated organization of creative workflows, real-time image systems, and collaborative networks (Kerr et al., 2024; Nebeling et al., 2021; Wei et al., 2025; Xu et al., 2025). These differences serve only as the background for the subsequent analysis, and specific findings are not developed in this section.

3.3 Conceptual Link between Virtual Production and Directorial Creativity

In the context of film directing, the importance of Virtual Production lies not only in the fact that it provides new technological tools, but also in the way it changes the environment in which directorial creativity takes place. Traditional directorial creativity is mainly organized around script interpretation, actor direction, mise-en-scène, shot selection, and editing rhythm. Virtual Production, by contrast, places the director within a dynamic system composed of Game Engine, Virtual Set, LED Screen, Digital Assets, Motion Capture, Camera Tracking, and Rendering Pipeline. Within this system, the director needs to maintain consistency across narrative intention, spatial logic, visual style, and cross-departmental collaboration.

From the perspective of scenographic practice, Beak (2026) argues that LED Volume can simultaneously function as a scenic environment, a lighting instrument, and a compositional partner, requiring creators to negotiate spatial, lighting, movement, and camera relations as an integrated whole. This view indicates that the scene in Virtual Production is no longer merely a background provided by the art department, but becomes a compositional system jointly operated by the director, cinematography, production design, lighting, and technical teams. Tsiavos and Kitsios's (2025) study of digital transformation in the film industry also points out that AI and digital technologies are changing multiple stages of the film value chain. Although their focus is not entirely on Virtual Production, their analysis of the digital reorganization of film industry processes suggests that directorial creativity also needs to be understood within the broader context of digital transformation (Beak, 2026; Tsiavos & Kitsios, 2025).

Based on the above conceptual definitions, this article argues that the relationship between Virtual Production and directorial creativity can be analysed through three dimensions. First, how is directorial creative judgment redistributed between pre-production and production? Second, how does the director conduct visual judgment and collaborative communication within real-time image systems? Third, how does directorial authorship expand from a stylistic imprint in the final film text to an organizational capacity over workflow, technical mediation, and aesthetic continuity (Beak, 2026; Tsiavos & Kitsios, 2025)? To avoid overlap between the conceptual background and thematic findings, this section only establishes the above analytical boundaries. Section 4 will further respond to the three themes of front-loading and visualization, real-time and collaborative decision-making, and workflow authorship based on the results of the thematic synthesis.

3.4 From Classical Auteur Theory to Workflow Authorship: Theoretical Derivation of the Framework

The concept of Workflow Authorship is not introduced as an isolated new term. It is derived from earlier debates on authorship, technological mediation, and production culture. Classical Auteur Theory understands the director as a central creative figure whose style, themes, and formal choices can be identified in the completed film text (Sarris, 1962). This view remains useful, but its text-centred orientation is less able to explain how authorship operates when image-making is distributed across digital assets, real-time engines, LED volumes, Virtual Art Departments, camera tracking, and cross-departmental workflows.

A second theoretical source comes from digital cinema and technological mediation. Film meaning is shaped not only by individual intention, but also by material technologies, visual systems, and modes of production. In Virtual Production, technology is not a neutral tool added to conventional directing. It changes how images are planned, tested, viewed, and revised. The key issue is therefore not whether technology weakens the director, but how directors exercise creative judgment through mediated image systems.

A third source comes from production culture and workflow studies. Production research shows that screen authorship is shaped by professional routines, labour relations, institutional structures, and collaborative practices (Caldwell, 2020). This insight is important because Virtual Production requires directors to coordinate with VFX supervisors, Virtual Art Departments, production designers, lighting teams, real-time engine operators, and AI-assisted systems. Authorship is therefore not removed, but redistributed across workflow, communication, and technical mediation.

Based on these theoretical sources, this article develops the Virtual Production–Directorial Creativity Framework. The framework addresses one problem: traditional text-centred authorship cannot fully explain how directors maintain creative subjectivity in Virtual Production environments. Workflow Authorship is proposed as an extension of Directorial Authorship, explaining how directors sustain creative intention through digital assets, real-time image systems, technical negotiation, team coordination, and aesthetic continuity.

Table 5. Theoretical Derivation of the Virtual Production–Directorial Creativity Framework

Theoretical layer	Core theoretical concern	Relevance to film directing	Limitation in explaining Virtual Production	Contribution to the new framework

Classical Auteur Theory	Director as the source of style, theme, and personal creative signature	Explains why the director remains central to cinematic meaning	Overemphasizes the completed film text and individual style	Provides the starting point for understanding Directorial Authorship
Film Form and Technological Mediation	Film meaning is shaped by apparatus, medium, image technology, and audiovisual form	Shows that directing is always mediated by material and technological conditions	Does not fully explain real-time, hybrid, and pipeline-based production	Explains why Virtual Production changes the conditions of visual judgment
Digital Cinema Theory	Digital tools transform image generation, compositing, spatial design, and post-production logic	Helps explain the transition from photographic capture to computational image-making	Often focuses on image ontology rather than directorial workflow	Connects Real-time Rendering, Digital Assets, and computational images to directing
Production Culture and Workflow Studies	Creative work is shaped by labour division, professional routines, institutional structures, and collaboration	Explains directing as a coordinated production practice rather than an isolated act	Needs further extension to real-time systems and Virtual Production pipelines	Explains authorship as coordination across teams, technologies, and production stages
Virtual Production–Directorial Creativity Framework	Directorial creativity is reorganized through Digital Assets, Real-time Visualization, Technical Mediation, and Cross-departmental Workflow	Explains how directors sustain creative intention in hybrid production environments	Requires future empirical validation through interviews, ethnography, and case studies	Leads to Workflow Authorship as an explanatory concept

This theoretical derivation clarifies that Workflow Authorship does not replace Classical Auteur Theory. Instead, it extends Directorial Authorship from the completed film text to the production process. Classical Auteur Theory explains why the director remains central to cinematic meaning, while Digital Cinema Theory and Production Culture explain why this centrality is now technically and collaboratively mediated. In this sense, Workflow Authorship is a process-based extension of auteur theory. It explains how directors sustain creative intention through Digital Assets, Real-time Image Systems, technical negotiation, team coordination, and aesthetic continuity. This theoretical lineage provides the basis for the debates discussed in the next section and for the thematic findings developed in Section 4.

3.5 Debates and Theoretical Tensions in Virtual Production

Although Virtual Production is often discussed as enhancing efficiency, visualization, and collaboration, its influence on film directing remains contested. The first tension concerns directorial control. Virtual Production may strengthen the director's control over space, camera planning, lighting, and visual continuity by allowing decisions to be tested earlier. Yet this control is increasingly mediated by technical systems, real-time engines, LED volumes, digital assets, and specialized teams. Directorial agency may therefore become more dependent on system stability and the responsiveness of the production pipeline (Dean et al., 2026; Swords & Willment, 2024a; Wei et al., 2025).

The second tension concerns real-time visualization. Real-time rendering and virtual scouting can make creative decisions more immediate and testable (Bodini et al., 2023; Jia et al., 2025; Kerr et al., 2024). However, real-time feedback may also compress the time available for reflection and experimentation. Visual judgment may become shaped by workflow pressure, system feedback, and production constraints.

The third tension concerns AI and automated workflow. AI-assisted tools and multi-agent systems may expand directors' capacity for scene generation, previsualization, lighting simulation, and workflow coordination (Azzarelli et al., 2025; Song et al., 2025; Xu et al., 2024; Zhao & Zhao, 2024). Yet they also raise questions about the boundaries of directorial agency. When images and production options are generated by computational systems, the director's role shifts toward selecting, constraining, reorganizing, and interpreting machine-generated possibilities.

These tensions define the central gap addressed by this review. Existing studies have shown that Virtual Production changes pipelines, visualization, collaboration, and AI-assisted workflows. What remains underdeveloped is a theory of how directors negotiate control, reflection, and authorship within these mediated systems. This gap provides the basis for the thematic synthesis in Section 4 and for the concept of Workflow Authorship.

4. Thematic Findings: Virtual Production and Directorial Creativity

As the thematic findings section of this article, this section presents the three core themes generated through thematic synthesis. Unlike Section 3, this section no longer repeats the conceptual definition of Virtual Production. Instead, it analyses how the existing literature collectively demonstrates the impact of Virtual Production on film directors' creative practice in relation to the research questions. Specifically, Section 4.1 addresses RQ1 by discussing the front-loading and visualization of creative workflows; Section 4.2 addresses RQ2 by examining the real-time and collaborative transformation of visual decision-making; and Section 4.3 addresses RQ3 by analysing the workflow turn of directorial authorship.

4.1 Front-loading and Visualization of Directorial Creativity

The first thematic finding is that Virtual Production shifts part of the film director's core creative judgment from the conventional production and post-production stages to the pre-development and pre-production stages, while transforming directorial imagination into a visualized, testable, and iterative working process. In traditional film production, many digital visual elements are often completed through post-production compositing, and directors on set can only make judgments based on storyboards, temporary composites, technical markers, or their own imagination. By contrast, through real-time rendering, game engines, virtual scouting, AI-generated environments, and previsualization, Virtual Production enables directors to evaluate scene space, camera paths, lighting atmosphere, and narrative rhythm at an earlier stage.

Chanpum (2023) points out that Virtual Production changes the feedback relationship from screenplay to final film through interactive and real-time technologies, allowing creators to test, modify, and confirm visual solutions more rapidly during the early stages. Its significance lies in the fact that directorial creativity no longer depends entirely on visual confirmation after shooting, but begins to enter an image environment that approximates the final film during the pre-production stage. Dean et al.'s (2026) study of industry practitioners in China, the United Kingdom, and the United States further indicates that the key issue in Virtual Production is not merely whether the technical system functions, but how creative intention, technical feasibility, resource allocation, and team responsibilities are coordinated before formal shooting begins. Their proposed concept of the pre-development phase suggests that directors need to become involved earlier in digital asset preparation, virtual set review, technical rehearsal, and production pipeline coordination (Chanpum, 2023; Dean et al., 2026).

Jia et al. (2025) regard real-time rendering and Virtual Production as important factors driving the formation of a non-linear convergence workflow in the film and animation industries. Within this type of workflow, creative judgment, technical execution, and visual verification no longer occur sequentially according to fixed production stages, but are cyclically adjusted within real-time systems. Leininger et al.'s (2025) study of AI-generated 3D environments also shows that AI-generated environments can be used in virtual film productions for conceptual exploration, the generation of scene variants, and rapid visual testing. This suggests that front-loading does not mean that creative judgment is fixed once and for all. Rather, it means that directors can compare, select, and reorganize a wider range of visualized options (Jia et al., 2025; Leininger et al., 2025).

Therefore, front-loading and visualization should not be understood simply as improvements in efficiency. Rather, they transform the temporal structure of directorial creativity. Directors gain an earlier capacity for visual anticipation, while also assuming greater responsibility for early-stage decision-making. Virtual Production transfers part of the complexity from post-production into pre-production and cross-stage workflows, requiring directors to possess stronger workflow literacy, visual organization, and technical negotiation skills. This theme directly addresses RQ1: through the pre-positioning of digital assets, virtual scenes, and real-time preview mechanisms, Virtual Production shifts directorial creative judgment from abstract conception toward visualized workflow organization (Chanpum, 2023; Dean et al., 2026; Jia et al., 2025; Leininger et al., 2025).

4.2 Real-time and Collaborative Transformation of Visual Decision-making

The second thematic finding is that Virtual Production makes the film director's visual decision-making more explicitly real-time and collaborative. In traditional green screen or post-production VFX workflows, directors, actors, and cinematography departments often cannot see the complete digital environment on set, and many visual effects can only be confirmed after shooting. By contrast, through LED Volume, real-time rendering, camera tracking, and virtual cameras, Virtual Production brings part of the final visual effect back to the shooting site, enabling directors to immediately view, compare, and adjust images during production.

Jia et al.'s (2025) study shows that real-time rendering technologies change not only production efficiency, but also narrative construction, creative experimentation, and production workflows. When the creative team can immediately test shots, lighting, scenes, and character relations within the same system, the director's judgment no longer depends on a single predetermined plan, but develops through a dynamic decision-making chain based on real-time feedback. Dean et al. (2026) also point out that the implementation of Virtual Production requires a highly coordinated working mechanism among the director, cinematographer, producer, art department, lighting team, VFX team, technical team, and studio management. Because on-set images are simultaneously shaped by the LED wall, game engine, tracking system, physical lighting, and digital scenes, the director's aesthetic judgment must be translated into a workflow language that can be jointly executed across multiple departments (Dean et al., 2026; Jia et al., 2025).

This collaborative tendency is also reflected in training systems and human–AI collaborative systems. Wei et al. (2024) propose MetaCrew, a multi-role VR training system for film production that is designed to enhance collaborative understanding among different production roles. This study indicates that Virtual Production-related competence should not be understood merely as individual tool operation, but as a multi-role collaborative capacity. Xu et al. (2024) propose FilmAgent, an LLM-based multi-agent collaborative framework that explores automated collaboration in virtual filmmaking, including script understanding, scene generation, character coordination, and shot organization. Song et al. (2025) also note that AI-driven workflows can expand the application boundaries of Virtual Production in cinematic creation, but their value needs to be repositioned in relation to directorial aesthetic judgment and team collaboration (Song et al., 2025; Wei et al., 2024; Xu et al., 2024).

At the same time, real-time operation does not automatically lead to higher-quality creativity. Real-time feedback may enhance the director's sense of control over the final image, but it may also compress the time available for reflection and make on-set decision-making more dependent on system stability and the responsiveness of technical teams. Silveira et al.'s (2026) systematic multivocal review of Virtual Production education shows that, although Virtual Production education is expanding rapidly, it still faces problems such as tool-oriented training, uneven access to resources, and imbalanced skill structures. This finding suggests that Virtual Production

requires directors and teams not merely to operate equipment, but to develop a comprehensive set of capacities involving interdisciplinary collaboration, technological understanding, and workflow management (Silveira et al., 2026).

Therefore, the second theme can be summarized as the real-time and collaborative transformation of visual decision-making. Its core implication is that directors no longer merely coordinate actors and cameras on set; rather, they coordinate cinematography, lighting, the virtual art department, VFX, AI systems, and technical pipelines within a real-time image system. This theme directly addresses RQ2: through real-time visual feedback and cross-departmental collaboration mechanisms, Virtual Production transforms the director from a singular on-set controller into a creative coordinator within a real-time system (Dean et al., 2026; Jia et al., 2025; Silveira et al., 2026; Song et al., 2025; Wei et al., 2024; Xu et al., 2024).

4.3 Workflow Turn of Directorial Authorship

The third thematic finding is that Virtual Production is driving a shift in directorial authorship from authorship centred on the final film text toward workflow authorship centred on workflow organization, creative coordination, and technological mediation. Traditional auteur theory usually emphasizes the director's personal imprint on a film's themes, style, narrative structure, and audiovisual form. However, within Virtual Production environments, image generation increasingly depends on digital assets, real-time engines, AI-generated environments, LED volumes, virtual cameras, camera tracking data, and cross-departmental chains of collaboration. Directorial authorship is therefore embodied not only in the final film text, but also in the production process, the chain of creative decision-making, and the organization of technology.

Chanpum (2023) points out that Virtual Production changes the feedback mechanisms of traditional filmmaking and enables creators to become involved earlier in the image-generation process. In relation to the research questions of this article, this means that directorial authorship is no longer expressed solely through the stylistic qualities of the final image, but is formed through the director's continuous organization of visual solutions, digital assets, technical constraints, and collaborative relationships across the entire Virtual Production pipeline. Jia et al.'s (2025) concept of a non-linear convergence workflow further indicates that real-time rendering and Virtual Production enable creative work, technical processes, and team collaboration to occur synchronously within the same system, rather than being transferred step by step through a traditional linear workflow. Accordingly, directorial authorship is increasingly reflected in whether the director can maintain consistency in narrative intention and visual style across previsualization, virtual scouting, on-set visualization, AI-assisted planning, and post-production integration (Chanpum, 2023; Jia et al., 2025).

This form of workflow authorship also involves the director's understanding of technological mediation. In Virtual Production, images are not captured by the camera alone; rather, they are generated through interactions among live actors, physical lighting, LED backgrounds, real-time rendering, digital assets, and tracking data. Although Chaurasia and Majhi's (2026) study of cinematic virtual reality sound design focuses primarily on Cine-VR, its analysis of the relationships among sound, space, and user perception in immersive media demonstrates that when the media environment of image-making changes, creators must reorganize the ways in which narrative, space, and sensory guidance are constructed. For Virtual Production, directors likewise need to reconsider the relationships among frame, space, movement, lighting, performance, and sound within hybrid environments (Chaurasia & Majhi, 2026).

Research on film education and AI-assisted production further suggests that workflow authorship is not a naturally acquired capacity, but one that requires training and interdisciplinary learning. Sun's (2025) study of the integration of Generative AI and XR into undergraduate Virtual Production pedagogy points out that future film and television creators need to understand narrative-driven design, AI-assisted visualization, and XR-based creative workflows. Silveira et al. (2026) also note that Virtual Production education has become an important issue in film education, although it still faces problems such as unequal access to resources and tool-oriented training. Studies by Xu et al. (2024) and Song et al. (2025) further show that AI can participate in scene generation, project planning, and workflow support in virtual filmmaking, but AI-generated content still requires directors to select, adjust, reorganize, and position it narratively. Therefore, AI-assisted Virtual Production does not weaken directorial authorship; rather, it changes the location in which authorship takes shape (Silveira et al., 2026; Song et al., 2025; Sun, 2025; Xu et al., 2024).

Therefore, the third theme can be summarized as the workflow turn of directorial authorship. Its core implication is that Virtual Production shifts directorial authorship from textual outcome to production process, from individual style to system organization, and from singular on-set authority to cross-stage collaborative coordination. The director remains an important creative agent, but this agency is increasingly manifested in the capacity to coordinate technology, teams, assets, space, and real-time image systems as an integrated whole. This theme directly addresses RQ3: through technological mediation, pipeline coordination, and the maintenance of aesthetic continuity, Virtual Production reconfigures directorial authorship as workflow authorship (Chanpum, 2023; Chaurasia & Majhi, 2026; Jia et al., 2025; Silveira et al., 2026; Song et al., 2025; Sun, 2025; Xu et al., 2024).

The theoretical implication of this finding is that Workflow Authorship should not be read as a rejection of auteur theory. Rather, it repositions auteur theory within a mediated production environment. The director remains a creative agent, but this agency is now exercised through workflow design, technical coordination, and the continuous interpretation of computationally generated visual options.

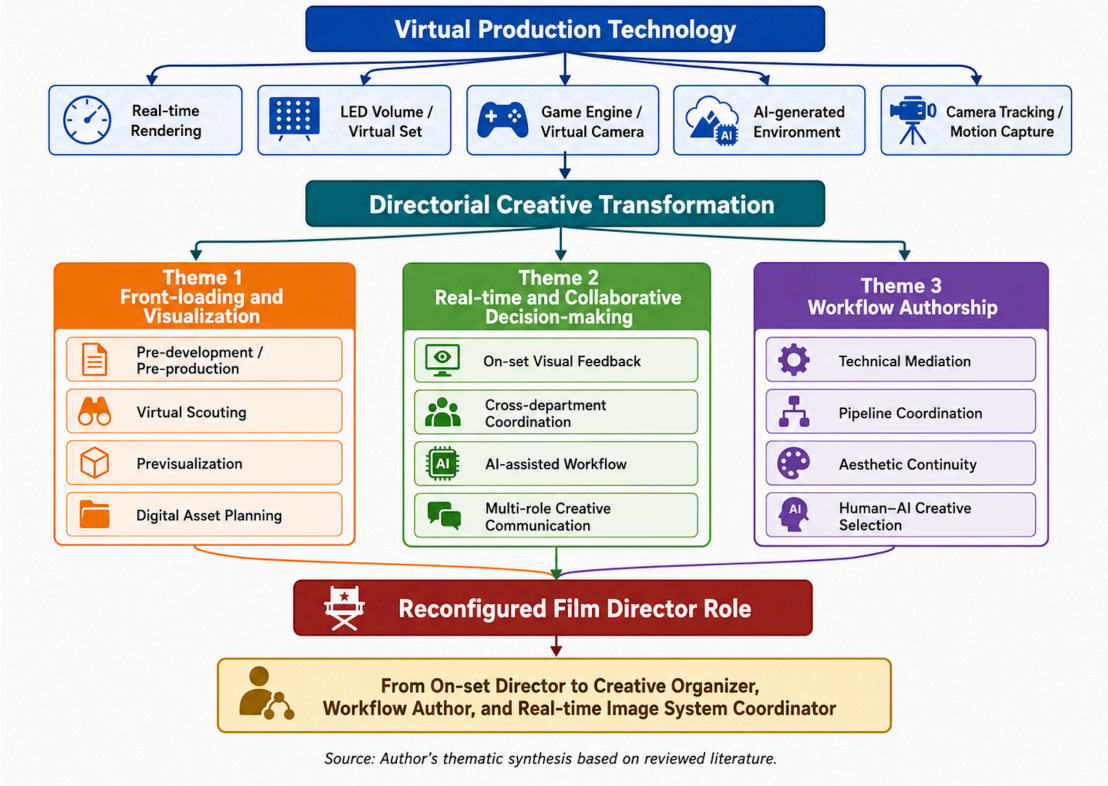

Figure 2 Thematic Framework of Virtual Production and Directorial Creativity

Figure 2 shows that the three themes identified in this section are not separate or parallel findings, but together constitute the Virtual Production–Directorial Creativity Framework. Within this framework, Virtual Production technology, through technological conditions such as real-time rendering, virtual scenes, AI-generated environments, and tracking systems, first promotes the front-loading and visualization of directorial creative workflows. It then transforms the real-time feedback mechanism of on-set visual judgment and the structure of team collaboration. Ultimately, it drives a shift in directorial authorship from a traditional text-centred model toward workflow-based authorship. This framework demonstrates that the impact of Virtual Production on directorial creativity is not a single technological effect, but a systemic transformation occurring across creative time, creative space, decision-making mechanisms, collaborative structures, and the construction of authorship.

4.4 Discussion: From Theoretical Tensions to Workflow Authorship

The three thematic findings should be read in relation to the tensions identified in Section 3.5. The synthesis suggests that Virtual Production both expands and redistributes directorial agency. Directors gain earlier access to visualized decisions, digital environments, and real-time feedback. However, this control is no longer exercised through individual on-set authority alone. It is distributed across digital assets, Virtual Art Departments, VFX teams, real-time engines, and cross-departmental pipelines (Dean et al., 2026; Swords & Willment, 2024a; Wei et al., 2025).

Real-time visualization also has a dual effect. It allows directors to test visual options earlier and faster, but it also requires more decisions to be made within technically coordinated workflows (Bodini et al., 2023; Jia et al., 2025; Kerr et al., 2024; Leininger et al., 2025). Similarly, AI-assisted Virtual Production does not simply replace the director. It relocates authorship from direct manual creation to the organization of creative options, technical constraints, and aesthetic continuity (Azzarelli et al., 2025; Song et al., 2025; Xu et al., 2024; Zhao & Zhao, 2024).

These debates clarify why Workflow Authorship is necessary. Traditional text-centred authorship remains useful for understanding style and theme, but it is insufficient for explaining directorial agency inside real-time, collaborative, and computationally mediated production systems. Workflow Authorship addresses this gap by explaining how directors sustain creative intention through pipeline coordination, technical mediation, team communication, and aesthetic judgment across production stages.

5. Conclusion

This article examined how Virtual Production Technology reshapes Film Directors' Creative Practice through a Qualitative Integrative Literature Review. In response to RQ1, the review shows that Virtual Production front-loads directorial decision-making by moving key visual judgments from post-production into pre-development, pre-production, and production. This reflects a broader "fix-it in pre-production" logic, where digital assets, virtual sets, technical testing, and visual planning are organized before principal photography (Swords & Willment, 2024). In response to RQ2, Virtual Production transforms visual decision-making by enabling real-time interaction among performance, virtual environments, camera movement, lighting, and collaborative feedback. This aligns with

Intelligent Cinematography, where AI, computer vision, NeRF, 3D acquisition, and virtual production technologies are increasingly integrated into cinematic image-making (Azzarelli et al., 2025). In response to RQ3, Directorial Authorship is reconfigured as Workflow Authorship, through which directors sustain creative agency by coordinating digital assets, technical systems, collaborative pipelines, and aesthetic continuity.

The main theoretical contribution is to move Virtual Production research beyond technical application and industrial efficiency toward Directorial Creativity and Authorship. Existing studies show that Virtual Production is reshaping professional skills, production networks, labour relations, and collaborative practices in the screen industries (Swords & Willment, 2024; Willment et al., 2025). Building on this work, Workflow Authorship explains how directors maintain creative intention within complex technical systems. It extends rather than replaces traditional authorship because authorship in Virtual Production is located not only in the completed film text, but also in production meetings, 3D scene editing, shared technical decisions, and common ground among creative and technical teams (Park et al., 2026).

This review also has practical implications for production and education. Directors need stronger workflow literacy and the ability to communicate with Virtual Art Departments, VFX supervisors, production designers, lighting teams, and real-time engine operators. Adoption conditions differ across production scales, as small and micro studios face barriers in cost, skills, and workflow adaptation (Bugahhoos et al., 2026). Film education should therefore combine aesthetic judgment, technical coordination, and ethical awareness, especially as Generative AI, Gaussian Splatting, NeRF, AI-driven set design, and automated lighting reshape image generation and production control (Hilal, 2025; Jamil & Brennan, 2025; Lee & Luk, 2025; Zhao & Zhao, 2024).

This review has limitations. It synthesizes existing scholarship rather than generating primary empirical data from directors, cinematographers, VFX supervisors, or Virtual Production crews. The field is also developing rapidly, and some emerging industrial practices may not yet be represented in peer-reviewed research. Issues such as labour politics, accessibility, sustainability, and inclusion require further study, especially because Virtual Production may support more accessible filmmaking conditions for d/Deaf, Disabled, and Neurodivergent cast and crew (Hoare et al., 2026).

Future research should move from conceptual synthesis to empirical investigation. Interviews, production ethnography, case studies, and comparative industry analysis could examine how directors negotiate creative control, technical constraints, real-time feedback, AI-assisted tools, and cross-departmental collaboration in practice. Comparative studies across high-budget studios, independent productions, film schools, and non-Western film industries would further clarify how Workflow Authorship operates across different production scales and cultural contexts.

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