International Journal of Education and Humanities
ISSN: 2770-6702 | Vol. 23, No. 1, 2026

Study on the Application of Unreal Engine in Futuristic Urban Sci-Fi Scene Construction

Xinhua Ran

Wuhan Textile University, Wuhan, China

Abstract: As an important narrative space in digital media art, the construction of futuristic urban sci-fi scenes is undergoing a paradigm shift from static modeling to real-time interaction. This paper takes Unreal Engine as the research object to explore its technical logic and aesthetic mechanisms in constructing futuristic urban scenes. The study finds that Unreal Engine, through three major technical pathways-procedural generation, real-time rendering, and virtual production-resolves the long-standing "scale-detail-efficiency" impossible triangle in sci-fi city construction. Furthermore, the engine not only serves as a tool intermediary but also participates as a "technical subject" in the production of meaning within the scene. It enables the city to transform from a viewed landscape into an experienceable "world," redefining the ontological status of virtual cities at the intersection of technical operation and aesthetic perception. This provides a new theoretical perspective for understanding the practice of "world-building" in the digital age.

Keywords: Unreal Engine, Futuristic City, Sci-Fi Scene, Real-time Rendering, Virtual Production, Procedural Generation.

1. Introduction

From the rain-soaked Los Angeles of *Blade Runner* to the layered New Port City of *Ghost in the Shell*, the futuristic city has always been a central vessel for science fiction imagination. These cities are not merely backdrops for the story but are the narrative itself-they carry profound inquiries about technology, power, and the human condition. However, in traditional CG production workflows, constructing a complete sci-fi city faces severe challenges: high-precision building models demand massive asset creation and lengthy rendering cycles, and once dynamic camera movements or interactive experiences are required, the limitations of traditional offline rendering become glaringly apparent.

In recent years, real-time 3D creation platforms, represented by Unreal Engine, have been changing this landscape. From virtual production for film to open-world games, from architectural visualization to metaverse spatial construction, Unreal Engine, with its core technologies such as Nanite virtualized geometry, Lumen dynamic global illumination, and PCG procedural content generation, has turned the vision of "building cinematic-quality sci-fi cities in real-time" from a dream into reality. More notably, the engine not only improves production efficiency but also fundamentally alters the way sci-fi cities are perceived and experienced-transforming the viewer from a "spectator" into a "present participant."

The core problematic of this paper lies precisely here: Through what technical mechanisms does Unreal Engine solve the core challenges of sci-fi city construction? What aesthetic consequences do these technical choices bring? And when the engine deeply participates in the production of meaning within the scene, how must our understanding of the "virtual city" be adjusted?

2. From the Scale Dilemma to Real-time Presence: Technological Breakthroughs of Unreal Engine

2.1. The "Impossible Triangle" of Sci-Fi City Construction

The construction of sci-fi cities faces a classic trilemma: **scale, detail, and efficiency** cannot be achieved simultaneously.

Scale is the first challenge for sci-fi cities. Unlike a single building or interior scene, a city is essentially a "system of systems"-it requires hundreds or thousands of building units, intricate transportation networks, layered spatial structures, and the infrastructure to support it all. The iconic "vertical city" form of the cyberpunk tradition further demands not just horizontal expansion but also vertical depth [1].

Detail is the second pressure. The persuasiveness of a sci-fi city comes precisely from its "imperfections"-worn walls, randomly flickering windows, neon signs of varying hues, piles of pipes and cables in corners. As environment artist Lutong He realized when creating a sci-fi laboratory in the style of *Halo: Infinite*, "Not every surface is perfect; scratches and wear on the edges add a sense of realism to the final result."

Efficiency is the hard constraint governing the previous two. In film production, rendering cycles directly impact project schedules; in games and interactive applications, frame rate and performance are uncompromising bottom lines. In traditional workflows, artists must make trade-offs among the three-either accepting visual monotony from modular repetition or enduring long rendering waits.[2]

2.2. Technology Cluster: Key Engine-Level Solutions

Unreal Engine's response to this dilemma is not a breakthrough in a single technology, but an interlocking "technology cluster."

Nanite virtualized geometry technology fundamentally

changes the rules of polygon budgeting. In traditional workflows, artists must painfully balance model precision against performance; high-detail high-poly models must undergo decimation before entering the engine. Nanite enables "automatic LOD for geometry"-it only renders triangles that are visible to the camera and can cover at least one pixel, allowing original ZBrush-level ultra-high-precision models to be imported directly into the scene [3]. This means those complex mechanical structures, rivets, and seams on sci-fi building surfaces no longer need to be "faked" with normal maps but are presented as true geometric forms.

The Lumen dynamic global illumination system solves the most challenging lighting problem in sci-fi cities. The essence of cyberpunk aesthetics is light-the colors of neon signs, the glare of holographic projections, the reflections on rain-soaked ground. Traditional baked lighting, while capable of producing high-quality indirect illumination, cannot respond to dynamic changes: when a player pushes open a door or the camera transitions from day to night, the pre-baked lighting appears rigid. Lumen achieves "real-time response of light to scene changes," making dynamic day-night cycles, destructible light sources, and moving holographic billboards possible.[4]

The procedural content generation framework directly addresses the scale issue. The PCG framework allows developers to define "generation rules" rather than manually placing each building: building density, block layout, road width, building height variation curves-these parametric rules drive the large-scale generation of the city. In the *Cassini* sample project, Epic demonstrated how to use shape grammar to build modular space stations and how to arrange elements at city scale using PCG's pathfinding and ray-casting functions. This significantly reduces the labor cost of building ultra-large-scale cities.

The synergy of these three technologies is particularly crucial: PCG provides the macroscopic skeleton of the city, Nanite ensures that each building maintains high precision, and Lumen maintains visual consistency across the entire city under dynamic lighting. Together, they break the traditional constraints of the "scale-detail-efficiency" triangle.

2.3. Workflow Revolution: GIS Integration and Asset Pipeline

Beyond technological breakthroughs, workflow restructuring is equally important. **The integration of GIS with Unreal Engine** enables city construction based on real geographic data. The methodological framework proposed by researchers Iordanidis et al. shows that importing GIS data into Unreal Engine can create "real-virtual" hybrid urban environments containing elements such as terrain, building footprints, and road networks. This is particularly crucial for constructing "near-future" style cities, which need to find a balance between the familiar and the unfamiliar.[5]

Optimization of the asset pipeline is also noteworthy. In the production of the award-winning short film *Neon Nights*, artist Indrajeet Sisodiya demonstrated the power of "modular thinking": using Unreal's foliage tool to "plant" building assets onto the terrain, controlling the randomness of window textures through material instances, and using manually placed point lights to simulate the illumination impact of neon signs on the surrounding environment. This workflow frees the artist's energy from repetitive labor, concentrating it on "narrative-driven scene arrangement"-thinking about "what the player will notice first upon entering the environment" and "how each asset serves the overall narrative."

3. From Tool to World: Urban Narrative in Virtual Production

If rendering technology answers the question of "how to make the city look real," then virtual production technology addresses "how to make the city a narrative medium."

3.1. LED Walls and the Generation of "Presence"

The core innovation of virtual production is shifting post-production compositing to the front. In traditional green screen shooting, actors perform against a blank background, relying on imagination; the CG background is composited in later. This not only increases post-production workload but, more critically, leads to a "disembodiment" of the actor from the environment-performances lacking environmental feedback often suffer from a lack of "presence."

LED wall technology changes this situation. In the *Into The Volume* project, a collaboration between Imagination and Territory Studio, a real-time digital backdrop of a near-future London street scene was created for Epic's London studio LED volume. The scene needed to support dynamic transitions from day to night, and the digital twin on the LED wall needed to correspond precisely to the physical props on stage. Unreal Engine's real-time rendering capability made this all possible: as the camera moves, the backdrop changes synchronously with correct parallax, allowing actors to truly "see" themselves standing on the street of a sci-fi city.[6]

This "real-time" capability brings not only improved production efficiency but also an ontological shift: the virtual city is no longer the "object" being filmed but the "environment" co-existing with the actors. It returns gaze, reflects actions, and responds to changes-this bidirectional interaction redefines the "reality" of virtual space.

3.2. The Camera as Narrative Subject: Reframing Cinematic Language

Virtual production also changes the way sci-fi cities are "viewed." In traditional CG production, camera movement is often constrained by rendering cycles-each new shot means another long rendering wait. Real-time rendering eliminates this bottleneck, allowing artists to explore cinematic language as freely as shooting in live-action.

But this raises a new question: how to avoid a "game-like" feel? The reason many engine-produced films and videos look "fake" is precisely because the camera movements are overly "free." In summarizing his experience making *Neon Nights*, Sisodiya emphasized: "How many flying, sweeping shots are there in reality? Even Marvel movies have to consider the possibility of real-life shooting." His solution was to return to a "human perspective"-simulating the subtle shake of handheld shooting, using transitions from out-of-focus to in-focus, and adhering to realistic drone flight speeds. The introduction of this kind of "limitation" paradoxically enhances the realism of the virtual city.[7]

In other words, virtual production is not a simple replacement of physical cinematography; it requires the creator to find a balance between "simulating physical constraints" and "utilizing virtual freedom."

4. The Sci-Fi City as a World Model

The discussion above leads to a deeper question: When Unreal Engine is used to construct a futuristic city, what exactly is being produced?

4.1. Simulation as a Design Method

In traditional architecture, the city model is typically static-a master plan, a physical maquette, or a navigable 3D model. They capture the city at a single moment, not the city as a dynamic system evolving over time.

Game engines open up another possibility: **the city as simulation**. Damjan Jovanovic of SCI-Arc explicitly articulated this shift when participating in the Getty PST exhibition project *Planet City Simulator*: "To imagine and simulate the scale and complexity of E.O. Wilson's 'Half-Earth' proposal, we need to move beyond maps and charts into the realm of video game simulation." His project constructed a simulation of a mega-city capable of housing 10 billion people, where players can intervene in different parameters of urban development and observe the system's long-term evolution.

This stance of "simulation as design method" carries profound implications. It acknowledges that the city is fundamentally a complex adaptive system-variables such as building density, energy consumption, traffic flow, and ecological footprint are coupled, exhibiting nonlinear dynamic behavior. Traditional drawings cannot capture this complexity, while engine-based simulation offers "testable design consequences." In this sense, the sci-fi city is not merely an aesthetic object but an "experimental platform" for extrapolating future urban forms.[8]

4.2. Procedural Aesthetics and Cybernetic Imagination

Procedural generation technology also embodies specific aesthetic and philosophical positions. The PCG framework prioritizes "rules" over "handcrafting"-the city's form is no longer entirely defined by the artist element by element but "emerges" from a set of parametric rules.

This resonates with the cybernetic tradition's interest in "self-organizing systems." Once parameters such as building density, height variation, and block layout are set, the generated city scene often exhibits outcomes the artist did not anticipate. Jovanovic calls this "complexity that exceeds the designer's intentions." This kind of "unexpectedness" is precisely the unique value of the procedural method-it simulates the unpredictability inherent in the growth of real cities.

But this does not mean the artist's role is diminished. On the contrary, defining the "generation rules" is itself a higher-order design act. The artist shifts from "placing each building" to "designing the grammar of urban growth"-a qualitative leap from "craftsmanship" to "meta-design." Post-generation interventions, such as "removing large buildings from streets" or "controlling changes in building density," reflect the dialectical relationship between algorithmic generation and manual curation.

4.3. The "Interactive Ontology" of the World

Finally, the sci-fi city constructed by Unreal Engine possesses a feature that traditional models lack: **interactivity**. In traditional architectural representation, the viewer's position is passive-viewing rendered images or animations along a predetermined path. In an engine-constructed environment, the viewer becomes a "player," able to explore freely, interact with the environment, and even change the state of the scene. [9]

The development practice of *Different Dimension* demonstrates how this feature translates into concrete game mechanics: players can switch local gravity direction within specific areas to achieve "wall-running" movement, while the Chaos physics engine ensures that all interactions have realistic collision feedback. This means the city is not just a "backdrop" but an active participant in "gameplay"-its physical rules, spatial structure, and lighting conditions collectively shape the player's experience.

This "interactive ontology" redefines the mode of existence of the virtual city. It is not a static representation, but a dynamic "world"-a field of meaning waiting to be explored, manipulated, and inhabited. In this sense, the engine-constructed sci-fi city is closer to Heidegger's concept of "world" (as a meaningful whole in which Dasein dwells) than to a mere spatial container.

5. Conclusion

This paper systematically examined the application of Unreal Engine in the construction of futuristic urban sci-fi scenes, analyzing across four levels: technical mechanisms, workflow transformation, narrative innovation, and ontological implications. The study finds:

First, through the synergy of its three core technologies-Nanite, Lumen, and PCG-Unreal Engine effectively resolves the long-standing "scale-detail-efficiency" impossible triangle in sci-fi city construction. This is not merely an improvement in technical specifications; it signifies a paradigm shift in production-from "manual carving" to "rule-based generation," and from "offline waiting" to "real-time feedback."

Second, virtual production technology transforms the sci-fi city from a "viewed landscape" into an "experienceable environment." LED walls and real-time camera tracking generate a new sense of "presence," while the engine's liberation of cinematic language demands that creators reconsider the relationship between the "virtual" and the "physical."

Third, the engine not only serves as a tool intermediary but also participates as a "technical subject" in the production of meaning within the scene. The cybernetic imagination embedded in procedural generation, the ontological commitment of simulation as a design method, and the "world" attribute brought by interactivity collectively require us to reconceptualize the ontological status of the virtual city-it is no longer a "representation" of reality but a new form of "reality."

Of course, this study has limitations: due to space constraints, it could not deeply explore optimization strategies for Unreal Engine on mobile and web platforms, nor fully address the ethical issues arising from engine applications (such as the potential impact of highly realistic virtual environments on user perception). Furthermore, with the further integration of AI-generated content and real-time rendering, the methods for constructing futuristic cities are bound to undergo a new wave of transformation-leaving ample space for subsequent research to explore.

References

[1] Iordanidis, C., & Georgiadis, C. K. (2025). Efficient Visualization of 3D Urban Environments in the Metaverse by Integrating GIS and Unreal Engine. *2025 8th International Conference on Information and Computer Technologies (ICICT)*, 327-332.

[2] Epic Games. (2024). Cassini Sample Project. Unreal Engine Official Documentation.

[3] He, L. (2025). Crafting Halo Infinite-Inspired Futuristic Lab With Substance 3D & UE5. 80 Level.

[4] Sisodiya, I. (2022). How to Create a Realistic Cyberpunk Metropolis in UE. Weiyuansu.

[5] Territory Studio. (2021). Into The Volume. Territory Studio Official Website.

[6] Huya Naiyun Accelerator. (2026). *Different Dimension* Development Engine Revealed: Next-Gen Cyberpunk Otherworld Built on Unreal Engine 5.

[7] Jovanovic, D. (2021). Damjan Jovanovic on Views of Planet City. SCI-Arc.

[8] AboutCG. (n.d.). UE5 PCG Sci-Fi City Large Scene Rapid Production Workflow Tutorial.

[9] AboutCG. (n.d.). Unreal Engine 5 Sci-Fi Hard Surface Valkyrie Full Workflow.