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From Hand-drawing to AI-Integrated Design: High-tech Architecture and Urban Design in the Wetware Era

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Abstract: As modern cities are primarily oriented toward economic growth rather than improving quality of life, the lack of humanistic care has become an important issue. The author explores the evolution of architectural and urban design workflows from traditional hand-drawing to AI-integrated design, reflecting on the shortcomings and improvement paths of high-tech architecture and urban design in terms of humanistic care, in conjunction with the Wetware theory. The hardware and software eras, centered on efficiency, led to emotional isolation and the lack of humanistic qualities in urban spaces. However, the Wetware era, through AI-integrated design and guided by "humanistic increment," transforms technological tools into creative partners, integrating emotional and ecological metaphors, and reconstructing the "technology-life-humanism" symbiosis. Finally, this paper reviews the ethical issues and technological limitations of AI workflows and offers prospects for future developments. Technological progress in design has emphasized efficiency, leading to emotional detachment and a lack of humanism in cities. The Wetware era seeks to rebuild the "technology-life-humanism" connection, using AI to express emotion and individuality. Yet, AI is mainly used in early stages, and challenges in technical compliance, ethics, and the role of designers remain.

Keywords: Wetware city, High-tech architecture, AI-integrated design, humanistic care, urban design

1. Research background

1.1. Modern cities

Modern cities are primarily oriented toward economic growth, with cities acting as the result of production arrangements and tools for manufacturing goods rather than means for improving quality of life. This has led to the development of modern cities being centered around objects, rather than people, and lacking humanistic concern. Lewis Mumford, in *The City in History: Its Origins, Its Transformations, and Its Prospects*, pointed out that the disorderly expansion of modern cities destroys ecological balance and is unsustainable, proposing the idea of organic planning and humanistic cities [1].

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1.2. Humanistic cities

In contrast to modern cities that prioritize economic growth, humanistic cities advocate for cities as organic entities, focusing on human daily experiences and community diversity. Departing from excess and involution, we encounter the meaning of life through humanistic sentiment, achieving a sense of abundance beyond our basic needs and even our dreams. Jan Gehl, in *Life Between Building: using public space*, emphasizes that urban public space design should center around human activities and implement more humane planning principles [2].

1.3. Wetware perspective

The concept of "wetware" was introduced by Rudy Rucker in 1988. Initially limited to the field of bio-art, it was later developed by Dennis Bray and became a term in new economic growth theory [3]. New economic growth theory divides knowledge into two categories: "software" and "wetware." "Software" refers to thoughts and codified knowledge stored outside the human brain, such as books, disks, and videotapes; "wetware" refers to tacit knowledge stored within the human brain and inseparable from its possessor, including abilities, skills, and beliefs. In a broader sense, pre-modern organizations were organized in hardware ways, modern organizations in software ways, and postmodern organizations in wetware ways.

In the context of urbanization, the hardware era of urbanization focuses on the material increment of cities, which can be seen in the case of Pruitt Lgoe Residential Area (Figure 1). The software era focuses on the intelligent increment of cities, which can be seen in the case of City Information Model (CIM) System (Figure 2). The wetware era focuses on the humanistic increment of cities, which can be seen in the example of Changsha Super Wenheyou (Figure 3), having vivid scenes that can trigger shared memories among people.

Figure 1: Hardware city (Pruitt Lgoe Residential Area) [4] Figure 2: Software city (CIM System) [5]

Figure 3: Wetware city (Changsha Super Wenheyou)

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2. Literature review and significance

2.1. Domestic and international research review

There has been some critical research on urbanization, modern cities, and modernist architecture both domestically and internationally. Gao Fan, in *Political Economy in the Evolution of China's Urban–Rural Economic Relations*, criticizes the current pursuit of disordered expansion, standardized spatial planning, and the short-term industrial production model [6]. Ebrahim Abbas Abdullah Abbas Amer, in *Urbanization, Growth, and Carbon Footprints*, offers a dialectical reflection on the achievements of urbanization and the challenges it faces [7].

Regarding Wetware theory, current research is primarily from abroad and often limited to fields such as computer science and bio-art, such as Charissa N. Terranova's *Bioart and Bildung—Wetware: Art, Agency, Animation, an Exhibition as Case Study*, with limited research in other fields, especially those related to urban planning and architecture [8].

2.2. Research significance and innovations

The significance of this study lies in exploring how architectural and urban design workflows in the context of the rapidly developing Wetware City, with tools like AI, can realize humanistic care and make technology truly serve humanity.

In contrast to previous research, this study approaches from the integrated scale of architecture and urban planning, breaking the disciplinary boundaries between architecture and urban-rural planning. This study explores the history of architecture and urban development, reflecting on the evolution of workflows from hand-drawing, physical models, and Computer-Aided Design (CAD), to AI-integrated design, focusing on humanistic care and its reflections. Additionally, this study innovatively applies wetware theory, previously limited to other fields, to analyze and evaluate architectural and urban design.

3. Evolution of architectural and urban design workflows

3.1. Hardware era: hand-drawing, physical models

Hand-drawn drawings and physical models have been the primary methods for architects and urban planners to communicate their visions and plans, dating back to ancient Egypt [9]. As shown in Figure 4, before the advent of CAD, designers had to use drawing boards, pencils of various grades, T-squares, and other tools to complete project drawings. One of the major drawbacks of this hand-drawing and physical model workflow is the lack of margin for error, where any change requires the entire project drawing to be redone. Typical examples of high-tech architecture during this period include Paxton's Crystal Palace , while urban design examples include Le Corbusier's " La Ville radieuse."

In the Crystal Palace, symbolizing "industrial utopia," the iron and glass structure represented industrial rationality [10]. However, the design primarily focused on structural innovation and visual impact, neglecting user needs, thus reducing architecture to a technical showcase rather than a place serving people [11].

In Le Corbusier's "La Ville radieuse," the functional zoning and high-rise buildings prioritized efficiency but destroyed the historical fabric and public spaces of Paris, ignoring the dynamic characteristics of cities as organic entities, resulting in the breakdown of community bonds [12].

The technological advancements of the hardware era prioritized material increments, focusing on scale expansion and efficiency improvement while ignoring the complexity and contradictions of architecture and urban design, leading to uniform cities and emotional isolation.

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Figure 4: Hardware era and its examples [9-12]

3.2. Software era: Computer-Aided Design (CAD)

Computer-Aided Design (CAD) radically transformed traditional workflows by offering significant advantages in precision and efficiency [9]. As shown in Figure 5, CAD software allowed for the rapid iteration of drawings and 3D models and platforms such as Revit enabled global parameter integration and multi-disciplinary collaboration, while parametric software like Grasshopper utilized algorithms to generate forms and optimize designs through performance simulations [13,14]. Notable examples of high-tech architecture in this period include UN Studio's Mercedes-Benz Museum in Stuttgart, and urban design examples include Zaha Hadid Architects' Istanbul Urban Design.

The Stuttgart Mercedes-Benz Museum's twisting path gradually ascends, combining movement with human perception to create an immersive exhibition experience. However, some critics argue that its spiral structure overly prioritizes visual spectacle and brand marketing [15].

The Istanbul Kartal Masterplan, generated using a wool algorithm for road networks, simplifies pedestrian flow into data nodes, ignoring walking needs and human perception [16]. The lack of public participation has also led to controversies surrounding the project.

Although CAD helped designers quickly iterate solutions and achieve optimal design theoretical outcomes, it reduced humans to data nodes, neglecting individual differences. Parametric inputs and weight distribution often reflected the designer's subjective judgments, making it difficult to achieve humanistic care. The true value of smart cities and parametric design lies not in technological display but in using tools to solve societal problems and realize humanism.

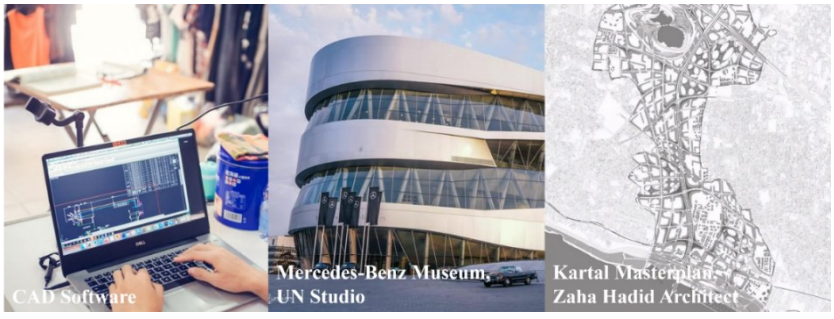

Figure 5: Software era and its examples [9,15-16]

3.3. Wetware era: AI-integrated design

The advent of AI-integrated design has had a profound impact on architectural and urban design workflows. As shown in Figure 6, AI can evaluate vast amounts of data and use algorithms and machine learning to generate design solutions that meet specific requirements [9]. Tools like Midjourney, which generate images from text prompts, allow designers to rapidly find inspiration by

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creating personalized, iterative design solutions [17]. As for the high-tech architecture of today, notable examples include Manas Bhatia's "Symbiosis" apartment and the Sidewalk Labs smart city experiment in Toronto's waterfront area.

Manas Bhatia, using Midjourney, envisioned a future of human-nature symbiosis in a "utopian" form. The buildings are not machines made of steel or concrete but are alive, with the ability to grow and breathe. Midjourney assisted in concept generation and place-making during the design process [18].

Toronto's Sidewalk Labs added a digital layer that integrated sensor networks, detailed community maps, simulation software, and a platform for citizens to log and manage their public and private data. Pedestrians could upload their moods and statuses to the cloud, where AI processed the data to optimize the pedestrian experience [19].

Figure 6: Wetware era and its examples [9,18-19]

4. How AI achieves humanistic care

4.1. From digital craftsman to creative partner

In architectural and urban design, traditional CAD and BIM have long been limited to mechanical work, focused on parameter iteration and material flow simulation, with the core logic centered on efficiency optimization and spatial compliance, making them technical executors of the designer's intent rather than thinking partners.

However, with the advent of the Wetware City era and the rapid development of AI, AI-integrated design goes beyond simulating biological systems. It can use complex systems modeling and multi-modal data fusion to generate creative solutions that combine technical rationality with humanistic perception. As shown in Figure 7, by integrating emotional computing and spatial experience data, AI tools such as Midjourney can simulate the metaphorical thinking of designers and propose space solutions with cultural narratives [20].

This creative generation transcends tool rationality, with outputs not only involving geometric shapes or parameter combinations but also incorporating perceivable spatial emotions and ecological metaphors. The leap from mechanical calculation to organic thinking marks the transformation of design tools from digital craftsmen to creative partners—designers and AI work together to build not only physical spaces but also living systems that carry humanistic spirit and ecological wisdom.

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Figure 7: Midjourney as creative partner capable of understanding emotion and atmosphere

4.2. Ethical reflections on AI in architecture and urban design

According to a report by RIBA (Royal Institute of British Architects), by 2024, 41% of designers have already started using AI [21]. AI-integrated design is mainly used in the earlier stages of projects, with software like Midjourney showing exceptional advantages in rapid concept generation. However, due to issues such as technical drawing compliance, AI-integrated design's use in later stages of projects remains limited.

Ethical concerns about AI in architectural and urban design primarily revolve around the role of the designer and issues like copyright, data leakage, and privacy in AI workflows. To achieve the humanistic increment of the Wetware City era, designers should remain central to the workflow. As AI tools do not inherently understand humanistic care, they can only serve as creative partners to help designers realize humanistic care. For instance, the architecture firm MVDRV has developed its own Lora model library to ensure the copyright of AI-generated images and prevent the misuse of source data [22]. For Toronto's Sidewalks Labs, the controversial issue is the privacy of data collection, showing that to make technology truly serve people, many ethical challenges still need to be addressed [23].

5. Conclusion

From hand-drawing to AI integration, technological progress has prioritized efficiency, yet over-reliance on tools eroded humanism in urban spaces. The Wetware era redefines this by merging "technology-life-humanism" through humanistic increment—using AI to embed emotion, culture, and ecology into design. While past approaches reduced people to data, AI now acts as a creative partner, translating prompts into culturally resonant solutions. For instance, projects like Sidewalk Labs' Toronto waterfront experiment demonstrate how sensor networks and community input can optimize public spaces, yet also reveal tensions between data utility and privacy.

However, AI's role remains limited to early stages, constrained by technical compliance (e.g., translating conceptual AI outputs into technical drawings) and ethical risks like biased algorithms or opaque data ownership. Future efforts require interdisciplinary collaboration—integrating ethicists to establish accountability frameworks and engineers to bridge AI's conceptual-to-practical gap. Designers must evolve as curators, guiding AI to balance technical precision with socio-cultural sensitivity. For instance, training AI on localized ethnographic data could enhance its ability to interpret community narratives, as seen in MVRDV's use of proprietary AI models to preserve creative ownership.

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Ultimately, AI should amplify—not replace—human creativity. The Wetware era's vision demands cities as living ecosystems where technology and humanity coexist, fostering shared memories and ecological harmony. Challenges persist—such as reconciling AI's energy demands with sustainability goals—but they illuminate the path toward truly humanistic, high-tech urbanism. By reimagining workflows as collaborative dialogues between human intuition and machine intelligence, cities can transcend efficiency to become spaces of empathy, resilience, and collective belonging.

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