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Intelligent Landscape Architecture as an Approach to Addressing Critical Issues

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ABSTRACT

It is a valuable tradition of landscape architecture to focus on the critical challenges to the humanity and to provide spatial solutions. Facing the major issues of global governance, such as climate change, resource scarcity and environmental constraints, abrupt disasters, and even the emergence of disruptive technologies, an "intelligent transformation" of landscape architecture is a compelling way to address them. Recently, driven by the great progress of new technologies including ubiquitous sensing, artificial intelligence, and virtual reality, the intelligent transformation not only helps landscape architecture better respond to the critical issues in the entire process of situational awareness, problem analysis, scheme making, outcome representation, effectiveness evaluation, and governance and optimization, but also provides new opportunities for the discipline's own transformation in terms of research objects, methodologies, and key skills.

KEYWORDS

Landscape Architecture; Critical Issues; Disruptive Technologies; Disciplinary Transformation; Intelligent Transformation; Global Governance

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Similar to its sister disciplines of architecture[1] and urban planning[2], landscape architecture in its modern form originated as a strategy to address critical challenges facing humanity[3]. Drastic urbanization since the industrial revolution has imposed humanity with a new Zeitgeist, and simultaneously brought new challenges, such as human's increasing anxiety of separating from nature during the process of urbanization[4][5], social disorders in the process of cultural transformation[6][7], as well as environmental pollution and ecological crises[8][9], all of which have become major concerns in the development of the discipline and practice of landscape architecture. Until today, such social commitments continue to be a valuable asset to the field.

The humanity in this era, featuring ubiquitous dwelling in high-density urban environments, continues to face critical challenges of the time. These challenges include climate change, resource scarcity and environmental constraints, and abrupt disasters, which are among the main topics of global governance today[10] and also worthy of the attention of landscape architects. In addition, the landscape architecture discipline itself, along with the society in general, is facing significant impacts by the emergence of disruptive technologies such as artificial intelligence (AI). How to respond to these challenges by means of landscape planning and design and to provide cross-scale spatial solutions for higher quality urban lifestyles constitute a crucial topic urgently to be responded to by the discipline and also the profession.

In this regard, the ongoing "intelligent transformation," driven by the great progress of new technologies such as ubiquitous sensing, AI, and virtual reality in recent years provides new opportunities for landscape architecture to better respond to the above challenges along its entire professional chain: situational awareness, problem analysis, scheme making, outcome representation, effectiveness evaluation, and governance and optimization. Indeed, it is right about time to explore how these new ideas and methods can be applied in the efforts in this field to respond to major real-world challenges such that a socio-technical fit is reached.

A precondition for solving a problem is situational awareness, adequately and accurately. Thanks to advances in data acquisition channels such as remote sensing, infrastructural sensing, and Social Sensing[11], new situational awareness tools, with their ubiquity, usability, and cost-effective advantages, not only provide new choices for landscape architects' toolbox, but also inspire new perspectives. New design paradigms that emphasize the importance of data, with various prefixes such as "data-informed"[12], "data-driven"[13], and "data-augmented"[14], demonstrate the enormous potential of landscape architecture based on larger-sized and more adequate, integrated, and accurate data.

Data does not usually speak for itself, and astute problem analysis is a sure way to realize the above-mentioned potential. Design analysis used to have been criticized for being actually irrelevant from the scheme it is supposed to support. To some extent, this is due to the limitations of conventional data analysis tools themselves. Admittedly, landscape architecture, as a branch of geography in a broad sense, had also been heavily influenced by the "quantitative revolution," and the "requiem for large-scale models"[15] has also inevitably collected its toll on the discipline's confidence on the meaning of data analytics. Nevertheless, with the advances in complex systems science, statistics, and data science in the past few decades, complexity[16] and credibility[17] revolutions have emerged in data analytic methodologies. New data analytic tools, such as causal inference, complex network analysis, and machine learning and deep learning, have transcended the mechanistic, deterministic world picture of the early quantitative revolution ages, and their efficacy has been tangibly demonstrated in a variety of fields. In landscape architecture, algorithm-driven problem analysis has been hence becoming feasible, allowing designers to understand, explain, and interpret the scientific aspects of design in a more rigorous and robust way, thus truly bridging the gap between observation and analysis with planning and design scheme generation.

In the stage of planning and design scheme formulation that has traditionally been regarded as the core skill of the designer, the emergent generative AI technologies, represented by applications such as ChatGPT (Dalle-E) and Midjourney empowered by the revolutionary algorithms of Attention[18] and Diffusion[19], have not just proven powerful tools for designers, but even appeared to pose a potential threat to the designer profession itself. Today's state-of-the-art AI-generated content (AIGC) programs have long been able to easily pass various forms of Turing tests, even demonstrating their capability to outperform human designers in certain built-environment planning and design tasks[20]. However, the generative AI technology in its current form has innate limitations, and an objective assessment of its effectiveness and capability boundaries when applied in landscape architecture is crucial for both the discipline and the profession. As such, ways forward can be directed and offer advices on continued knowledge and skill learning for practitioners. Meanwhile, in terms of the representation of design schemes, with the urban science pioneers' advocacy of "digital twins"[21], new tools for representing designs in a more immersive and interactive way with the real world are also rapidly evolving. Apparently, assessing the applicability and capability boundaries of these tools is an equally important task.

Finally, landscape architecture is, after all, about people. This means that human beings ourselves should be taken into account as an explicit factor in the full realization of design effects, as well as in evaluating such effectiveness. This has inspired various approaches to social mobilization around design, as well as evidence-based design evaluation paradigms[22]. For the former, conventional means of public engagement is still in effect, while new approaches to audience education and social mobilization, such as participatory interactions and gaming[23], are also thriving. For the latter, in parallel with advances in environmental cognition and behavioral sciences, VR/XR technologies have been introduced to establish immersive virtual environment exposures, and wearable biosensors such as eye-tracking, electroencephalography (EEG), electrocardiography (ECG), electromyography (EMG), and functional near-infrared imaging (fMRI), among other cognitive technologies, have been applied to observe humanistic physiological, psychological, and behavioral feedbacks. Thus, by directly establishing the association between design schemes and user preferences to formulate and improve landscape architecture solutions, one seeks a human-centered understanding of the design, which is also a notable future direction of the field.

This edition of Landscape Architecture Frontiers hosts a forum for in-depth discussion of the above topics. Responding to the critical challenges of climate change and decarbonization efforts, natural disaster prevention and resilience-building, effective use of compact urban space, and social and professional impacts of disruptive technologies, this edition applies various intelligent approaches including ubiquitous sensing, AI, and digital twining techniques to explore the scientific issues involved, and try to offer solutions from the landscape architecture perspective. We hope to trigger a broader discussion to advance the vision of intelligent landscape architecture as an approach to addressing the critical issues of the world.

Competing interests | The author declares that he has no competing interests.

REFERENCES

[1] Corbusier, L. (1973). *The Athens Charter. Grossman Publishers*.

[2] Howard, E. (1902). *Garden City of To-morrow*. Swan Sonnenschein & Co., Ltd.

[3] Yu, K., & Li, D. (2004). An introduction to Landscape Architecture: The profession and education. *Chinese Landscape Architecture*, (5), 10–11.

[4] Thoreau, H. D. (2001). *Walden Pond*. Commonwealth Editions.

[5] Tuan, Y.-F. (1974). *Topophilia: A Study of Environmental Perception, Attitudes, and Values*. Prentice-Hall.

[6] Tönnies, F. & Harris, J. (2001). *Tönnies: Community and Civil Society*. Cambridge University Press.

[7] Jacobs, J. (1961). *The Death and Life of Great American Cities*. Vintage Books.

[8] Carson, R. (2002). *Silent Spring*. Houghton Mifflin Harcourt.

[9] Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (Eds.). (1972). *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. Universe Books.

[10] Hewson, M., & Sinclair, T. J. (Eds.). (1999). *Approaches to Global Governance Theory*. State University of New York Press.

[11] Liu, Y., Liu, X., Gao, S., Gong, L., Kang, C., Zhi, Y., Chi, G., & Shi, L. (2015). Social sensing: A new approach to understanding our socioeconomic environments. *Annals of the Association of American Geographers*, 105(3), 512–530.

[12] Tang, Z., Ye, Y., Jiang, Z., Fu, C., Huang, R., & Yao, D. (2020). A data-informed analytical approach to human-scale greenway planning: Integrating multi-sourced urban data with machine learning algorithms. *Urban Forestry & Urban Greening*, (56), 126871.

[13] Kitchin, R. (2015, August 10). Data-driven, networked urbanism. *Social Science Research Network*.

[14] Long, Y., & Shen, Y. (2015). Data augmented design: Urban planning and design in the new data environment. *Shanghai Urban Planning Review*, (2), 81–87.

[15] Lee, D. B. (1973). Requiem for large-scale models. *Journal of the American Institute of Planners*, (39), 163–178.

[16] Batty, M. (2005). *Cities and Complexity: Understanding Cities With Cellular Automata, Agent-based Models, and Fractals*. MIT Press.

[17] Angrist, J. D., & Pischke, J. S. (2010). The credibility revolution in empirical economics: How better research design is taking the con out of econometrics. *Journal of Economic Perspectives*, 24(2), 3–30.

[18] Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, L., & Polosukhin, I. (Eds.). (2017). Attention is All You Need. *Advances in Neural Information Processing Systems 30*. NeurIPS.

[19] Ho, J., Jain, A., & Abbeel, P. (2020). Denoising diffusion probabilistic models. *Advances in Neural Information Processing Systems 33*. NeurIPS.

[20] Zheng, Y., Lin, Y., Zhao, L., Wu, T., Jin, D., & Li, Y. (2023). Spatial planning of urban communities via deep reinforcement learning. *Nature Computational Science*, 3(9), 748–762.

[21] Batty, M. (2018). Digital twins. *Environment and Planning B: Urban Analytics and City Science*, 45(5), 817–820.

[22] Ye, Y., & Qiang, D. (Eds.). (2022). Attempts on computational urban design: Little Lujiazui public space quality improvement plan in Shanghai. *New Architecture*, (4), 94–99.

[23] Abt, C. C. (1987). *Serious Games*. University Press of America.

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智慧化景观设计作为应对关键挑战的途径

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摘要

关切人类社会所面临的关键挑战并尝试提供空间维度的解决方案，是景观设计学的宝贵传统。面向当今全球治理中气候变化、资源环境紧约束、突发性灾害、乃至颠覆性技术的涌现等重大议题，景观设计学的“智慧化变革”是一条引人注目的应对途径。在近年来泛在感知、人工智能、虚拟现实等新技术长足进步的推动下，智慧化变革不仅有助于景观设计在态势感知、问题分析、方案决策、成果表达、效果评估，以及治理优化的全链条中更好地回应各项关键挑战，也为学科本身在研究对象、方法论及关键技能等方面的转型发展提供了新的机遇。

关键词

景观设计学；关键挑战；颠覆性技术；学科转型；智慧化变革；全球治理

编辑 田乐

与其姐妹学科建筑学[1]和城市规划[2]类似，现代意义上的景观设计学是作为应对人类社会所面临关键挑战的对策而发源的[3]。工业革命以来的城市化浪潮为人类贯注了新的时代精神，也带来了种种新的挑战，举凡城市化进程中人与自然的分离焦虑[4][5]、文化转型中的社会失序[6][7]、环境污染和生态危机[8][9]等，皆成为景观学科和实践发展中的主要关切。这一入世的传统延续至今，是值得继承的宝贵财富。

当前，普遍生存于高密度城市环境中的人类依然面临着这个时代的关键挑战。这些挑战包括气候变化、资源环境紧约束、突发性灾害等，它们是当今全球治理的主要议题[10]，也是值得景观设计师关注的课题。此外，景观学科自身也与整个社会一道面临着人工智能（AI）等颠覆性技术所带来的重大冲击。如何以景观规划设计手段回应这些挑战、为更高质量的城市生活方式提供跨尺度的空间解决方案，是亟待学科和行业回应的重要课题。

对此，近年来泛在感知、AI、虚拟现实等新技术的长足进步所推动的“智慧化变革”，为景观设计在其态势感知、问题分析、方案决策、成果表达、效果评估，以及治理优化等全链条中更好地回应上述挑战提供了新的机遇。探索这些新思想、新方法在景观设计回应重大现实问题的努力中的应用方式，以达成技术和社会层面的契合状态，正当其时。

解决问题的必要前提是充分、准确的态势感知。得益于遥感、传感和社会感知[11]等数据采集渠道的进步，新的态势感知手段以其泛在性、可用性和成本优势，不但为景观设计师的工具箱提供了新的选择，更启发了全新的视角。强调数据重要性的新设计范式，冠以诸如“数据支持”[12]、“数据驱动”[13]、“数据增强”[14]等前缀各领风骚，充分展示了建立在更多、更全、更准确数据基础上景观设计的巨大潜力。

数据通常不会自己说话，精到的问题分析是发挥数据潜力的必由之路。以往的设计分析常被批判为与方案脱节，这在一定程度上也是传统数据分析工具自身的局限造成的。作为广义地学的一个分支，景观学科也深受地理学“计量革命”的影响，而“大型模型的安魂曲”[15]也不可避免地负面影响了本学科对数据应用的信心。然而，随着20世纪八九十年代至21世纪以来复杂系统科学、统计学，以及数据科学等学科的进步，数据分析方法论也迎来了复杂性[16]、可信性革命[17]。因果推断、复杂网络分析、机器学习和深度学习等新数据分析工具超越了早期“计量革命”式的机械论、决定论世界图景，其功效已在多个学科领域得到切实验证。在景观领域，算法驱动的问题分析已经成为可行，允许设计师以更加严谨、稳健的方式理解、解释和阐释设计中的科学问题，从而真正搭建起从观察分析到方案决策的桥梁。

在设计师传统上的核心技艺——方案形成环节，随着Attention[18]和Diffusion[19]等革命性算法机制的普及应用，以ChatGPT（Dalle-E）、Midjourney等应用为代表的生成式AI技术的发展已经不仅使之成为设计师的得力工具，甚至似乎已对设计师这一职业本身构成了潜在威胁。当今的AI生成内容所制作的设计方案早已能够轻松通过各种形式的图灵测试，在部分建成环境规划设计任务中甚至展现出了超越人类设计师的方案设计能力[20]。然而，当前形态的生成式AI技术毕竟有其局限，冷静地评估其应用于景观设计的效果及其能力边界，以此展望其应用前景，并对从业人员提出适当的持续学习和转型建议，是当务之急的工作，有助于整个学科和行业的高质量内涵式发展。与此同时，在设计成果的表达方面，响应城市科学带头人关于“数字孪生”[21]的号召，更加沉浸式且联动于真实世界的成果表达工具也在快速发展。评估这些工具的适用性和能力边界也同等重要。

最后，景观设计毕竟是关于人的。这意味着在设计效果的充分发挥及其有效性评估方面，“人”应被作为一个显性因素纳入考虑。这启发了各种围绕于设计的社会动员途径，以及具身循证的设计评估范式[22]。对于前者，传统的公众参与手段仍在发挥效用，而参与式互动、游戏等新的受众教育和社会动员途径也在蓬勃发展[23]。对于后者，与环境认知和行为科学的进步同步，人们开始引入虚拟现实、混合现实等技术建立沉浸式虚拟环境暴露，并应用可穿戴生物传感器，如眼动仪、脑电图、心电图、肌电图、功能性近红外成像（fMRI）和认知技术等方法观测人本化的生理、心理和行为反馈，通过直接建立设计方案与使用者偏好的关联，形成和改善景观设计方案，从而寻求以人为中心的理解，也是方兴未艾的学科发展方向。

本期《景观设计学》为上述议题的深入探讨提供了一个论坛：针对气候变化与双碳行动、自然灾害预防与韧性、紧凑城市空间有效利用、颠覆性技术的社会和行业影响等关键挑战，应用泛在感知、人工智能、数字孪生等智能工具探讨了其中的科学问题，并尝试给出景观维度的解决方案。希望以此激发更加广泛的讨论，以推动将智慧化景观设计作为解决关键挑战途径的愿景。