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CULTIVATING A CULTURE OF COMPUTATIONAL DESIGN THINKING

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Accelerating developments to confront growing global challenges, and the simultaneous influence of automated digital processes, are causing a fundamental upheaval in the field of landscape architecture. The current challenge for the profession is to take the lead in international discourse on urban development and integrate heterogeneous fields of action that are both "physical and philosophical, scientific and poetic, and capable of integrating past, present, and future potentials into a single meaningful whole."[1] The critical understanding that it is vital for the field of landscape architecture to take a leadership role in defining environmental design principles and modes of design thinking, in a time marked by an increased inundation of automated, "black box" design processes, is underscored by a need to revisit the principles of early computational design thinking pioneers.[2]

The history of computation goes far beyond the development of computing technology and relates to the "interaction between internal rules and (morphogenetic) pressure that, themselves, originate in other adjacent forms (ecology)."[3] This complex theory and framework of relationships is based upon concepts from a wide variety of disciplines, including mathematics, computer science, cybernetics, biology, and philosophy. The rapid development of technology and broad accessibility of digital tools and computational methods had its first significant influence on architectural and landscape architecture in the 1960s. This first manifestation was driven by a deep theoretical discourse between the fields of cybernetics and architecture, which led to initial attempts to integrate artificial intelligence (AI) into design methodology, a movement led by Negroponte and subsequently developed at the Massachusetts Institute of Technology.[4] It is relevant to mention here that discussion of the notion of AI leads back to classical Greek philosophy and the project to "describe human thinking as a symbolic system."[5] The newly gained consciousness of global challenges during the 1960s, together with enthusiasm for revolutionary computational tools and methods, motivated pioneering attempts to integrate computational design for solving complex urban questions and strongly influenced our current interaction with data and the information it encapsulates.[6]

A second wave of change can be observed in the 1990s. Initially labeled "blobitecture," this movement was originally driven by aesthetic discourse and subsequently ushered in the era of parametric design.[7] At the beginning of the twentieth century, the widespread use of parametric software promoted the rise of parametric design protocols among many schools of architecture and design, classified by Schumacher as "Parametricism as a Style."[8] Over a period of almost fifteen years, digital design focused only on the integration of cutting-edge digital tools, without a deeper reflection into a future-oriented understanding of computational design thinking.

Today, in a time marked by rapid computational advancements such as machine-learning and human–robotic interaction, we again face the challenge of developing novel concepts in this new context of computational design thinking. After a long period of diverse tool-based experimentation, our field is asked to place the focus on fundamental questions in relation to the "What?" and "Why?" and no longer solely on the "How?" In 2011 Menges and Ahlquist had already concluded that "over many years of teaching computational design, we have realized that the main challenge does not lie in mastering computational design techniques, but rather in acculturating a mode of computational design thinking."[9] This critical reflection should enable us to embrace the importance of creatively and sensitively translating a diverse spectrum of processes into a formal thinking structure, allowing the area of design to extend to science and the larger area of systems thinking.

This discourse ultimately proposes that computational design thinking must be understood as an intellectual, open-ended process. Such an orientation allows the questioning and rethinking of established linear and isolated digital processes in order to integrate new potentials from the area of complex system theory through links to neighboring knowledge areas.[10] Through this change of paradigm, marked by a fusion of the virtual and the real, and the omnipresent influence of digital technology in our everyday life, design will ultimately meld entirely into computational design. This is not about the emergence of a new ideology, as discussed ten years ago; it is the logical next step in order for our profession to establish its future relevance, providing timely and future-oriented strategies for the grand challenges ahead.[11] The retracing of computational design over the past sixty years reveals a systematic dispute over design versus technology, tangible and embedded knowledge versus technological advancements, humans and the digital realm. We should steer away from these juxtapositions to lend the vector "technology, creativity, and impact" the freedom and scope it is due. Understanding the beauty of complex relationships, the flexibility of dynamic systems across scales rooted in a deep understanding of natural phenomena, leads to new and powerful constructs for computational design thinking, which are both interactive as well as responsive: computing with nature.

1 Christophe Girot, *The Course of Landscape Architecture: A History of Our Designs on the Natural World, from Prehistory to the Present* (London: Thames & Hudson, 2016), 313.

2 Stephen M. Ervin, "Turing Landscapes," in Bradley E. Cantrell and Adam Mekies, eds., *Codify: Parametric and Computational Design in Landscape Architecture* (London: Routledge, 2018), https://doi.org/10.4324/97813156477912018.

3 Achim Menges and Sean Ahlquist, *Computational Design Thinking* (Chichester: Wiley, 2011), 8.

4 John D. Kelleher and Brendan Tierney, *Data Science* (Cambridge, MA: MIT Press, 2018), https://doi.org/10.7551/mitpress/11140.001.0001.

5 Tanya Lewis, "A Brief History of Artificial Intelligence," *Live Science*, December 4, 2014, https://www.livescience.com/49007-history-of-artificial-intelligence.html (last updated December 9, 2021).

6 Richard Buckminster Fuller, *Operating Manual for Spaceship Earth* (Carbondale: Southern Illinois University Press, 1969; Donella H. Meadows et al., *Limits to Growth* (New York: New American Library, 1972); Nicholas Negroponte, *The Architecture Machine: Toward a More Human Environment* (Cambridge, MA: MIT Press, 1970).

7 Kostas Terzidis, "Algorithmic Form," in Achim Menges and Sean Ahlquist, eds., *Computational Design Thinking* (Chichester: Wiley, 2011), 94–110.

8 Patrik Schumacher, "Parametricism as a Style—Parametricist Manifesto," *Patrik Schumacher.com*, https://www.patrikschumacher.com/Texts/Parametricism%20as%20Style.htm (accessed January 31, 2023).

9 Achim Menges and Sean Ahlquist, eds., *Computational Design Thinking* (Chichester: Wiley, 2011), 8.

10 Pia Fricker, *The Real Virtual or the Real Real: Entering Mixed Reality* (Berlin: Wichmann, 2018), https://doi.org/10.14627/537642044.

11 Pia Fricker, "Computing with Nature: Digital Design Methodologies Across Scales," in Rosalea Monacella and Bridget Keane, eds., *Designing Landscape Architectural Education: Studio Ecologies for Unpredictable Futures* (London and New York: Routledge, 2022), 438.