BOOK REVIEW

UNDERSTANDING CITIES THROUGH NETWORK AND FLOWS

THE NEW SCIENCE OF CITIES

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Complexity theory has become a popular frame for conceptualizing and analyzing cities. The theory proposes that certain large systems are characterized by the nonlinear, dynamic interactions of their many constituent parts. These systems then behave in novel and unpredictable ways—ways that cannot be divined by examining the components of the system. Complexity theory problematizes traditional reductionist, linear methods of scientifically analyzing and predicting cities. It also opens up a new world of scholarship to researchers keen to formulate new kinds of sciences that take complexity into account (e.g., Wolfram 2002). These attempts usually follow Kuhn's (1962) theory of paradigm shifts: new evidence and modes of thinking undermine an established science, and a new science emerges to replace it.

In *The New Science of Cities* (2013), Michael Batty argues that we need a new kind of science to understand cities as complex systems of networks and flows between people, goods, resources, and institutions. Batty is a professor in The Bartlett at University College London (UCL) and was the director of its Centre for Advanced Spatial

Analysis. Perched at the vanguard of the quantitative approach to geography and planning for decades, he is arguably also the preeminent advocate for applying complexity theory to urban studies. His best-known previous works, *Fractal Cities* (Batty and Longley 1994) and *Cities and Complexity* (2005), argued for understanding cities through the tools and concepts of the complexity sciences, such as cellular automata, agent-based models, and fractals. Batty's latest book, *The New Science of Cities*, synthesizes his wide-ranging contributions to urban geography, modeling, and urban complexity studies. It also extends his body of work by situating it within a new theoretical framing that sounds similar to theories devised by Manuel Castells (e.g., 2009): flows and networks, rather than locations, are the key to understanding and designing cities.

The book is organized into three sections. The first begins with the relevant basics of complexity theory, urban economics, network science, and what Batty terms the "laws of scaling" (38). These laws consider how urban characteristics change in proportion to city size. Scholars from the natural sciences have recently delved into theories of city scaling by controversially extending mathematical models from physics into the urban domain (e.g., Bettencourt and West 2010; Bettencourt 2013). Batty's treatment is more nuanced and grounded in urban disciplinary literature, contextualizing his assertions in the theories of Jane Jacobs (1961; 1970) and Christopher Alexander (1965; 1977) and the empirics of urban economists such as Edward Glaeser (2011). The first section continues with a chapter explaining the traditional thinking on flows—particularly spatial interaction and gravity models—and concludes with a chapter that surveys network science.

The second section forms the heart of the book as it draws the foundational concepts from part one into a quantitative toolkit for studying cities. Here Batty develops his science of cities. He first delves deeper into methods of analyzing city scaling and hierarchy, the insights of which sometimes feel a bit nebulous, but many of his visualizations are compelling. Additional chapters cover analyses of network structure, measures of complex networks, and an exploration of urban morphology through the lens of his UCL colleague Bill Hillier's (Hillier et al. 1976) space syntax theory. The second section concludes with two chapters on the subjects for which Batty is perhaps best-known: fractals and urban simulation. Since the 1990s, Batty has argued that complex city systems produce a fractal urban form characterized by self-similarity and space-filling growth. This section offers a succinct overview of this topic before closing with a survey of urban simulation, particularly nonequilibrium models, dynamics, and processes of change.

In the third and final section, Batty turns his attention to the design of cities. Here he assumes a more normative stance in seeking to render technical and scientific the collaborative planning theories of scholars such as Friedmann (1987), Healy (2007), and Innes and Booher (1999; 2010). Batty applies linear algebra and Markovian methods to abstract networks to cast consensus building and decision making as essentially processes of sequential averaging. This is usually a humanistic field of study, but Batty's discussion of Markovian design machines and optimization comes across as technocratic and less grounded in reality. Its lack of empirics and observations of reality may raise questions about its nature as a science. The author somewhat acknowledges this issue, but this particular application of his analytical toolkit seems rooted in neoclassical theories of equilibrium and optimality. This feels odd given the book's grounding in complexity theory, which tends to reject these notions.

Despite being embedded in complexity theory and nonlinearity, *The New Science of Cities* at times falls back on linear and reductionist modes of analysis and optimization. Batty admits that his methods are primarily intended for exploration and learning rather than prediction, making them perhaps more appropriate for descriptive urban studies than normative urban planning. Others have likewise noted that city planning agencies, for practical reasons, rarely adopt large dynamical nonequilibrium models (Simmonds et al. 2013). Also, Batty's examples of applications to inner-city poverty and resource allocation problematically ignore power dynamics, politics,

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and irreconcilable differences—though these are surely phenomena that can emerge from complex urban systems—as he formulates his theory of collective action based on interpersonal exchange.

Fortunately, these quibbles do not outweigh the book's many strengths, as Batty offers a masterful synthesis of what urban modeling can draw from the complexity sciences. Today, we have a new understanding of urban complexity, networks, and flows. Batty forcefully argues that this implies that the old science of cities, namely the reductionist modernist program, must be swept away by quantitative scholars, not just their qualitative peers. His new science demonstrates an analytical approach to studying cities that takes advantage of recent advances in disaggregate behavioral modeling and simulation. Taken as a whole, Batty's approach to modeling and understanding cities rejects the traditional top-down command and control of cities as equilibrium systems. His preference for incremental change over comprehensive master-planning concurs with complexity's implications for uncertainty and unintended consequences. Further, the modesty of his writing is refreshing in a discipline that so often espouses grand theories and absolute claims to knowledge and prediction.

The book is well-written and handsomely packaged with many interesting visualizations. These figures are all printed in grayscale, which occasionally obscures their meaning, but the preface helpfully refers readers to full-color versions online. Intra-chapter organization could be improved for clarity, as the text is often quite dense and key points occasionally feel buried. Nevertheless, the author capably ties urban theory to the quantitative methods of the complexity sciences. Readers need only a basic understanding of linear algebra, matrix algebra, and graph theory to comprehend the most technical passages. Those already familiar with Batty's oeuvre (and scholarship by related researchers in journals such as *Environment and Planning B*) will enjoy this state-of-the-art synopsis of the field. For readers new to these topics, this book offers an entry point into complexity theories of cities, urban network analysis, and quantitative reformulations of collaborative planning and theories of flows. It should be a useful reference for years to come.

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