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BOOK REVIEW

The new science of cities, by Michael Batty, Cambridge, MA, The MIT Press, 2013, 496 pp., $45.00/£31.95 (hard cover), ISBN 978-0-262-01952-1

This is perhaps the most ambitious book written by Mike Batty so far, in which he aims to lay the foundation for what he calls the new science of cities. Ohio-based artist Amy Casey's artwork *Twist* (amycasepainting.com) is featured prominently on the hard cover of Batty's book. Casey's artwork, according to Batty, captures the essence of complex cities, which contains a mixture of memes and genes, tendons and neurons, machines and organisms, etc. As artist Paul Klee once observed that 'art does not reproduce what we see; rather, it makes us see.' Like Casey's artwork, which has artistically shown us how everything in the real world can be linked together in convoluted ways, Batty's new book has also enabled us to see patterns of urban development in refreshing ways.

After a brief preamble, the book is organized in three parts with a total of 14 chapters. The three chapters in Part I cover the foundations and prerequisites for the rest of the book. Chapter 1 is a synoptic overview of all the major concepts for the new science of cities, followed by a more detailed discussion on flows and networks in Chapters 2 and 3, which constitutes the foundation for his new science of cities. The six chapters in Part II are devoted to cover the positive (focusing on 'what is') dimension of the city science, and the five chapters in Part III focus on the normative (focusing on 'what should be') aspect of the new science. In Part II of the book, Batty applies the tools and methods introduced in Part I to examine six aspects of urban growth and development: (1) rank-size and growth clocks (Chapter 4); (2) hierarchies and systems of cities (Chapter 5); (3) space syntax (Chapter 6); (4) complex networks (Chapter 7); (5) fractal growth (Chapter 8); and (6) urban simulation (Chapter 9). The simulation models covered include simple stochastic models, bottom-up evolutionary models, and aggregate land-use transportation models. Part III of the book shifts gears from understanding cities to their design. The central concern of all these five chapters in Part III is how to resolve conflicts or reach consensuses between relevant stakeholders in the design and decision-making process for urban development. Although less technical than the chapters in Part II, the breadth and depth of the five chapters in Part III are equally impressive, ranging from hierarchical design (Chapter 10), Markovian design (Chapter 11) to theories of collective action (Chapter 12) and urban development as exchange and communication (Chapters 13 and 14). The book ends with a brief concluding chapter on the future of the science of cities, with intriguing musings on the prospects of integrating and synthesizing both the positive and normative science of cities.

With an active research career spanning over five decades, Batty has made extraordinary contributions to the development of urban modeling by the three books he published earlier (Batty 1976, 2005, Batty and Longley 1994). The current book is a continuation of his life-long quest to better understand cities and urban development through modeling, simulation, and visualization. As a common thread of Batty's urban modeling work, he relied predominantly upon quantitative methods and techniques to better understand the complex social phenomena as they manifest in our cities, but there has been a major shift in Batty's overall conceptualization on how cities work. Batty's earlier modeling work in the 1970s took a top-down approach inspired by social physics through concepts and models built around gravity, spatial interaction, and entropy maximization. In contrast, Batty's later work favored a bottom-up approach with theoretical inspirations from complexity science and network science using concepts of flows/networks, power laws, and emergence. With the goal of moving toward the establishment of the new science of cities, this book represents a grand synthesis of multiple concepts and tools drawn from complexity science, urban economics, regional science, transportation studies, and urban geography. According to Batty, to understand cities, we must view them not simply as places in space but as systems of networks and flows. Accordingly, to understand space and the cities, we must understand flows, and to understand flows, we must understand networks. Batty succeeded admirably in bringing together the vast interdisciplinary literature related to both the positive and normative aspects of urban modeling in one volume. His effort to reconcile the science of cities and the science of design through the evolutionary models discussed in Chapter 8 is truly groundbreaking. The learning capabilities, which underlie both complexity science and theories of collection action, are the key to link the real and the ideal, the normative and positive. Targeting primarily researchers taking a modeling approach to studying cities, this book will become an instant classic on the urban modeling. Unlike the quantitative modeling work in social sciences in the 1970s and the 1980s, which have often been dismissed by critics as generating more heat than light, Batty's new book has revealed some of the defining features and deep structure in our cities, which are often characterized by complexity and uncertainty.

Furthermore, I also believe that this book is a significant contribution to the foundations of GIScience. In his address to the Royal Society, Goodchild (2011) argued that 'if there is a single challenge of GIScience it is this: to find useful and efficient ways of capturing and representing the infinite complexity of the geographical domain in the limited space and binary alphabet of a digital computer (p. 12).' From a GIScience perspective, Batty apparently has developed new ways of capturing and representing the infinite complexity of cities from a flow/network perspective. As of today, representations of networks in GIS are still dominated by representations of road networks inherited from road transportation networks. Although our capabilities in analyzing networks using GIS have significantly improved in recent years, they are nonetheless still confined to transportation networks based upon the concepts and tools of network from a previous era. Batty's new book, through his synthesis of the applications of networks for urban studies, potentially offers GIScientists new models for representing, analyzing, and modeling the complexity of the world from a network-centric perspective. The growing interest in networks and network science also creates new demands for innovative visualization techniques to map flows of materials, energies, and information on various networks. Further integration of GIS with network science may potentially break new ground for innovative applications of GIS in solving many of the pressing problems facing the world today. Additionally, this is a timely book for the GIScience community due to the growing global interests in geodesign. Part III of Batty's new book is the most rigorous and formal treat of design according to the theory of collection action I have seen so far. I'd highly recommend this book to anybody who is interested in the theoretical foundations of GIScience and geodesign. I am convinced that Batty's book is not just a significant contributions to the science of cities, it will also go down in the history of the development of GIScience as a major milestone. GIScientists should have a lot to learn from this book as from any other mainstream GIScience books published lately.

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