

and later development, fringe belts are subjected to specific economic dynamics, an idea that he would then explore and substantiate in numerous empirical studies. In addition, Whitehand deepens our understanding of fringe belts by unveiling the role of various agents in their land-use change dynamics. More recently, he contributed to expanding the scope of the notion by applying it to new fields of inquiry, including in China.

Larkham (Chapter 4) discusses how Whitehand has contributed to clarifying the nature of agency and the role of agents of change in morphogenetic processes. Larkham defines *agency* as comprising 'the range of processes by which things happen in the urban landscape', including the decision-making process and its consequences for built forms (p. 70). He suggests that the notion of agency has been instrumental in Whitehand's historico-geographical theory of urban form, the framework of which relies on 'inductive and deductive chains of inference, relating particularly to innovation and construction activity, within the context of social and economic forces' (p. 73).

Karl Kropf (Chapter 5) pays a tribute to the quality of Whitehand's scientific contribution, while exploring how rigour is achieved in urban morphology by the use of an array of comparative techniques. Kropf highlights in particular how, in the absence of experimental control, painstaking comparative work conducted at different spatial resolutions is essential to reveal and contrast typical configurations, as a preliminary step to elaborating explanatory frameworks.

Ivor Samuels (Chapter 6) works on the relationship between academic research and practice in Whitehand's investigative work and writings. Again, regular readers of this journal have probably noticed the call made by Whitehand in several of his editorials for researchers to reach out to practitioners and vice versa. Whitehand has always been aware of the practical implications of his research. He believes, rightly, that morphologists could have a lot to contribute to city planning, urban design and heritage preservation. As further evidence of Whitehand's concern for this, it percolates several chapters of the book. In spite of the obvious benefits, collaboration remains difficult to foster, as Whitehand himself experienced first-hand when invited to participate in UNESCO meetings on heritage conservation.

This book offers an excellent introduction to the work and thinking of one of the most prominent urban morphologists. It does so in an honest way that does not hide some of the challenges

and difficulties faced by Whitehand in the course of an exceptionally productive career. He has been able to renew himself as a researcher and to remain relevant for more than 5 decades. This reader is certainly looking forward to his future contributions.

*Pierre Gauthier, Department of Geography, Planning and Environment, Concordia University, 1455 de Maisonneuve Boulevard West, Montréal, Québec, Canada. H3G 1M8. E-mail: pierre.gauthier@alcor.concordia.ca*

**Inventing future cities** by *Michael Batty*, MIT Press, Cambridge, MA, 2018, 282 pp. ISBN 9780262038959.

Michael Batty starts from the stance that when it comes to cities 'we now stand at a threshold with respect to what we are able to predict (or rather not predict)' (p. ix) and that the future of cities is something we can only invent. This initial hypothesis might come as a surprise to those familiar with Batty's previous works, from *Urban modelling: algorithms, calibrations, predictions* (Batty, 1976) to *The new science of cities* (Batty, 2013), which have offered a rich panoply of models, analyses and simulations representing the cutting edge of city science and prediction. The present work does not offer solutions, visions or recipes, but instead offers a reading of where we stand today in relation to cities: their size, form, function, relations and dynamics. It proposes approaches to investigate, theorize, envision, plan and design their future.

The first chapter lays out the hypothesis of unpredictability centred on an understanding of cities as complex systems, and what that entails. The city is a process involving many individual actions of many different actors in fast cycles, occasional large and slow planned interventions, and subject to external unpredictable events. Urban form, the product of this process that we see, is from this perspective a state in the city's evolution, not necessarily ever in equilibrium. Here Batty also introduces a collection of five laws or principles that are inherent in complex systems and cities: Zipf's law, Glaeser's paradox, von Thünen's standard model, Well's proposition, and Tobler's first law of geography. These laws are used in subsequent chapters to explore the nature of cities.

The book then continues with a sequence of six chapters offering an understanding of cities: their increase in size and population; the definition of their limits and hierarchies; their form and functions; their daily flows and rhythms; their transformation over time through sprawl, densification or regeneration; and the impact of technological waves that currently culminate in the smart city. This is offered in a masterful multi-layered narrative – fitting the complexity of the subject matter – that interweaves the physical and the digital, the static and the dynamic, and the past and the present, in a way that is capable of engaging readers from a broad spectrum of disciplines working on the city, and providing a breadth of understanding that is not readily found elsewhere. Batty looks at history for the origins of the phenomena, concepts, theories and technologies being introduced, uncovering interesting links and references. This highlights that the most advanced technological transformations of today are rooted in tradition and are part of the process of urbanization that has been developing for millennia. In this respect, the book is accompanied by a rich notes section (pp. 221–51), a natural outcome of the need to bring up facts, stories, and references of the past and present, without digressing into often interesting details in the main text.

Some themes dominate, often formulated as challenges: namely, that there will be more and larger cities, but more population will be living in small and medium-sized cities that should receive increased attention; that it is important to consider the connections between cities and regions; that we need to develop complex network models that integrate different types of networks (for example, social, economic, infrastructural, communications and environmental) that constitute the city; and finally, that time, at different scales and in different cycles, is a force that must be considered. The final chapter does not offer a vision of the future city. Instead it prompts the reader to take on these challenges if we are to address the major problems facing future cities, in terms of climate, economy, health or society.

While those working on urban morphology have a rich set of references and tools to understand the physical form and processes of formation of cities, including more recent computational and mathematical models (D'Acci, 2019), they might be less prepared to deal with the fast temporal dynamics of the present that are changing the way we work, travel, communicate, shop or learn, which will influence the future of cities. In

embracing the challenge to study these dynamics, they can contribute to shaping the smart city, which is rich in technology and big data, but lacks a coherent theory of the city to give useful purpose and meaning to the rich analytics available. In return, urban morphology can play a central role in inventing future cities.

## References

- Batty, M. (1976) *Urban modelling: algorithms, calibrations, predictions* (Cambridge University Press, Cambridge).
- Batty, M. (2013) *The new science of cities* (MIT Press, Cambridge, MA).
- D'Acci, L. (ed.) (2019) *The mathematics of urban morphology* (Birkhäuser, Springer Nature Switzerland, Cham).

*Jorge Gil, Department of Architecture and Civil Engineering, Chalmers University of Technology, Sven Hultins gata 6, Gothenburg, Sweden. E-mail: jorge.gil@chalmers.se*

**The mathematics of urban morphology**, edited by *Luca D'Acci*, Birkhäuser, Springer Nature Switzerland, Cham, Switzerland, 2019, 564 pp. ISBN 978–3–030–12380–2.

The editor of this book, Luca D'Acci, provides a rich overview of the quantification of urban form using mathematical models. The book is organized in six parts, covering fractals, cellular automata, spatial networks, complexity, other forms of quantification, and interdisciplinary commentaries. Exploring urban morphology using more abstract and mathematical methods is relatively new, as Michael Batty points out in his Foreword, in which he highlights the pioneering work on the quantitative approach by the Centre for Land Use and Built Form Studies in the 1970s. About 30 years ago, in the wake of complexity theory, the mathematical approach developed further, with emphasis on transformation of urban form rather than on the description of its geometry.

In the first part, discussing fractals, the majority of contributions discuss the counter-cumulative distribution of city sizes (and other elements), all ending up showing that these distributions follow Zipf's Law. This means that they fit power law