



THE NEW SCIENCE OF CITIES

MICHAEL BATTY

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Michael Batty



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Science may be described as the art of systematic over-simplification—the art of discerning what we may with advantage omit.

—Karl Popper, *The Open Universe: An Argument for Indeterminism* (1992)

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Preface

We live in an age of cities. By the end of this century, it is likely that most of the world's population will be living in one type of city or another, as urbanization and globalization become the norm and our past rural pursuits slowly disappear. When all the world's a city, it is questionable whether the term "city" will continue to have the same resonance it has had for the last 5,000 years. Our focus on individual cities will probably lessen as we explore the way a system of cities composed of most of the world's population actually functions. To understand what is happening, we need to take seriously the idea that cities are places where people come together to "interact" with one another. As our technologies enable people to connect ever more easily and in many new ways, our understanding must be enriched by studies of networks, interactions, connections, transactions, and every other possible way in which we are able to communicate with one another.

This book takes literally the idea that cities are devices that enable us to communicate. In doing so, we are able to use them to increase our prosperity by providing environments in which we can work together, innovate together, and generally share the fruits of our labors. Until quite recently, most of this sharing took place in individual cities, but increasingly our technologies enable us to share and communicate at a distance. At one level, this is trade, and although fundamental to ancient and modern societies, the global world that has emerged is dissolving our reliance on material movements in favor of the ethereal and the social. Information is replacing as well as complementing energy. Thus, to understand the contemporary city—to fashion a science that is able to explain city growth, sprawl, decline, and so on—we must underpin our theories with ideas about how we relate to one another.

These ideas have been anticipated before. Fifty years ago, Jane Jacobs, in her seminal book *The Death and Life of Great American Cities* (1961), argued that it is not enough to simply study the location of things in cities as we have done in the past; instead, we need to consider location as lying at the heart of how evolving networks of relationships provide the cement that holds people together in cities.

Richard Meier, in the preface to his book *A Communications Theory of Urban Growth* (1962), talked of urban environments “continually bombarded by messages,” and he produced an outline for a theory of cities as kaleidoscopes of information. Peter Haggett and Richard Chorley in their book *Network Analysis in Geography* (1969) produced a wonderful and challenging review of the way networks were being used in geography that focused very much on parallels between cities as human systems and geomorphologies as physical systems. Around the same time, Waldo Tobler produced a long line of influential papers on geometry and flows that served to keep the morphological message alive in geography until recent times, when these ideas began at last to connect up with the new science introduced here.

Yet despite these occasional and prescient contributions, we have continued to think of cities as spaces and places. We recognized that these were stitched together by transportation, but we have never attempted to see the city as a set of networks from which locations naturally emerge. We have always tried to unpack actions and activities at locations into interactions rather than the other way around, by attempting to see locations as the product of interactions. In this book, I switch our traditional focus from locations to interactions and, in so doing, invoke many ideas about networks and flows.

There is another traditional dimension to cities relating to their physical or spatial form, and we will not downplay this here. It is quite possible, of course, to study cities as networks and interactions without focusing on their form. Indeed, much of the literature on urban studies tends to treat urban phenomena and cities as being about aspatial and nonspatial issues, about processes, rather than about physical or spatial form. But urban planning and design, which is the most obvious and perhaps least intrusive way of intervening in the evolution of cities, is based on physical rather than social or economic instruments of control and management. I will keep this perspective here, while acknowledging that we could treat the material of this book in a very different manner, notwithstanding that the focus of our discussion might be the same. My perspective is thus unashamedly about the physical and spatial artifacts that define our cities. The tools I will introduce that underpin the new science I argue is needed to grasp the challenges of the near future are thus manifestly physical and spatial in their treatment of systems of cities and cities as systems.

This is not a book that will tell you what the future city will be like or even how one might create better cities, but it will provide what I consider tools for and perspectives on a science that can be used to explore these futures. Yet this world of science will inevitably be incomplete, as science always is. Karl Popper’s wonderful insight that science is “the art of discerning what we may with advantage omit,” which is the quote I use to introduce this book, provides one of the leitmotifs for this work. Readers need to be aware that this is a partial set of insights and that

there are many directions in this science that are inevitably inconsistent with one another, as I am at pains to emphasize in the concluding chapter. This science, however, has not sprung Phoenix-like from the ashes of an earlier world, but builds on strong traditions in social physics, urban economics, and transportation theory, on regional science, urban geography, and of course on the systems approach to physical planning, which has now morphed into the complexity sciences. I have a deep respect for these traditions, and they are echoed everywhere in the text that follows. More particularly, many of the ideas here build on my previous forays into this way of thinking; as first represented in my book (with Paul Longley) *Fractal Cities: A Geometry of Form and Function* (Academic Press, 1994; available for download at <http://www.fractalcities.org>) and in my book *Cities and Complexity: Understanding Cities Through Cellular Automata, Agent-Based Models, and Fractals* (MIT Press, 2005). A summary of these ideas can be gleaned from <http://www.complexcity.info>. Far be it for me to instruct you to read these, but the material therein does underpin many of the approaches and methods introduced here.

There are many developments in this new understanding of cities that are currently emerging. I hint at these here, but they are implicit in the development of this science and its application. The digital revolution has now penetrated our culture so deeply that the many new forms of communication transforming our cities are now yielding up their secrets in the form of very large databases, providing us with opportunities for analysis and modeling that are quite different from those available in an earlier age. Cities are becoming “smart,” and in many ways the kind of science reported here can inform how they might become “smarter.” But more particularly, the dissemination of this science using new forms of visualization offers new ways of thinking about the design of future cities. I will not venture here into planning support systems, participation in design using new online technologies, and the like, but I am well aware of this movement, which forces us to embed these ideas into the wider policy context. This, in fact, is the focus of my research group in the Centre for Advanced Spatial Analysis at University College London, where various research projects have provided me with some of the illustrations of “big data” pertaining to networks and flows in cities used here. I acknowledge particular contributions below.

Many others have helped me get this far. Paul Longley, who worked with me on fractals in the 1980s, has been my colleague for nearly thirty years, and his dry humor continues to remind me that science is contingent and always temporary but, nevertheless, that we should strive for the best. Peter Hall, my longtime mentor from my first permanent appointment at Reading University in the 1970s, continues to support this way of looking at cities while supporting many others who follow his pluralistic approach, which is entirely consistent with the sentiments I express here. There is a good group of urban morphologists at University College London whose

work is complementary to these ideas. Stephen Marshall's views on evolution and cities, Bill Hillier's ideas about how the physical and spatial syntax of cities molds their function and vice versa, and Phil Steadman's work on configurational forms all find implicit expression in this work, and I thank them for their insights and influence. I must also thank my original teachers George Chadwick and Brian McLoughlin, who in the late 1960s introduced me to the systems approach in planning and set me on my way to where I stand on these matters today. They are sadly long gone, but I hope they would recognize a little of their contributions in what follows in this book. I fear they might not, for the terrain of how we understand cities has changed radically and is still changing fast. However, in the methods and models we use, there is still synergy and complementarity with their earlier era.

I want to thank the editorial team at MIT Press, particularly Susan Buckley, Virginia Crossman, and Kristie Reilly for their splendid work on bringing the book to publication.

My wife, Sue, helped me with some of the figures and proofs of the book, which would not have been possible without her, and it is as much hers as mine. My son, Daniel, remains a clever skeptic on all matters of cities and continues to test me on the plausibility and wider import of the ideas therein. The book is for them.

Michael Batty

Welsh Saint Donats
Cowbridge, Vale of Glamorgan
October 2012

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Some of the figures in this book were originally produced in color but are printed here in gray tones. Where possible, notes on the figure captions indicate the range of colors used and their translation into gray tones. Readers who wish to examine the figures in color should access the website <http://www.complexcity.info/newsience>, where they will find the original color versions.