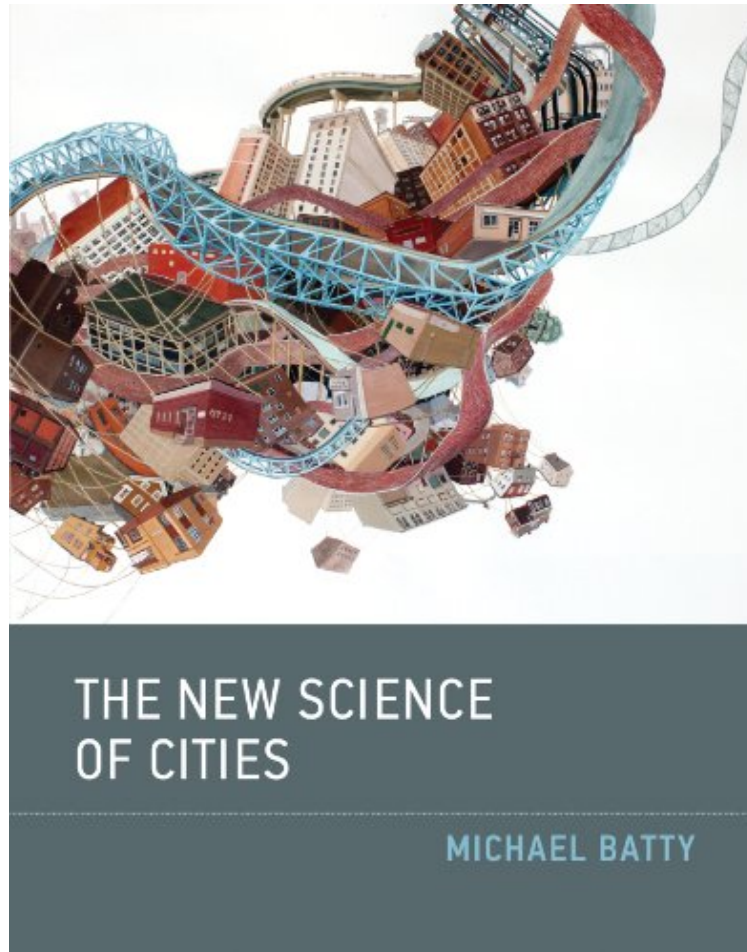


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The New Science of Cities (MIT Press)

Michael Batty

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Michael Batty : The New Science of Cities (MIT Press) before purchasing it in order to gauge whether or not it would be worth my time, and all praised The New Science of Cities (MIT Press):

0 of 0 people found the following review helpful. Feels like a nice tea time discussionBy expateconomisteThe book has a promising title and I was excited to get my hardback copy. I have been studying and publishing urban economics papers for quite a bit now. Unfortunately, the book disappoints on many levels. To sum up the issues, one could say that it feels like an educated conversation at tea time. The ideas are far reaching and broad, intellectually stimulating perhaps. But they lack a thorough and clear discussion. Basic mathematics is introduced and then left on the side (See "Ebb and Flow"), not to be used later in the book. The author moves from one city to the next in the same sentence. We're left with the impression that either (i) the book goes through too fast through all examples, or (ii) that the "new" "science" of cities is not quite at the level of rigor that we expect of a science.46 of 47 people found the following review helpful. Narrower than the title suggests (3.75 stars)By A. J. SutterIf you're a student or expert in spatial analysis -- say, a reader of Environment and Planning B, a journal that this book's author (MJB) has edited for many

years -- it's very possible you'll find this book a masterful survey and extension of the professional literature. If, however, you're a general reader interested to learn new and stimulating facts about properties that the world's cities have in common, you'll almost certainly be disappointed. There's very little empirical discussion of cities in this book, and a great deal of math (mostly matrix algebra, with a bit of graph theory thrown in). A more descriptive title for this book might be something like "Mathematical modeling of cities and the planning process." You should also be advised that this new "science" is essentially economics. There isn't any biology or ecology involved, or anything about how the built environment affects the local weather (as it sure does here in Tokyo); and even the bit of physics the book contains is sometimes off-kilter. I came to the book as one of those general readers, albeit with a fairly high tolerance for math-heavy exposition. I found the book frustrating on several levels, as I'll describe below. Nonetheless, I admire the author's attempts to synthesize his field, and also the modesty with which he makes claims for this purported new "science." Throughout the book he is scrupulous to point out the limitations and the tentative or even metaphorical nature of many of the techniques he describes. For these reasons, as well as the book's possibly being intended for an expert-only readership (notwithstanding the MIT Press's marketing that roped me in), I give the book close to a 4-star rating despite my own issues with it. While that's the short of it, the rest of this rather long review delves into the things that disappointed or even troubled me about the book. In fairness again, I should note that some of those things -- maybe even more of them than I recognize -- arise from the conventions of spatial analysis and its sister discipline, urban economics, rather than from the specific approach taken in this book. And the following long list notwithstanding, I suppose it's to the book's credit that instead of giving up on it, I kept hoping it would get better. I'll start out commenting on style, and get more substantive as I go farther down the list. I hope that at least some of the earlier points might be addressed in a subsequent edition of the book.

A. There's a lot of room for improvement in the illustrations. First, this book is really crying out for an insert of color plates or color printing within the text -- some illustrations are almost unintelligible in black/white. Unfortunately, the publisher followed a recent trend and punted the color pictures to an online website. There have been some delays in uploading them, but a bigger question is how long will the site stay active. Not an issue if they were in the printed book, which might last decades. For other illustrations, it wasn't just lack of color but lack of context that made them hard to use. To get the most out of the maps and hierarchical diagrams in Chapters 2 and 3, you'll need to know something about the geography and sociology of London neighborhoods (I don't). Chapters 6 and 7 present "spatial syntax" and "heat map" illustrations of a French town called Gassin; the reader is advised that these maps don't give a good visual portrait of the town's physical layout -- but we're never given a conventional map or aerial photo of Gassin to see for ourselves. Ditto for Cardiff in Chapter 8, where we're shown results of computer simulations of its growth, without any schematic of the un-simulated city for comparison. (BTW the issue described in this paragraph itself illustrates how models are the featured actors in this book, with real cities merely the supporting players.)

B. The text, too, could be more user-friendly. Paragraphs are long and dense, with important points or definitions sometimes buried in the middle (e.g., the definition of "hierarchy" @152). Other concepts are often explained by reference to the specialist spatial analysis literature instead of to sources more accessible to a general readership. E.g., when MJB takes pains to distinguish his sense of a "dual" graph and a "more common" sense of that term, he points the reader to an out-of-print 1971 design monograph by March and Steadman (@182-183). But if you check a good standard graph theory textbook, like Diestel, or even just Wikipedia, you can quickly learn that MJB's use of "dual" already has its own name: "line graph" (Diestel @4).

C. Readers with a natural sciences background may also be confused or even exasperated by some of the analogies to physics and the treatment of some mathematical topics. Here are three examples: (1) Chapter 2 discusses "gravitational" models of flows of people between two cities. These are based on equations with the form $T_{ij} = K P_i P_j (d_{ij})^{-a}$ [1] where the P's are populations of two cities and d is the distance between them; it's supposedly like Newton's equation for gravitational force, $F = G M_1 M_2 r^{-2}$. Different to the physics approach, though, the treatment of [1] in this book doesn't obey the rules of dimensional analysis. T_{ij} is sometimes described as a "flow" and sometimes as a "force," even within the same sentence (@ 48, 52) -- but a flow includes a dimension of $[time]^{-1}$, whereas a force has $[time]^{-2}$. Later, MJB rearranges equation [1] to create certain quantities that he likens to "potential energies or summations of forces (Stewart, 1941)" (@64), even though energies and forces aren't dimensionally comparable, either. And a few pages later, he splits the proportionality constant K into a product of $K_i K_j$, and then considers the case when " $K_i = K_j = K$ " (@71). This can only make sense if K is a pure number (equal to 1, BTW), in which case the left- and right-hand sides of equation [1] can't be dimensionally balanced. Also disappointing is that equation [1] is never compared to empirical data in the rest of the book, so we're never told what a real-life value for the exponent /a/ might be. Another issue here is that the Stewart 1941 reference doesn't provide an explicit expression for demographic potentials and doesn't mention summations of forces at all. Moreover, as is clear both from that paper and from his longer 1948 paper in Sociometry on "demographic gravitation" (not cited in the book), Stewart developed his "potential" in the context of a static gravitational field, which is quite different from this book's context of population flows. (Incidentally, I hope that in a future edition MJB will drop Stewart altogether, because the man was a galloping racist. In his 1941 model of rural population density, he blames the inaccuracies in his model on the "concentration [of] the Negro population" in certain states -- i.e., he hadn't counted them in his

calculations. In 1948 he proposed that the (metaphorical) "molecular weight of negroes [sic] in the Deep South averages only 1/3" that of the (predominantly white) residents of the Northeastern and Midwestern states. That's even worse than in the 1789 US Constitution, where a slave was reckoned at 3/5.) Economists usually cite to Jan Tinbergen's "Shaping the World Economy" (1962) as the source of gravity models. That would have been appropriate here, too, because his equation for flows of international trade has roughly the same mathematical form as [1], albeit with a significant difference: Tinbergen's equation was dimensionally kosher. Tinbergen himself didn't use the gravity analogy, perhaps because he found empirically that the distance exponent in his model has a rather un-gravitational value of around -1.(2) In Chapter 8 we're told, "In cities, filling the two-dimensional plane with particular forms of development from the parcel to the street line and at different densities suggests that their fractal dimension lies between 1 and 2. Thus this dimension becomes the signature of urban morphology, which is the outcome of processes that generate fractal shapes" (@250-251). This passage doesn't make it clear that on a 2-dimensional surface it will be the *boundary* of the city that has fractal dimension -- not the city per se, which, being an area, has dimension 2. Moreover, a fractal dimension between 1 and 2 is the "signature" of *any* fractal curve on the plane. (See the definition in Mandelbrot's classic book, which appears in MJB's reference list, of a fractal as a set for which the Hausdorff dimension strictly exceeds the topological dimension (Mandelbrot 1982 @15).) If one took this passage at face value, every island would count as a city, since its coastline shares the same fractal "signature."(3) Chapter 9 develops expressions for "entropy" and "free energy" in connection with flows of people between home and work. We find "the total energy $C = S + F$," where the right-hand side "expresses energy in two varieties -- 'unusable,' which is entropy S , and 'usable,' which is the free energy F ," citing Atkins 1994 (@282-283). In physics, though, entropy and energy don't have the same dimensions: S has dimensions of energy divided by temperature. BTW that's what it says in Atkins's 2010 physical chemistry textbook and all of the other thermodynamics, stat mech and chemistry textbooks on my shelf -- so although I don't have it to hand, I'd be surprised if Atkins 1994 said something different. Of course the "science of cities" is NOT physics, so one could object that its formulas don't need to be precisely analogous. I would agree, but this then begs the question of whether the analogy is illuminating at all. D. If a fondness for physics analogies coupled with loose dimensional bookkeeping calls to mind neoclassical economics (NCE), that's no mere coincidence: NCE provides substantive inspiration for the "new science of cities" as well. (I leave aside here the question of whether NCE deserves to be called scientific at all.) Consider: "Cities exist primarily to bring individuals together to trade the products of their labor. Historically, clusters of individuals formed at points where their labor could best exploit natural resources while providing sustainable locations where production could be achieved." (@16-17.) Reading this, I couldn't help thinking of those just-so histories of mankind one finds in 17th and 18th Century philosophical works, confidently stating as fact conjectures that conform to the writer's favored theory. Can anyone really know that ancient city sites always afforded the "best" exploitation of resources? And that this was always the "primary" reason for their founding? I don't think, say, Hobbes, Locke or Rousseau would have ignored the role of military and spiritual considerations in the founding of ancient cities. The NCE influence perhaps also explains why the reader must occasionally slog through descriptions of highly artificial mathematical models, such as one in which cities' populations change only by swapping residents (@124-128). It may also explain why certain dissociated points of view are accepted as reasonable, such as the rather disquieting prospect of "an entire new class of models [that] is generated if the population is allowed to become negative, as is the case when the population might be considered as capital or wealth." (@127-128.) But the influence of NCE and its expansionist aspirations is nowhere stronger than in the way the book brands a blend of economics and fashionable math as "the" science of cities, with an exclusive emphasis on flows of commercially significant goods and services. What about cities' numerous impacts on biology, ecology, meteorology, geology, and much else? For example: the way waterfront high-rise buildings have changed Tokyo's climate over the past 15 years; the heat island effect that's increased the number of thunderstorms in Phoenix AZ; the proliferation of sinkholes around that same city due to the population's demands on the water table; the nationwide impact of the growth of Beijing and Tianjin on China's water supply; and so on. Why are these and other similar concerns unworthy of being integrated into a "new science of cities"? E. Part III, a set of five so-called "normative" chapters, disturbed me the most. They incorporate the all-too-typical discourse about "governance" -- the idea that what works in running a business should be applied to public affairs -- but go beyond this, by replacing politics with mathematical notions of equilibrium. Sometimes this fits explicitly into an NCE framework, such as the allusion to Walrasian "tactic;tonnement" in averaging the difference between a matrix summarizing actors' interest in land, and another matrix summarizing their control over it (@414). All interests are of course measured in cash values. An even loopier idea is to use the theory of Markov matrices to reach decisions about public policy; the idea here is that when you crash these matrices together often enough, they often reach an equilibrium or "stationary" state -- embodying your "optimal" decision -- in the long run. (By "loopy," I mean that it sounds like what 1st-year grad students who've recently learned about Markov matrices dream up on a cocktail napkin after a couple of beers. Nonetheless this line of thought has a long academic pedigree, apparently.) To create such matrices requires that each actor in a planning decision be able to quantify a priori his, her or its interests vis-à-vis; vis all others', and possibly to update these with each iteration (or possibly not). People are removed from the process once their set of matrix

entries has been tabulated by the master planners cranking everything through its Markov paces. No matter that MJB tells us occasionally that such models are metaphorical -- the metaphor is a pretty chilling one. Moreover, no case is made for why an "equilibrium" decision should be the best decision. Even if there were a strong case, the possibility of realizing such a decision is about as plausible as the NCE notion that an economy can reach an equilibrium when each household figures out a priori how what its preferences are for every possible bundle of goods during, say, the whole year ahead. Or even less plausible than that, because certain problems identified by NCE economists are entirely ignored here. E.g., Kenneth Arrow pointed out that it's impossible for a set of voter preferences to be aggregated in a way that they are transitive for the whole community, given certain prima facie desirable constraints (please check Wikipedia if you need more specifics). MJB never tells us what happens if the community preferences are intransitive -- and much less if various individuals' preferences suffer from this drawback, too. Mathematical problems aside, the real issue here is that equilibrium is the negation of politics. Nothing in this book contemplates a situation where an actor makes a concession on an issue today because she expects reciprocity in the future; where an actor makes an apparent concession today because he's giving an opponent enough rope to hang himself; or where power simply wins. Machiavelli, not Markov (and not the Prince but the Discourses) would have been more apt here: the basis for the greatness of a city lies in providing appropriate institutions for the conflict between rich and poor. Or, as a French children's book (Godard Pilon's *laquo; Les deacute;mocraties raquo;*;) wisely put it, achieving democracy is always a battle. The task of achieving it shouldn't be taken out of the hands of citizens and put into the hands of "planners." In sum, I wanted to like this book better than I was able to. I should mention that MJB was very gracious in a few brief emails we exchanged about it, early in my reading. Also, some of his editorials in *Environment and Planning B* (available on his website) are more down-to-earth and humane than one might guess from the rather detached perspective of this book. I hope he will put those good qualities to use in a sequel.

15 of 15 people found the following review helpful. Applying complex maths to simplistic city models By Alex Kafka I fully agree with the detailed review provided earlier by A.J. Sutter, including the potentially misleading title and marketing, the lack of readability posed by the prose style and communication through mathematics, the impossibility to interpret the b/w illustrations in the book without downloading the colour web versions (i.e. dark red that represents high connectivity is the same shade of grey as dark blue that represents low connectivity), the neoclassical economics bias, etc. Most problematic I found however that the book attempts to advance a 'science of cities' without paying much attention to real cities. The mathematical formulae proposed are only applied to simplistic diagrams with limited resemblance to their real-world models, and there is no discussion of how the results of the analysis relate to actual urban environments. Thus for example when analysing networks in fig.7.3-7.4 the conversion of streets into axial lines around London's Regent Street misses about a third of the connections and glosses over the problem of converting a curved street into linear axial lines, fig.7.5 calls a square grid "Manhattan grid", while fig.7.9-7.13 show a map of Melbourne CBD that omits dozens of streets but includes several connections between the rail and street network that do not actually exist. In none of these examples is there comprehensive discussion of what the results of the analysis could mean, and there is no comparison with data about real flows. This is consistent with the absence in the list of references of much of the relevant urban sociology, environmental psychology and urban design studies literature. The risk of a 'science of cities' that simplifies urban morphology to a level where its geometry is mostly lost and doesn't pay due attention to human social behaviour is that it can lead to the kind of results that modernist planning led to. While Castells and Jacobs are briefly mentioned in the book, their criticism of theories/doctrines that lack empirical grounding hasn't been heeded here.

In *The New Science of Cities*, Michael Batty suggests that to understand cities we must view them not simply as places in space but as systems of networks and flows. To understand space, he argues, we must understand flows, and to understand flows, we must understand networks -- the relations between objects that comprise the system of the city. Drawing on the complexity sciences, social physics, urban economics, transportation theory, regional science, and urban geography, and building on his own previous work, Batty introduces theories and methods that reveal the deep structure of how cities function. Batty presents the foundations of a new science of cities, defining flows and their networks and introducing tools that can be applied to understanding different aspects of city structure. He examines the size of cities, their internal order, the transport routes that define them, and the locations that fix these networks. He introduces methods of simulation that range from simple stochastic models to bottom-up evolutionary models to aggregate land-use transportation models. Then, using largely the same tools, he presents design and decision-making models that predict interactions and flows in future cities. These networks emphasize a notion with relevance for future research and planning: that design of cities is collective action.

A brilliant synthesis of how concepts from complexity science change our understanding of cities. Scaling, fractals, and simulation models are clearly explained and used to demonstrate how flows and networks shape cities and how they can be better predicted and managed for improving urban planning and design. A great book for an emerging urban science. (Denise Pumain, Université de Paris; Institut Universitaire de France) As

Michael Batty reminds us with fascinating historical excursus, the idea of developing a 'science of cities' is not new. However, today's explosion of measurements in the urban field -- the so-called big data phenomenon -- is opening up possibilities that were unthinkable just a few years ago. New research territories are looming, to which this book is a compelling and perfectly timed guide. (Carlo Ratti, Director, SENSEable City Lab, MIT) Michael Batty has followed a career that has made him the prime interpreter of urban modeling in all its forms. Now his remarkable work has become the foundation of a new science of urban flows and networks that uses big data and sharp theory as tools to dig deep into how and what cities are, and how they can be designed in better ways. This is the book that sets the benchmark that all others will have to follow. (Nigel Thrift, Vice-Chancellor, University of Warwick) Overall, *The New Science of Cities* is an ambitious and laudable undertaking, one that Batty admits cannot be comprehensive, but which, even so, may well be seen as a milestone. (New Scientist) About the Author Michael Batty is Bartlett Professor of Planning at University College London, where he is Chairman of the Centre for Advanced Spatial Analysis (CASA), and Visiting Distinguished Professor at Arizona State University. He is the coauthor of *Fractal Cities: A Geometry of Form and Function* and the author of *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals* (MIT Press).