Editorial

Models again: their role in planning and prediction

In the early months of this year the Planning Educators Electronic Mail Network, PLANET, was dominated by a vibrant discussion about the role of complexity in thinking about cities and their planning. The debate was started by Martin Krieger (17 February 2015)\(^{(1)}\) in a post to the list which he titled “chaos, nonlinearity, path dependence, complex adaptive systems, agent-based modeling, butterfly, uncertainty (as in Heisenberg UP), fuzzy, catastrophe”. He said:

“Over the last decade or more, the above terms have become legion in our field and social science. Please lead me to real work that reveals stuff that is not revealed by merely looking at historical examples. What I mean is models that have quantitative predictions, with reasonable parameters based on empirics.”

The debate that then began was dominated by many insightful comments, but in a way Martin’s question to us to reveal examples of “models that have quantitative predictions” fell on somewhat stony ground. In short, my reading of all the contributions was that there were no such examples that are robust enough to convince anyone that this kind of science can make predictions that are borne out, confirmed, or validated, at least in any strong sense.

In a rather different context but at the same time, I was asked by a commentator on transportation models to speculate on what models were likely to look like ten to twenty years on—in the medium-term future. So much has changed in terms of modelling styles, computational abilities, and data availability that models have changed too. The question then turns on whether or not models have got better in terms of their predictions. This of course is set against a world where cities and their transport are getting ever more complicated, more complex, and where many different models applied to the same phenomena are now available, each giving different predictions, each focusing on different aspects of the same problem. I will outline two responses to these issues that reflect very different assumptions: first, there is the question ‘what do we think models will actually be like?’ in the medium-term future while, second, there is the question ‘what would we like models to be?’ I will address the second question first because my response builds on what has been happening to such models during the last twenty years, and I will begin by sketching some of this background.

Since transportation models were first developed in the early 1950s in the United States, they have become richer and more detailed. They began as models of how populations generate trips in aggregate terms in different zones of the city and the models then worked out how such trips were distributed and assigned to the transportation network, noting how capacities and congestion could be handled during what came to be called the ‘four-step process’—trip generation, trip distribution, modal split, and then assignment. Aggregate models quickly evolved into disaggregate where the activities of individual trip makers could be simulated, and this was then relaxed even further when such trip making decisions became embedded and considered within the wider patterns of daily activities which represented the human motivations for why trips are generated. These latter ‘activity models’ tend to represent trip makers individually subject to various constraints and rules about trip making.\(^{(1)}\)

\(^{(1)}\)You will need to be registered to look at the Archives on this list but if you register at https://listserv.buffalo.edu/, you can find Martin Krieger’s e-mail and the entire thread at https://listserv.buffalo.edu/cgi-bin/wa?A2=ind1502&L=PLANET&F=&S=&X=BD132F9E964D7A52EB&Y=m.batty%40ucl.ac.uk&P=44962
and take a rather different approach to simulation. They cast trip makers as individual agents
who interact with one another in competing for space to make trips, modelled using processes
based on microsimulation.

Thus transport models began with aggregate models of how populations in small areas
make trips on different modes; they then moved to examine how these same kinds of model
could be formulated in terms of how a generic trip maker made choices between different
travel alternatives (these were discrete choice models reflecting the way different choices
of travel were made, building on a strong stream of economic theory); then they embraced
the paradigm of travel activities and time budgeting which were encapsulated in techniques
of microsimulation; ultimately moving on to even richer and more detailed structures
which loosely can be called agent-based models. As we have moved from aggregate spatial
interaction through discrete choice to activity-based and now to agent-based models, the
data and computational requirements have got greater and greater while in parallel, data
themselves have got easier to collect and computation has become ever more tractable.

However, there is still a major trade-off between more aggregate traditional models
that are easier to use and much more routine versus these more elaborate and detailed ones
which are much harder to build and whose data and computational needs always stretch the
limits of what is available and possible. The other key feature that in a sense those of us in
modelling have always been aware of, because ‘models are abstractions, simplifications of
the real thing’, is that, when we make models richer by disaggregation and by adding detailed
processes of trip decision making, we make them much harder to validate. A consequence
of this is that, in general, aggregate, more traditional models probably perform better than
their newer, richer, and more complex counterparts and, even if they do not perform any
differently, neither kind of model ever performs as well as we would like.

The dilemma is this: the more we enrich the model hoping to improve its simulation of
the existing situation, the more problematic is its validation and the more unlikely we are to
replicate the present to the extent we would like. But we know that the things that we put into
these newer models are important and the paradox is that, if we leave them out and revert to
simpler models, we are negligent of not using information that we know is important to the
way people make trips and use transport. In short, as we have improved our models in terms
of structure and detail, they have not necessarily got any better in terms of their performance,
but they have got better in terms of what they represent.

The big question (for me) is whether or not such models can ever get better in terms of
their performance. I fear not for many reasons. First, the very systems that we are attempting
to simulate are getting more complex. It is as though we need to run with our models to
keep standing still. We must develop ever-richer models to deal with this complexity, but
there is no stability in the system we are modelling. Take trip distribution: fifty years ago
the biggest single trip making activity was the journey to work; now it is no more important
than trips to school and health care and so on; and work of course is changing in itself due
to online activities. Then take retail activity. There are massive changes going on in the
online world that are hard to observe and even harder to simulate using traditional models
which are changing how we purchase and deliver goods. In fact, this notion of how cities are
structured in terms of new information technologies—the use of e-mail, social media, web
access, search, and so on—is complicating the process of transportation and our mobility in
ways that are very hard to represent and model in traditional as well as even the newer ways
of simulation. Much of the world that we model is becoming virtual, digital, ethereal almost,
while our world of models is still almost entirely physical.

The second reason is that we are finding it increasingly difficult to produce good
comprehensive datasets that cover all the elements we wish to model. Data are getting better,
but much of what we now need is invisible to us or too costly to acquire. The third reason
relates to modelling itself and the fact that “essentially, all models are wrong, but some are useful” as George Box, the famous English statistician once said (Box and Draper, 1987). We seek simplifications so that we can distil the essence of the questions we wish to address, but in urban systems it seems that any simplification at all is too great a simplification and we lose the essence of what we are interested in. The fourth question is that, for any model to be tractable, we need to close the system. In a global world where transport flows, many of them critical to the functioning of the system of interest, cross the boundary between the city or system of our concern and those that are beyond our remit or even interest, we can never close the system and our models are bound to be incomplete. In short, we are increasingly breaking the rule that for a good model we need to close the system effectively. In truly open systems which cities have become, this is now impossible.

The fifth question, which in some respects is the hardest of all, relates to prediction in human affairs. We know that we cannot predict a future that we assume we are active in determining. Karl Popper (1956) told us this many years ago and he argued that such ‘historicism’ as he called it was a misguided aim in social science and social affairs. Indeed, in disciplines that build models of the past the problem is even greater because we find it hard not to assume that behaviours are stable through time when we know they cannot be (Van Der Leuw, 2004). We all know this deep down, but our inclinations are to assume the best and consider that somewhere there might be a world where our predictions turn out to be true. And of course there is the somewhat weaker position that many of us take where we consider that some of what we might predict will turn out to be true, notwithstanding the fact that most of what we attempt by way of forecasting is demonstrably false even in the short term. It is sometimes thought that short-term forecasting is more reliable than long-term but even this is problematic (Batty, 2012). So if we cannot build models that enable us to forecast, then what should we do? Even predicting ranges of answers in terms of alternative scenarios is plagued with problems for at some point a decision maker grappling with the future must choose one from many possibilities however wrong that might be. And wrong it will be as George Box kept impressing on us.

This is a dilemma of the first order. Many have commented on this over many years and will continue to do so for it is in the nature of things—in the nature of human systems—and this is the situation we must live with. The big question is, if we hold the view that the future is unpredictable, what do we do? Do we use models that we know will always give us the wrong answer? And of course we will only know this in hindsight. Or do we persist and suspend reality when we develop models, assuming that the predictions that we make will turn out to contain some truths? But even then, we seldom know which truths are more likely then others.

Having sketched all this background, I will return to the two questions I posed at the onset: to remind you of these, I said first: in the future, ‘what do we think models will actually be like?’; while second: ‘what would we like models to be?’ I will address the second question first. I think that we need models because they impose a framework, an order on our thinking about the present and the future that imposes a discipline on how we try to address problems of land use and transportation rigorously. Without some such discipline, we can only resort to intuition and to responses that are influenced by the politics of the situation, by our prejudices. Models are thus there to inform the debate and there is still the prospect of using them conditionally to address ‘what if” scenarios that can then be used to bound the debate. These sound like very fine words I know and, if we cannot demonstrate that any prediction can be borne out from the simplest or the most complex models, then it is entirely understandable that the effort of building them may not be judged to be worthwhile. Using a model is thus an act of faith on the part of model builders and policy analysts alike, on the part of any professional involved in the process of inventing a better future. At the end
of the day I am reminded of the words of John Gillespie in 1969 when he was the Assistant County Planning Officer of Cheshire and I was a junior researcher. He said: “If we don’t use models, we might as well predict the future by reading the leaves at the bottom of a teacup.” He was serious. He argued there was no alternative. He had a passionate belief in science: not the science of prediction but the scientific method, its discipline in how to go about developing a more effective understanding. At the end of the day, this is a matter of faith and belief and, if you deny science, then you will deny models of any kind.

This is not to say that we do not need to be discriminating about types of models: we do. There are good and bad models, good and bad applications, good and bad data, and so on. This brings me back to the first question: what do we think models will actually be like in the future, meaning the medium-term future of the next ten to twenty years. I think it will be increasingly difficult to convince policy makers of the value of computer models but what will exist is a love–hate relationship, with all those involved accepting and agonising over the tension between science and its use and application in human affairs. As cities get more complex and as our choices and behaviours get ever more heterogeneous, as form gets increasingly disconnected from function, as much of the world of cities and their transport becomes more invisible through electronic flows which will connect to material and people flows in ever more intricate ways, we will increasingly feel the need for a science to make sense of all this. The demand for models will thus increase, but so will the disillusionment because our models will increasingly lag behind the complexity of the system we are grappling with. I cannot foresee how we will handle this dilemma. I think what might happen is that the quest for comprehensive models will disappear, with more and more partial models being built of bits of the system that address more specific problems. This might be one response in the face of manifest complexity, but it is probably the wrong one.

To an extent, what we probably need is many different models of the same phenomena because different models reflect different perspectives on the same system and problem. How we handle this possible plethora of models that counter one another is another urgent question. The argument that we need several different and competing models of the same system is pretty untenable at first sight if each of these models is wrong in the George Box sense. But if they remain useful …? It will take an act of supreme faith to argue that we need many different models to provide a wider perspective on the future when the future seems to be ever more unpredictable and we become increasingly aware that it was always so.

Michael Batty

References
Batty M, 2012, “Managing complexity, reworking prediction” Environment and Planning B: Planning and Design 39 607–608
Box G E P, Draper N R, 1987 Empirical Model Building and Response Surfaces (Wiley-Blackwell, New York)
Popper K R, 1957 The Poverty of Historicism (Routledge and Kegan Paul, London)
Van Der Leuw S E, 2004, “Why model?” Cybernetics and Systems: An International Journal 35 117–128