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Editorial

Smart cities, big data

I first wrote about 'smart cities' almost as soon as I began writing these editorials in the early 1980s. Back then, the PC (personal computer) or micro (microcomputer) was sweeping the world of computing and hard on its heels came the development of local area networks (LANs). In fact, LANs, as many other features of the PC, had been invented in the 1970s at Xerox Parc but it was not until the 1980s that they became ubiquitous and this heralded an age of wide area networks (WANs) that paralleled the Internet in general. What I remember most of those years were my visits to the Far East—in 1986 to Japan where I saw for the first time large-screen technologies in shopping centres and the implementation of fibre optic networks for wide-area Internet access, in the name of regenerating old industrial landscapes as they prepared for the postindustrial age (Batty, 1987). In the late 1980s, when I visited Singapore, the city-state advertised itself as the 'Intelligent Island', and my visits to the National Computer Board mightily impressed me. I heard about how routine services could be delivered to the entire population through WANs (Batty, 1997), two or so years before the World Wide Web was invented. What then came to pass in the 1990s was the fact that services everywhere could be delivered in similar ways across the web. Singapore is still in the vanguard.

In the 1980s the focus on instrumenting the city using network technologies was enshrined in the idea of the wired city. Dutton et al's (1987) edited book of the same name articulated this idea, but this was based on an earlier conception 'The Wired Society', a term coined by Martin (1977) whose influence on IT and society still pervades the world through his philanthropy. The notion of wiring the city then was essentially one of providing networking for very diverse activities without any very specific uses in mind, although by the mid-1990s there was a sense in which routine services such as those provided by municipalities—libraries, welfare services and so on—might be delivered using WANs. To an extent, there was a continued slower progression involving the use of ICT (information and communication technologies) in emergency service support, building on an earlier generation of operations research techniques for automating and streamlining police, ambulance, fire, waste disposal, etc. Various related conceptions of the wired city were in vogue at that time, such as cybercities, information cities, intelligent cities, and virtual cities with the focus more on representing the city using various digital media from computer-aided design to virtual reality games and worlds. Many of these conceptions were based on visions of what wired cities might become rather than on the reality of what was actually possible then. It needed yet another ratchet up of the IT spiral to really propel our cities into a world where service delivery and related activities could effectively be delivered using deeply embedded seamless computing, and only then could our cities could become truly computable (Batty, 1997).

What has changed these initial conceptions of the wired city is the development of ubiquitous devices of comparatively low cost that can be deployed to sense what is happening over very small time scales—seconds and faster—as well as over very fine levels of spatial resolution. Such devices that range from purpose-built sensors to individual hand-held devices that are as mobile as those using them provide massive capability to store and transmit data that pertains to movement and activity levels across space and time. Some of the most elaborate applications involve transport.

RFID tags as the basis for electronic ticketing is yielding massive datasets on public transit systems where the majority of users are required to use such tickets while individual transport using cars is being enabled using in-car devices that capture movement and location as well as from hand-held devices themselves that accompany the passenger and the driver wherever the vehicle moves. These datasets are everywhere, although are often locked away from those like ourselves who wish to mine and interpret them for purposes of understanding and design.

Other systems involving energy use at fixed locations—at home and work—are slowly being implemented through various forms of smart metering but also through integration of the various information systems that are used to record activity and pricing. There are vast quantities of information, much of it of doubtful quality so far but it will improve, which is associated with social media and networking (Batty, 2010). In particular, text messaging systems such as *Foursquare* and *Twitter* can be mined to extract some positional as well as frequency data, although assembling network links is more problematic. Constructing locational information on the built environment, for example, from photographs posted on *Flickr*, from data on *Facebook* and so on is being widely explored while various forms of tagging is accelerating the communication of data about many different kinds of objects to users for purposes of entertainment, advertising, and serious pursuits involving work-day activities.

The idea of integrating much of this diverse data together to add value to our conceptions of how it might be linked to other more traditional data as well as focusing it on specific ways to make cities more efficient and more equitable, has come to define the 'smart cities movement'. Many large-scale IT companies see the next great wave of applications related to groups rather than individuals, and these are seen most clearly in how large groups behave with respect to routine activities in cities. IBM, Cisco, Siemens, and a host of other companies are investing heavily in systems that can be used to mine traffic and related data which lie at the basis of an improved understanding of how cities function, as well as enabling new methods of improving the efficiency of such systems with respect to their operation and the quality of the experience from the point of view of the traveller. It is only a matter of time before these technologies are extended to many other features of cities, such as energy use in the home and in the car, to the automated construction of new forms of built environment, and a host of other routine activities in cities that clearly have the potential for such enabling. The key question is no longer technological; as ever it is organisational.

One of the obvious but much misunderstood features of these new urban technologies is the fact that they produce massive streams of data in real time and space. In cities, there has never been anything equivalent hitherto and we are just beginning to grasp the nature of this 'big data' as it is being popularly referred to. In fact, so far, most of the datasets from which we are able to extract real meaning are quite small in comparison with the sort of data that can been captured using instrumentation associated with physical processes. If the movements of people in a large city like London, for example—where there are something like 3 million travellers a day using some form of public transport (in a city of 8 million persons)—are captured at every time they register their location, then much of this data can be reduced or aggregated so that sequences with evident meaning can be extracted. Nevertheless, this kind of data is available continuously (for all future time?) and in this sense, it does not only encapsulate routine and relatively stable behaviours but, within it over sufficiently long periods of time, one can begin to extract changes to the structure and form of the city and the way people behave. Think of this data being supplemented by many other forms of transport data, by data on financial transactions in time and space, and by data relating to social and economic interactions which are part of e-mail and related

communications. We have barely begun to get a sense of the dimensions of this kind of data, of the privacy implications, of ways in which we can code it with respect to meaningful attributes in space and time. The data associated with the economy of course can be disaggregated to space and time in its finest form and this provides an entirely new dimension to thinking about how cities function. For many years, progress on understanding urban economies has been painfully slow—but with new data, with big data, the prospects are emerging of a new understanding of space–time financial transactions which in turn will drive new theory.

New data begets new theory and already it is clear that the very focus of our interest is beginning to change. Most urban theory and indeed planning and design fifty years or more ago was predicated on radical and massive change to city form and structure through instruments such as new towns, large-scale highway building, redevelopment, and public housing schemes. Planning was little concerned with smaller-scale development except its design, for nowhere was the function of the city understood in terms of how small spaces and local movements sustained the city. In short, the routine and short term were subsumed in the much longer term. New data and big data are changing all of this, as is the way the city is being wired and organised to deliver routine services. The focus of much new work in thinking about how cities might be improved is on the short term and the routine but, as we have noted, the routine if considered over a long enough time span and wide enough spatial domain merges into the long term. This is an issue that has barely been broached to date—how short-term big data informs longer-term data is part and parcel of our concern for how we might integrate traditional datasets from household interviews and so on with crowd-sourced data where there is less control, and remotely or directly sensed data.

Smart cities and big data may be the hot topics of today, but the implications of how the city is being wired, how it is generating new data, how this data might force new theories and models relevant to our understanding, how we might use our strategic models and intelligence to plan the city, building on this new understanding—these are all crucial questions to be explored. In one sense, all this is part of a world that is fast becoming digital in all its dimensions, where we can develop our understanding and our design ideas digitally, using representations and data that are also digital and developing new ideas for the future which will be implemented and will change the digital basis of everyday urban and social life. Our need to understand how all these dimensions are coalescing, merging, complementing, and substituting for one another has never been more urgent. It constitutes a major challenge for planning and design in the near future.

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