The Limits of Urban Simulation

An Interview with Manuel DeLanda

How effectively can we model cities through digital simulation? Neil Leach pursues this question in an interview with Manuel DeLanda, Adjunct Professor at SCI-Arc, Pratt Institute and the University of Pennsylvania.
Manuel DeLanda has exerted an enormous impact on architectural culture. For several years now the self-styled ‘street philosopher’ has been teaching at some of the world’s leading schools of architecture. He is the author of a number of highly influential books, including his critically acclaimed volume on urban growth patterns, A Thousand Years of Non-Linear History.1 However, he also has a background as a programmer, and has written numerous high-profile articles about architecture and digital design, such as ‘Deleuze and the Use of the Genetic Algorithm in Architecture’.2 It was therefore pertinent to ask him whether he has made any connections between his interest in digital simulation and his research into urban planning.

‘On one hand, some of the earliest applications of far-from-equilibrium thermodynamics and nonlinear dynamics to social science were simulations of urban growth patterns, as in the work of Peter Allen. Those early simulations were very influential in my work, partly because those two areas of physics are crucial to theories of self-organisation. On the other hand, despite my early interest in artificial intelligence, it is only now that I am mastering the technical details of simulations (from cellular automata and genetic algorithms to multi-agent systems) to write my new book, technical details that are necessary to any serious approach to urban dynamics. Unfortunately, the new book had to stop with a chapter of pyramid building in Egypt in which the simulations are applied to institutional organisations not cities. So a full encounter between digital simulations and urban settlements in my work will have to wait for the future.’

Nonetheless DeLanda does have some interesting observations to offer on the potential of using digital simulations for urban settlements. We need to distinguish between the various forms of simulation. For DeLanda there are two types, continuous and discrete. ‘Continuous urban simulations use differential equations to capture the rate of growth of a given city (as a function of other rates, like immigration rates, birth and death rates of citizens, rates of energy consumption) or to capture rates of urbanisation over entire regions. In computers the continuous differential equations must in fact be “discretised” over a space-time grid of a given resolution, but their continuous nature is recovered as the spatial distances and temporal intervals become smaller.’

But there are also fully discrete models of urban simulation in which one attempts to derive those rates of growth from the bottom up. ‘These are called “multi-agent” systems, and consist of discrete entities (agents) whose behaviour is specified by rules (and hence it is not emergent) but which can interact with each other and produce emergent effects from these interactions. In a given simulation the trick is to find the level of resolution for the agents. Are they supposed to be individual persons? Or individual communities, such as those inhabiting specific neighbourhoods? Or individual organisations, like schools, hospitals, government agencies, factories? In this second kind of simulation the most important thing is to be clear as to the relations between agents at different scales.

In his work, DeLanda treats these as relations of part to whole. ‘Persons are the component parts of communities and organisations; communities the component parts of social justice movements and of social classes; and organisations the component parts of industrial networks and federal governments. Cities, in turn, are the physical locales in which those entities perform their day-to-day activities, and they themselves display a nested set of part-to-whole relations: individual buildings, individual neighbourhoods and districts and so on. Thus, before applying multi-agent simulations one must be clear about these nested sets in which wholes at one scale are the parts of wholes at the next scale.’

This brings us to the question of buildings themselves. DeLanda mentions buildings in the context of ‘physical locales’. He also mentions one specific building type: the pyramid. But in his work the pyramids are read in terms of the organisational structure of their building processes, rather than in terms of their physical form. What relevance—if any—would the actual form of buildings have within his frame of reference?

‘Unfortunately I do not have a good answer to this question because I have never written anything about design, architectural or otherwise. But the analysis of locales in which practices are conducted (buildings, neighbourhoods, cities) does relate to form in two different ways. First of all, they are all typically divided into regions (rooms with different functions, such as kitchens, bedrooms, living rooms, or buildings with different functions, like churches, pubs, offices, factories, or neighbourhoods with different functions—residential, industrial, governmental) and these regions must be accessible from one another; that is, there must be a certain connectivity (by doors and hallways, streets and alleys, mass transportation and so on).

‘Both the regionalisation of buildings and their connectivity have a history, which I have only superficially explored. The main example I use comes from Fernand Braudel who claims that prior to the 18th century the connectivity of French residential buildings was such that servants had to walk through the master bedroom to reach other rooms. Then a change occurred in the connectivity, isolating the master bedroom and therefore affording its occupants privacy for the first time.’

If we were to strip away any notion of aesthetics from our understanding of design, and treat the fabric of the city as a mineralisation of the human exoskeleton, as the form that is generated in response to complex social, cultural, economic, geographic and other factors, as DeLanda had suggested in A Thousand Years of Non-Linear History, might this nonetheless give us something to work with?

‘In that book I approached the subject in terms of the collective unintended consequences of intentional action. These consequences are much more obvious in the case of decentralised decision making than for the centralised case. I used as my extreme examples the medieval core of Venice, whose labyrinthine structure was the unintended product of many decentralised personal decisions, and Versailles, a city planned to the last detail by centralised decision-makers in the French government. Clearly, most cities (or even different parts of a city) are a combination of these two extremes. And different periods of history display different combinations in which one or the other of the two extremes predominate. I have in mind here the period starting after the Thirty Years War, when the concept of national sovereignty first appeared in a peace treaty (in effect signalling the birth of international law). This age also marked the end of the city-state, the final absorption of cities into larger territories, and the transformation of former regional capitals into national capitals, many of which were then submitted to intense planning and reorganisation.’
DeLanda places great emphasis on ‘decision-making agents’. In practice, however, many urban interventions are based on rules – zoning laws, building codes and regulations, rights of light and so on.

However, for DeLanda digital simulations of these processes need to be quite complex. ‘To simulate these processes we need multi-agent systems that are more elaborate than, say, those used in the program Sugarscape, in which agents have a metabolism (they must gather or trade resources to survive) and move around in space creating stable settlements. Yet they hardly make any decisions (they follow rules). So we need something like the type of agent known as Belief-Desire-Intention agents, who can not only make decisions based on their beliefs and desires, but also attribute to others such intentional states and use those attributions to modify their own decisions. With these agents, and some way of representing authority structures so that we can have binding centralised decisions, we could test the collective effect of many of them on the form of neighbourhoods or even entire cities.’

It is important here to see these agents not as abstract entities that embody the collective intelligence of an entire society, but as individuals or groups as such. ‘There is no such thing as the collective intelligence of an entire society, but as individuals or groups as such. ‘There is no such thing as the collective intelligence of an entire society. I wrote my last book (A New Philosophy of Society) precisely to demolish that idea once and for all. Rather, agency must be attributed to concrete, singular, individual entities existing at many levels of scale: persons are agents, but so are communities (when they form coalitions in social justice movements, for example). Institutional organisations too are agents, as are assemblages of such organisations, like industrial networks or federal governments.’

When using multi-agent simulations, we must first establish at what scale we will be modelling a given phenomenon. ‘For example, when modelling trade between two cities, does it make a difference what individual persons carried out the trade? (Yes, if we are modelling very short timescales). Or is it the sustained regularity and volume of trade over many decades that influenced urban form? In the case of planning bureaucracies the same question emerges. In the case of the planning of Versailles we must include the agency of Colbert, since he was personally instrumental in the making of many decisions. In other examples, the actual bosses of a bureaucracy do not matter: the same outcome would have occurred regardless of the current leader. The point is that we cannot tell a priori what level of agency is the most important without considering actual historical situations.’

DeLanda places great emphasis on ‘decision-making agents’. In practice, however, many urban interventions are based on rules – zoning laws, building codes and regulations, rights of light and so on. ‘And, if we are to believe Christopher Alexander, human beings always favour a form of ‘pattern language’. Some fairly sophisticated rule-based engines for simulating urban growth, such as CityEngine, have been developed for the gaming industry. So what does DeLanda see as being the limitations of these engines in modelling the specificities of urban form?’

‘Rule-guided behaviour is a standard approach in simulations of populations of agents. But our brains are not rule-based; neural network simulations work exclusively with pattern recognition and pattern completion, and do not store explicit representations, but only a pattern of strengths in their synapses, a pattern capable of recreating the original pattern of excitation when stimulated. It is the pattern of excitation that acts as a kind of implicit, distributed representation.

‘On the other hand, there is no need to put neural nets into agents in every simulation. The behaviour of an agent using neural nets seems from the outside to be rule driven so for some purposes we can replace them with explicit rules. And then, of course, there are institutional norms and regulations that act as external constraints on behaviour. These can be simulated simply by adding explicit constraints to agents, but if what we want to do is to analyse how building practices co-evolve with regulations, then the latter need to be modelled in more detail.

‘Government organisations (bureaucratic agencies) must be added to the simulations as institutional agents, their authority (and the authority of their edicts) modelled both in terms of their legitimacy (does it derive from tradition, or from their proven track record?) and the means of their enforcement. As legitimacy changes and as enforcement practices evolve, the rules themselves change.

‘So it is a matter of what timescales we are simulating: for the timescale typical of the duration of a construction project (say, a few years) norms and regulations can be modelled as given and unchanging; for longer timescales (say, the evolution of land-use succession in a city over many decades), the norms themselves must be allowed to change.’

Amid the rash of recent attempts to explore the potential of generating digital simulations of urban growth, DeLanda offers us some cautionary advice. Before we can generate buildings themselves, we must model the decision-making processes that give rise to them. And in order to do this, we must be able to devise intelligent decision-making agents that can influence others and reflect upon their own decisions. Only then, it would seem, would we be in a position to simulate the growth of actual cities.