In his book *Emergence: The Connected Lives of Ants, Cities and Software*, Steven Johnson presents the city as a manifestation of emergence. The city operates as a dynamic, adaptive system, based on interactions with neighbours, informational feedback loops, pattern recognition and indirect control. ‘Like any emergent system,’ notes Johnson, ‘the city is a pattern in time.’ Moreover, like any other population composed of a large number of smaller discrete elements, such as colonies of ants, flocks of birds, networks of neurons or even the global economy, it displays a bottom-up collective intelligence that is more sophisticated than the behaviour of its parts. In short, the city operates through a form of “swarm intelligence”.

‘Emergence’ has become a highly popular term in recent architectural discourse, but it is worth recalling that the term itself does not necessarily refer to contemporary design issues. On the contrary, it could be argued that emergence could be viewed most clearly in traditional urban formations. For it is precisely the less self-conscious forms of urban aggregation that characterise the development of traditional settlements, from medieval villages to Chinese hutongs or Brazilian favelas, that fits best the simple rules of emergence, such as ‘ignorance is useful’ or ‘pay attention to your neighbours’. These forms of urbanism constitute a relatively homogeneous field of operations, where individual components do not stand out, but conform to the pervasive logic of their surrounding environment. In this sense, we might understand emergence as operating within the framework of what Gianni Vattimo calls ‘weak thought’ (pensiero debolé). This is not to say that the signature buildings of the contemporary city do not offer examples of emergence. Rather, emergence is most recognisable in the proliferation of architectures of the everyday.

Yet ‘emergence’ does have a highly contemporary relevance. Importantly, Johnson extends the principle of emergence to the operations of certain software programs. If cities and software programs display a similar emergent logic, how might we make use of digital technologies to model a city? Let us begin with a note of caution: the complexity of material computation within the city far exceeds anything that we might be able to model as yet through digital computation. Nonetheless, it would seem important to address this question, and explore the potential of computational methodology for modelling urban form.

It is clear from the outset that whatever computational methodology is adopted it must itself follow the logic of swarm intelligence. In other words, it needs to exceed the capacities of fractals, L-systems, cellular automata and other systems that operate largely within their own discrete internal logic. Fractals and L-systems are limited for modelling patterns of growth in that they are programmed to behave in a particular way, and in general cannot adjust their behaviour in response to external stimuli. Meanwhile, although cellular automata can respond to their neighbours, they are fixed spatially, and therefore tied to certain underlying grids. What we are looking for, then, is a multi-agent system comprised of intelligent agents interacting with one another and capable of spatial mobility.
Swarm Intelligence

There are a number of ways of modelling swarm intelligence within a computational framework. Manuel DeLanda outlines a model of agent-based behaviour that could be developed to understand the decision-making processes within an actual city. These agents should be seen as concrete, singular individual agents, and not as abstract agents that embody the collective intelligence of an entire society. DeLanda’s research to date is based on institutional organisations rather than urban forms of the city, and while he envisages the possibility of a model which uses a system of intelligent agents capable of making their own decisions and of influencing others in their decisions in order to generate urban form in some way, he has yet to develop this model.

The term ‘swarm urbanism’ has been used fairly extensively within design circles. Often this refers to a form of ‘swarm effect’, where a grid is morphed parametrically using either digital tools or Frei Otto’s ‘wet grid’ analogue technique. Such techniques, while producing interesting effects, are limited in that they are either topologically fixed (as with a morphodynamic lattice) or base geometrically fixed (as with the wet grid), and cannot make qualitative shifts in form and space outside of these set-ups. The advantage of a genuinely bottom-up emergent system of swarm intelligence where individual agents with embedded intelligence respond to one another is that it offers behavioural translations of topology and geometry that can have radically varied outputs.

One practice that does use swarm intelligence as a fully bottom-up multi-agent design tool is Kokkugia, a network of young Australian architects operating from New York and London. They have deployed this technique at a macro level for a project in the Docklands in Melbourne, an urban redevelopment currently under construction focusing on the extension of the Central Business District into a disused port territory, and have extended it to a micro level with the design of actual buildings, as with their Taipei Performing Arts Centre.

With their swarm urbanism projects, the concern of Kokkugia is not to simulate actual populations (of people or institutions) or their occupation of architecture, but to devise processes operating at much greater levels of abstraction that involve seeding design intent into a set of autonomous design agents which are capable of self-organising into emergent urban forms. They are therefore not interested in mapping the motion of swarming agents to generate an urban plan as a single optimal solution, but rather in developing a flexible system embodying a collective self-organising urban intelligence. An application of swarm logic to urbanism enables a shift from notions of the master-plan to that of master-algorithm as an urban design tool. This shift changes the conception of urban design from a sequential set of decisions at reducing scales, to a simultaneous process in which a set of micro or local decisions interact to generate a complex urban system. Rather than designing an urban plan that meets a finite set of criteria, urban imperatives are programmed into a set of agents which are able to self-organise.

This approach tends to produce a result which – if not reducible to a single steady-state condition – will eventually coalesce into a near-equilibrium, semi-stable state always teetering on the brink of disequilibrium. This allows the system to remain responsive to changing economic, political and social circumstances. Kokkugia therefore sees the urban condition as one of constant flux: ‘Our urban design methodology does not seek to find a single optimum solution but rather a dynamically stable state that feeds off the instabilities of the relations that comprise it.’

Rhizomatic Urbanism

One way of taking this approach further from a theoretical perspective is to appropriate the notion of the ‘rhizome’ from Gilles Deleuze and Félix Guattari as an urban planning strategy. In their seminal work, A Thousand Plateaus, Deleuze and Guattari seem to offer a theoretical model that resonates closely with the logic of emergence. For example, they refer extensively to multiplicities, to packs of wolves and to the rhizome. Meanwhile, one of the central tenets of their philosophy is ‘population thinking’ – the idea that ‘the population not the individual is the matrix for the production of form.’ Moreover, they touch upon the logic of the city itself as a space of flows. Deleuze and Guattari describe the town/city as a network, a phenomenon of transconsistency, that ‘exists only as a function of circulation, and of circuits.’ For cities and towns themselves must be understood as amalgams of ‘processes’, as spaces of vectorial flows that ‘adjust’ to differing inputs and impulses, like some self-regulating system.

Kokkugia, Melbourne Docklands, Melbourne, Australia, 2008

The Melbourne Docklands proposal is an investigation into an urban design methodology based on the emergent capacities of swarm intelligence. This speculative project posits a further intensification of the masterplan in a manner that transforms its urban typology through the concept of urbanism as an ecosystem.

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is subjected to continuous movement and variation.20 As perceives both wasp and orchid in terms of a multiplicity. The orchid has evolved in response to the wasp. and the orchid becomes like the wasp, or – more precisely mutual ‘becoming’. The wasp becomes like the orchid, attributes that attract the wasp, but so too the wasp has developed a pattern of behaviour that serves the orchid. The orchid has developed ‘housed’ by the orchid, thereby giving the description a multiplicity that produces new stable bodies through disparate bodies. Difference is in the service of a fusional body that was displaced by this parasitic exchange of movement, thereby giving the description a...