Nonlinear Urbanism: a new model for urban development

Introduction

In the nineteenth century the nascent profession of landscape architecture[1] inherited a set of conceptions of nature[2] that had been part of the western mind-set for more than 2000 years (Collingwood 1945, Soper 1995, Macnaughton and Urry 1998). These conceptions, which comprise our understanding of nature, are multiple, ambivalent and often contradictory. For instance, nature is often seen as 'other' than human when we confront forest fires or hurricanes as forces beyond our control, or when human artifice is seen as a 'corrective' to nature (Soper 1998), as in eighteenth century landscape writings which view art as 'finishing' what nature has started. And yet humans are also often regarded as part of a kind of universalist nature that incorporates human and non-human worlds in endless union where the being of humanity is viewed as on a continuum with nature (Smith 1996). Sometimes nature is seen as the ancient 'home' of the human race, from which humans are alienated and to which they need to 'get back.' Researchers in anthropology and sociology refer to nature as 'constructed' and this constructivist position is present in the writings of landscape historians such as John Dixon Hunt who sees park design, for instance, as presenting or representing nature in culturally determined ways (Hunt 2002: 209). Scientists understandably mostly take a realist position with respect to nature, considering its attributes to exist outside discourse, as the focus of their investigative work. Even within a realist framework, however, nature is ambiguated, referring to the ontological modes of the human and non-human, the environment and all its various forms of non-human life and the object of study of the natural sciences, among many other things.

history

Many societies had asked questions about the natural world and humans relation to it, but it was the ancient Greeks[3] who first demanded answers disconnected from mythological and religious traditions. They had asked how does change, differentiation, diversity occur? Whence the continual transformations, the cycles of birth, death and decay? Their answer was to postulate an unchanging, eternal substratum – the One – and an endlessly changing multiplicity of things – the Many – that are somehow generated by the One. The One (being) was real; the Many (becoming) was illusory. The world we see, the world of change, is unreal. Underneath or behind it (the metaphors of relationship are manifold) is reality. Nature, understood as all there is, is a composite of a world of sensation and its ground or cause. Form, therefore, is an appearance. Only primary qualities are real; secondary

[1] The American profession, that is.
[2] Ideas to do with the natural world and the relation of humans to it.
[3] More precisely, the presocratic Greek philosophers Thales, Anaximander, Anaximenes, Heraclitus and Parmenides, flourishing circa 500BC.

qualities are not.[4] The Greeks also separated space and time. Because change and differentiation occur in time or, to put it another way, because it is through the changing phenomena of the world that we experience or register time at all, time must, like these phenomena, be illusory. The Greeks effectively banished time from their primary ontological schema and emphasised a spatial order of being which was static and timeless. As part of the natural realm, human beings should, if they wished to actualise their potential, keep their minds fixed firmly on the perfect and eternal and shun the time-bound and illusory world of things.[5]

This division of nature (that is, the universe) into the One and the Many, the division of space and time into separate absolutes, and the positing of humans as a part of and yet separate from the natural world, underpinned all thinking about nature through the Roman, mediaeval, renaissance and enlightenment periods.[6] This is a fairly rough and ready characterisation of the history of nature but it is, in general terms, agreed on by most philosophers and scientists (Torrance 1992, Simmons 1993, and see Albert Einstein's 1953 Foreword to the Galileo's *Dialogue Concerning the Two Chief World Systems* for a particularly clear exposition). Alongside the rationalist tradition of nature, however, a counter-tradition developed, based on the so-called Hermetic corpus. This understanding of nature drew its sustenance on the one hand from the Greek sense that the world was alive, 'ensouled' as Aristotle put it, and on the other from the writings of Plato whose conception of the universe as a *harmonus mundi* based on aesthetic principles of order and perfection influenced the Christian mystic-philosophers. The mediaeval and renaissance magic traditions were largely neoplatonic, and their philosophies of nature (as evidenced in the work of for, instance, Marsilio Ficino and Giordano Bruno) were quite different from the more Aristotelian conceptions of the scholastics.[7]

The renaissance gardens of sixteenth century Italy exemplify the philosophies of nature of the time. Like the universe itself they are based on perfect geometrical forms such as circles and squares, they are finite or bounded, and within them humans celebrate their participation in the loving bounty of a beneficent God. The Orto Botanico of Padua and the Villa Lante are exemplars of this conception of the universe.

The scientific revolution of the seventeenth century dramatically changed the Greek paradigm, although its basic tenets remained intact. Within little over

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[4] This distinction was first made by Democritus (c.260-c.370 BC). Primary qualities are those which things do actually have, secondary are only powers to produce experiences in us.

[5] Thales of Miletus (born 630 BC) is known as the first philosopher. He virtually invented cosmology and stands as a transitional figure between mythopoeic and rational thought. By the time he died he had produced a number of concepts that have characterised our understanding of nature ever since: the distinction between natural and artificial, the distinction between natural and supernatural, the idea that local differentiation can be explained by recourse to an underlying principle and that this principle informs all matter, that nature is intelligible, that nature is Being.

[6] There were myriad variations on the these themes.

[7] Of course it was more complex than this generalisation. Many scholastics were inluenced as much by Plato as Aristotle, and the magician-philosophers of the renaissance cleaved to much that was Aristotelian in origin. For instance the four elements underpinned the theory of correspondednces.

one hundred years, beginning late in the sixteenth century, nature became mathematicised, mechanised and cast as 'other' to humans (Westfall 1992). Mathematics and particularly geometry, became the key to nature. Descartes invented the mathematical coordinates by means of which objects could be mapped in space. As a result it became possible to extend the astronomical and dynamical studies of Copernicus, Kepler and Galileo to a general theory of nature. The Copernican revolution had replaced the geocentric universe with a picture of the universe as an infinite spatial continuum populated by planets ands stars moving according to mathematical laws of nature. Galileo, and then Newton, showed that motion was continuous, explicable by mathematics, and eternal. Once set moving the universe no longer needed God. In the popular simile of the day it was like a clock which, once wound up, simply kept going. Primary qualities were still real, however, and secondary qualities still illusory.[8] These primary qualities of nature could only be apprehended and understood through mathematics, astronomy and mechanics. This was the road to scientific truth.[9]

The baroque gardens of seventeenth century France demonstrate the topological structure of baroque nature. These landscapes could go on spatially forever, in any direction just like the infinite universe. They were composed, like the universe, of points and lines. They were the physical correlative of Descartes' x – y coordinate system. Across the great plateaus of Versailles human beings moved like atoms or counters on a board.

The Newtonian conception of nature was not challenged until late in the nineteenth century. It was, however, shadowed and to some extent animated, by the counter-tradition, which had developed alongside and often in combination with the strain of natural philosophy that eventually became what we now call science. This other canon of beliefs and practices (which included but was not restricted to alchemy and magic) had also been crystallised by the Greeks, particularly Heraclitus of Ephesus for whom 'all things are flux.' Plato, too, had referred to 'the matrix of all things' in the *Timaeus*.[10] Heraclitus maintained that there was no unchanging substratum, that in fact everything changes. There is only differentiation.[11] Heraclitus stands at the beginning of a tradition that includes Lucretius, Paracelsus, Bruno and Gassendi. These thinkers share a take on physical reality that is not based on the separation of objects from the flux. Nor on the notion of a primordial being and an illusory becoming. But their views were unable to generate the technological advances made possible by normal science, and they got left behind. Paradoxically, however, it was advances in the physical sciences that opened a door for the 'men of flux.' The development of fluid dynamics and the investigation of heat that led to the steam engine set off a new line of scientific investigation which eventually led to Einstein and the repudiation of the static universe and the notions of space an time. Einstein showed that space and time are relative and introduced the idea of the field.

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[8] Locke, Hume and Berkeley were eighteenth century champions of the division.

[9] For Plato, the Forms (his version of primary qualities) could be apprehended through steadfast philosophical enquiry.

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He freed time of its absolute character and reduced it to just another dependent variable, another coordinate in kinematic transfer equations. Time became relative and contingent. It became space-time, a newly conceived entity; a field – and a field, moreover, that is not reducible to its component dimensions. There was now no need to posit a material substratum as a carrier for forces and events, or a condition to which events are reducible. The notion of field expresses the complete immanence of forces and events.

Einstein's concept of the matter-energy field describes a space of propagation, or emergence,a space of effects. It contains no matter or material points. Instead he speaks of functions, vectors, speeds. His physics was an attempt to think outside the box of natural philosophy and science, to conceive 'the pure event' independent of a susbstratum or a material medium. Nature was no longer a unity which conditioned multiplicity. It was now an energetic activity of differentiation, a function through which it was possible to express the principles of immanence, dynamism and continuity.

nonlinearity

In May 2000 Rem Koolhaas and Bruce Mau won an urban design competition with an entry that (perhaps unintentionally) enshrined the general principles of nonlinear dynamics. The design, for Downsview Park, Toronto, Canada's first national urban park and the most ambitious public park project undertaken in North America in decades, was not a design at all, but a 'strategy.' Koolhaas' team rejected the implicit assumption that the physical design of the site would be the most significant criterion in the project's selection. They argued that the process of landscape planning and development itself, necessarily an open-ended set of complex processes developed over time, was more significant to the urban outcome than was a detailed physical design that would be rendered redundant by subsequent social, economic, and cultural developments. The strategy used ecological process as a model for future design. It proposed a 'logarithm' rather than a formal model for the site's future development. This contrasts with the discipline of urban design where the precise specifications of the formal, spatial and material qualities of urban place are considered essential. Koolhaas and Mau used landscape as the medium through which future urban development on the site might be conceived, with a strategy of public ownership in which open space and environmental conditions are considered paramount to future development decisions (Waldheim 2001). [12]

Koolhaas and Mau shift the subject of investigation from substance to pattern, from objects to relations, from quantity to quality. These are characteristics of nonlinear systems. Nonlinear dynamical theory, also called chaos theory, is the study of systems which are open-ended, unpredictable and dynamic. The equations which describe such systems do not generally have explicit solutions (Hayles 1990). They have complex forms, which often develop as a

[12] Waldheim, C *Landscape Architecture* March 2001 Vol 91 No 3

result of feedback from within the system. Nonlinear dynamical theory has been applied to many kinds of systems, from ecosystems to economic systems, from chemical maps to urban networks. Nonlinear mathematics provides ways of mapping clouds and nervous systems. It is most effective in describing patterns. Patterns cannot be measured and weighed: to understand a pattern a configuration of relationships must be mapped. The structures that emerge from such mapping have certain crucial characteristics. They are revealed as interactive webs of influence, differential networks characterized by large numbers of highly mobile components that are linked to one another by various modes of communication. In short they are like ecosystems. But dynamical systems theory is not a theory of physical phenomena. It is a mathematical theory that is applied to a wide range of physical and non-physical phenomena, a mathematics of relationships and patterns, of equations, of algebra and topology. The contrast with the mathematics of Newtonian physics could not be greater. The transition from classical science to quantum mechanics and then dynamical theory was not just a change of emphasis. It was not that now the spotlight was going to go on the relations between structures rather than the structures themselves, but that the structures were now conceived differently, were, for all intents and purposes, no longer discreet or absolute, but relational. The notion of a separation between being and becoming was put into question as the importance of time and temporality became recognized. Instead of space and time, there was space-time.

So the science of nonlinear dynamics was a response to the possibility of understanding how nonlinear events, such as eddies in rivers, clouds, weather patterns and population dynamics occur in the physical world. It soon incorporated social phenomena, with economists, sociologists and anthropologists applying nonlinear theory to their investigative programmes. Once the theory got going it seemed as if nonlinear systems were everywhere. By the 1990s it was being applied to cities. Urban systems, too, were open-ended and unpredictable. It turned out that chaos theory had developed into a tool for devising new strategies in urban development. Why?

In the 1960s Ilya Prigogine developed his theory of dissipative structures while studying systems under conditions of non-equilibrium. He realized that systems that are far-from-equilibrium must be described by nonlinear equations. He discovered that as a system moves further away from equilibrium it reaches a point of critical instability, at which a new pattern emerges.[13] This he called self-organization. It is a characteristic of what he termed ‘dissipative structures’ (Prigogine and Stengers 1984). Classic thermodynamics had led to the concept of equilibrium structures such as crystals. Prigogine introduced the concept of dissipative structures to emphasize the paradoxical close relationship between structure and order on the one hand and dissipation on the other. In classical thermodynamics the dissipation of energy was regarded as waste. Prigogine changed this view by showing that in open systems dissipation becomes a source of order.

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[13] For example, uniform temperature throughout a liquid which changes from conduction to convection

According to Prigogine, dissipative structures not only maintain themselves in a stable state far-from-equilibrium, but may even evolve. When the flow of matter-energy through them increases, they may go through new instabilities and transform themselves into new structures of increased complexity. Prigogine showed that, while dissipative structures receive their energy from outside, the instabilities and jumps to new forms of organization are the result of fluctuations amplified by positive feedback loops.[14] The so-called 'runaway' feedback, that had always been regarded as destructive in cybernetics, appeared as a new source of order and complexity in the theory of dissipative structures. Feedback is a characteristic of any system in which the output, or result, affects the input of the system, thus altering its operation. Put another way; information generated can influence the generation of further information. Positive feedback, or autocatalysis, is a property of nonlinear systems. An autocatalytic process is one that catalyses or accelerates itself. Classical physics did not have the tools for finding this out. Newton could predict the moon's orbit from the laws of gravity, but did not have the equations to describe the nonlinear feedback produced if another moon is introduced into the system, when orbits become chaotic and linear prediction impossible. For the first time in history the study of feedback loops enabled researchers to distinguish between the pattern of organization of a system and its physical structure. A system may be chaotic, but not random.

Such systems,or dissipative structures, have three main features. One, they are open and part of their environment, and yet they can attain a structure and maintain it in far-from-equilibrium conditions. This undermines the traditional view that systems must be examined as if they were isolated from their environment. These systems also run contrary to the second law of thermodynamics which states that such systems move towards molecular disorder rather than order. Two, the flow of energy in these systems allows them spontaneously to self-organise (creating and maintaining a structure in far-from-equlibrium conditions) by developing novel structures and new modes of behaviour. Self-organising systems are therefore said to be 'creative.' Three, dissipative structures are complex. Their parts are so numerous that there is no way a causal relationship between them can be established. Instead their components are connected by networks of feedback loops operating at different levels, different scales and different rhythms.

networks

The emphasis on patterns of organization rather than on structures has led to recent cross-disciplinary developments in what has come to be called network theory. Scientists from a range of disciplines (physics, economics, telematics, cell biology, computer technology) have been investigating the hypothesis that network structures have a deep underlying order and operate according to simple but powerful rules. Networks, or 'connected systems' across a variety of situations, (Internet search engines, terrorist organizations, living cells)

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[14] It is the sudden move across levels of organisation that inspired the title of Charles Jencks' book *The Architecture of the Jumping Universe.*

seem to exhibit similar behaviour patterns and structural organization (Barabasi 2002).

One of the first properties of networks to be discovered was the relatively small number of links between most nodes of a network. A simple logarithmic pattern is shared by most networks so that nodes come in clusters with short vectors between them. These clusters are themselves served by relatively weak links over relatively long distances that net the clusters into a matrix . Mathematicians Duncan Watts and Steven Strogatz have developed a 'clustering coefficient'. Their example is of a circle of friends:

> The clustering coefficient tells you how closely knit your circle of friends is. A number close to 1.0 means that all your friends are good friends with each other. On the other hand, if the clustering coefficient is zero, then you are the only person who holds your friends together, as they do not seem to enjoy each other's company.(Barabasi 2002:47)

'Small worlds,' as these clustering networks with many close links and a few distant links are called, are also characterized by 'hubs, or 'connectors,' nodes with an extraordinary large number of links (Buchanan 2002: 73). Connectors are present in very diverse complex systems, ranging from the economy to the cell. They follow strict mathematical laws, particularly the mathematical expression called a 'power law.' Apparently, nature generates, on occasion, quantities that follow a power law distribution instead of a bell curve. Power law distributions do not have a peak. The graph of a power law shows a continuously decreasing curve. If a network displays a bell curve distribution it means that most of its nodes have the same number of links, and there are no nodes that have many more links than the others. A power law distribution shows a network with a few nodes that have a huge number of links and many nodes with a few links. Such a network is called 'scale-free' because it has no characteristic node or scale. In a scale-free network the several large hubs define that network's topology, and its mobility. What is more, physicists have learned that power laws rarely exist in random networks. They most often signal a transition from disorder to order and, now that scientists are looking for them, have been spotted in the field of nonlinear dynamics as occurring in phase transitions (the transition point where a system is poised between two phases, such as water on the verge of becoming ice). The significant point here is that nonlinear systems (liquids, magnets, superconductors) display identical power laws in the critical moments as they emerge from disorder. The conclusion drawn from this was that self-organising systems can be mapped mathematically to demonstrate regularities. Such systems are governed by two main laws: *growth* and *preferential attachment*. Networks grow by adding new nodes, which prefer to attach to the more connected nodes, causing the emergence of a few highly-connected hubs. The rich get richer. Networks are always in a state of emergence. They are dynamical systems that change over time, as a result of organizing principles acting at each stage of the network formation process. The scale-free hub topology of the network both accommodates, and is caused by, the evolutionary processes of self-organising dynamic systems. Scientists are mapping becoming.

The question is how landscape architectural design work with nature when it is conceived as a 'complex, infinitely entailed, dynamic system or fluid manifold?' (Kwinter 2001: 24). How can landscape design can connect with matter-energy networks (or fields) at specific and local points, assisting the various systems with which it engages in their transformations? Can it, for instance, activate specific virtualities by generating instabilities in the system?[15] Will the system respond, as nonlinear theory implies, by transmitting a 'perturbation' from level to level, dissipating it through different sets, until a singularity emerges, a kind of difference produced by transformations at particular points along particular flows? Will this singularity combine, or be combined, with other flows to produce other differences at other scales and other levels? After all, what we call 'things' are energized by morphological processes that occur nowhere else but in themselves. Since the landscape designer works within the system, mapping the system from an external viewpoint is impossible. The system, of which the designer is a part, is mapped from within, and since the system is ever mobile, the mapping is never finished.

city

The emphasis in seventeenth century baroque aesthetics on spatiality and visuality was played out in the great urban projects of the nineteenth century, such as Haussmann's makeover of Paris, Vienna's Ringstrasse and Nash's plan for West London. In the early twentieth century cities became understood primarily as arrangements of buildings and other urban elements across a relatively unproblematic floor.[16] Mid-century urban planners such as Lynch (1960), Cullen (1961), and Bacon (1967) sought to provide theorems for urban design and planning based on empirical, spatial and visual categories designed to increase order and organisation in the urban system. Specific landscape conditions were often neutralised. Cities were zoned and spatial conditions were changed accordingly. Planners saw the city as a potentially ordered system that was prey to turbulence and disorder. Through better planning theory and practice urban order could be maximised and disorder minimised. This approach stems ultimately from classical philosophy of nature,[17] and the ancient Greek antinomies can still be found at the basis of much current urban design discourse. For instance, the natural/artificial binary developed by presocratic philosophers led to an extremely influential model of the city as an artificial realm from which nature is divided or

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[15] French philosopher Michel Serres places turbulence at the very heart of nonlinear dynamical theory. He uses the figure of the parasite to explain. The parasite first presents itself as a malfunction, an error, or nise within a given system. Its appearance elicits a strategy of exclusion. Epistemologically, the system appears as primary, and the parasite as an unhappy addition that it would be best to expel. Such an approach, according to Serres, misses the fact that the parasite is an integral part of the system. By experiencing a perturbation and subsequently integrating it, the system passes from a simple to a more complex condition.. Thus the parasite ultimately constitutes the condition of possibility of the system. By way of disorder it produces a more complex order. See Serrres (1982).

[16] See Le Corbusier, (1933), Hitchcock and Johhnson (1934)

[17] Presocratic philosophy is a dramatisation of the struggle of order over chaos.

separated.[18] Even in Plato's *Republic* we find an urban theory which walls the city off from natural processes, conceiving the latter by turns as primitive and disorderly.[19] The current emphasis on bringing nature 'back' into the city relies on a conception of the city as not natural. Under conditions in which nature is divided from urban life, it is permitted to re-enter the city as framed, acculturated, attenuated.

When nature is no longer stable, predictable, or knowable, when it is chaotic, when, in fact, there is little to distinguish the natural and the artificial at all, perhaps a new paradigm is required. The new framework for the investigation of nature by design seems to tally with the sense that society too is chaotic. This is nowhere to be more tellingly observed than in the development of the contemporary city, understood as an unpredictable and open-ended phenomenon unfolding through multiple time frames, and it is this aspect of nonlinear dynamics that has found its way into urban theory. The study of pattern is crucial to both natural and urban systems, because systemic properties arise from a configuration of ordered relationships. Their patterns share a common property: whenever we look at natural systems we look at patterns of organization we call networks. Whenever we look at cities, we look at networks.[20] If, as according to Deleuze and Guattari, all forms have a common resource, and this common resource can be diagrammed, then the diagram of a city will show the matter-energy flows constitutive of that city (De Landa 1999: 121). It is this possibility that has engaged a number of urbanists and designers in Europe and America, as evidenced by the quantity of design publications devoted to (and written by) them.[21] Drawing often on Deleuze and Guattari, these writers and designers promote a way of seeing the world for which the natural/artificial distinction is simply not relevant. Both natural systems and urban systems are self-organising, nonlinear and chaotic. Clearly this is not good for the people who look after cities. Stability and order are much easier to administrate than unpredictability and flux. Most twentieth century urban design has supported a symbiotic relationship between cities and the elected bodies that administer them. The ideal of the masterplan, for instance, demonstrates how predictability and investment go hand in hand. It is no coincidence that the primary visual tool of New Urbanism is the masterplan.

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[18] Nature can be considered as having been conceived as an urban malfunction or error, and expelled rather than integrated into the system of the city.

[19] And in the *Phaedrus* Socrates remarks that he prefers the social realm of the polis to the natural world of the agrarian countryside.

[20] Not forgetting, however, that, as we have seen, networks - webs, matrices - are not the only structure-generating patterns, and that systems are usually amalgams of both networks and hierarchies.

[21] See, for instance, most of 'New Science = New Architecture?',*AD* 67 (9/10) 1997; Bettum and Van Heusel, 'Channeling Systems: dynamic processes and digital time-based methods in urban design,' in *Contemporary Processes in Architecture AD* 70 (3) 2000; Batty, M Editorial in *Environment and Planning B: Planning and Design* 27(2) March 2000; Salingaros Nikos, 'Theory of the urban web' in *Journal of Urban Design* 3 1998; Peter Davidson and Donald Bates with Jeff Kipnis, 'Future Generations University' in *Architecture After Geometry AD* 67 (5/6) 1997.

artweb

Artweb is an ongoing research project funded by the Auckland Arts Regional Trust and being conducted at the writer's tertiary institution. The research attempts to develop a strategy that enshrines the *modus operandi* of nonlinearity - the time-sensitivity, the responsiveness, bottom-up patterns of self-organisation, and a disorderly rhythm of growth - in a nonlinear model for urban development. The project hopes to address some of the issues outlined above, and to base its investigation on the new understandings of nature and the city. It is therefore speculative, experimental and ambitious.

Artweb is a proposal for a community-based urban greenway that is invented and operationalised by the arts and the environmental design disciplines (architecture, landscape architecture, garden design). In its Auckland, New Zealand version it begins with a re-conceiving of the Auckland metropolitan area as a moving field of relationships, a network of interactive distribution systems, such as capital, traffic, water, telematics and information. A generative technique is required that can deal with these complex systems that operate at different levels simultaneously. Such a technique would be interactive and multi-disciplinary, and capable of moving back and forth between the various cultural realms that comprise the Auckland isthmus. There are three steps involved in the development of this approach. First, the city is theorised as a continuous field of intensities, rather than as a duality in the form of a set of objects disposed across a background radically different from the objects. Second, a survey of this field is not restricted to physical objects and processes, but includes the invisible and ephemeral along with the visible and enduring; incorporating the sonic, the olfactory, the legislative and infrastructural, unformed matter and raw energy; including cultural mapping of narrative and symbol, the outlawed and marginalised, and so on – the categories are infinite.[22] Third, the output is not a design, by definition immobile and intransitive, but a strategy that is flexible and adaptive, that can accommodate change over time and respond to changing economic and political forces.

A team comprising artists, scientists[23], and designers has been established to work together on the implementation of a network of physical pathways throughout the Auckland region. Utilising railway corridors, urban streamways, motorway medians, school grounds, golf courses, wetlands, private and public property, the project proposes a physical network of marginalised, left over, under-utilised and under-actualised sites and passages, distributed throughout the region and linked in a number of different ways, both physically and electronically. The urban web thus generated would be a real-time evolutionary circuit that changes and absorbs, emits, transmits and conducts information and experiences. It would also help to rebuild the ecological structure of the region by focusing appropriate funding, expertise and imagination on the incremental development of an

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[22] This aspect of the project is not unlike the mapping propositions of James Corner, but the way the mapping is used by the project is quite different from Corner's still quite synoptic and distanced approach.

[23] (such as ecologists, botanists, geologists and information technology specialists

ecologically sustainable urban infrastructure. How will it achieve these lofty aims?

The project has commenced with a series of GIS mappings of the Auckland Region depicting social, cultural, ecological and biological patterns and systems.[24] The mappings reveal the city as composed of multiple levels of organisation acting in different ways, each level advancing through time individually (in fact each of the levels is likely to contain its own time frame). Representations of these levels are superimposed and through the process of layering, *intensities*, are identified.[25] Individual intensities are considered not as autonomous points but rather as microcosms constituted by specific tropes and organising figures characteristic of the 'culture-system' inhabited by the region.[26] Intensities are not substantive. Nor do they constitute cultures; cultures constitute intensities. Moreover, the concept of the regional culture-system implies that different situations within a given spatio-temporal field are self-similar. That is to say, their elements (be they physical, symbolic, legislative or economic) are all products of the same classification system, the same social code. Of course, what counts as an intensity is a matter of how phenomena meet various criteria that are established along with the taxonomic system that is being used to identify them.

Intensities occur where relational events aligned on each layer coincide geographically. Movement between the GIS layers occurs where the events align. These areas are ripe for change, because at this point the macroscopic properties of the systems they actualise are extremely sensitive to microscopic perturbation. An intensity might develop in a situation where the *patupaiarehe*, the fairy folk of Maori legend, are said to have lived, a situation which might also incorporate, for instance, an ecologically degraded bush remnant, a culvert in an urban stream, a Trans Metro railway station and a hundred year old oak tree. Once a number of these intensities have been identified through GIS mapping the physical locations of the intensities are identified and, wherever possible, they are linked up. The result is a virtual map series of a physical network of potential situations.[27] Perturbation occurs through intervention in these situations – artistic, scientific and landscape architectural.

How do the local and the global intersect in artweb? It is argued that this nonlinear urban strategy problematises the local/global relation in new ways.

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[24] The GIS component of ArtWeb stores information about the region as a collection of thematic layers that are connected by geography. Any classification systems can be used. These are just the beginning. Artists, scientists and designers can invent their own taxonomies by means of which the region may be mapped and intensities permitted to emerge.

[25] Deleuze uses the term 'haecceity' to describe this mode of individuation: 'A season, a writer, a summer, an hour, a date have a perfect individuality lacking nothing, even though their individuality is different from that of a thing or a subject.' See Deleuze and Guattari (1987: 261).

[26] Culture-system is an anthropological term, used by Clifford Geertz. It is not ideal, but I can think of no other that captures the range of epistemological, behavioural, affective and linguistic practices that characterise what Serres refers to as 'regional epistemologies' and Foucault as 'epistemes.'

[27] The use of the word 'situation' is adopted from Connolly (2003). It implies a vastly wider aggregation of structures and forces than the word site.

Global theory is not applicable to dissipative systems organised around particular local sites, and yet the taxonomic schemes used to establish the GIS classifications that identify the sites may themselves be the product of global theory. Different levels tend to act in different ways, however, so that the locality intrudes itself as a necessary descriptive feature, defeating or at least destabilising totalisation. The map series comprises various levels both of description and behaviour. Events on one level connect with or give way to events on the next, and so on. The connections between levels mean that tiny initial changes can quickly be magnified and brought up to macroscopic expression. Movement from level to level is therefore significant. The local and the global reproduce each other so that sometimes universals appear to run through the system, and sometimes not. Structural principles (or taxonomic systems) relate different sites together by self-similarity, along with rules that state how these principles evolve over time. The local designates the site within the global at which the self-similarities characteristic of the system are reproduced. The way a particular site is understood cannot be separated from the specific organisation of signs that characterises it.

In the artweb project artists and designers can work with the mathematical, spatial, geographic and cartographic conventions that set the representational system up, engaging with the specific kinds of mark-making by means of which these conventions are instantiated in physical form. They may create classification systems based on interests in dragonfly habitats, lizard populations and *tui* flight-paths, or on the taxonomy of the sublime; on patterns of fast-food consumption or traffic-calming devices. On the other hand, artists and designers can work purely in the physical realm, permitting artworks to emerge from the specific properties of a finite swatch of terrain; from some kind of engagement with the oak tree, the Maori legend, the railway station and/or the stream. Scientists and artists can team up to design research projects that investigate empirical events (such as coliform counts in urban streams) by means of remote-sensing devices whose data can be converted into art works and laboratory operations for display on the world wide web. For, as a counterpart to the physical urban web, the project also proposes the implementation of a *virtual* network that models and monitors the physical one. This component will link the physical Auckland urban web to the Internet. Changes that take place in the urban field will be registered in cyberspace, and accessible via the project web pages. These pages will link the project to other similar projects around the world, spreading the local initiative and inviting new initiatives, feedback and input from elsewhere. To do this, the remote sensing devices, including web-cams, that are established at selected locations, will all relay real time data to the website. This information includes ecological data such as bird counts to check how many *tui* are coming back into areas after revegetation, or waterway pollution levels, as well as images and data from art projects associated with the selected locations. Artists and designers will work with local authorities, landscape architects, ecologists and in some cases engineers to establish a site development trajectory which permits the artwork to emerge in interaction with the entire situation (instead of happening as an afterthought, as is often the case). Thus, if the artwork is located in a specific terrain, a 'site,' it becomes identical with the site, a quality of the site, or a site condition. The artists and designers proposals are realised in the urban network through local authority, corporate and private sponsorships, and through science and arts grants. The potential for academic research is matched by the potential for landscape architectural practitioners to become involved in projects that 'bubble up' through the community system as well as being commissioned.

Artweb offers an alternative engagement with the physical coordinates of the Auckland isthmus. It can be considered hierarchically, as a series of levels on which observers may operate according to whim or necessity. It can be considered as a viscous medium, dense with particular and specific situations at various moments of emergence. It can be considered as a web of art-sites for Aucklanders and visitors to Auckland to navigate in their leisure time. It does not disrupt existing and planned urban structures but insinuates itself into the interstices of those structures, and grows and fades according to internal and external stimuli, developing from within, a dissipative system that is able to reinvigorate itself through its openness to catalytic input from within and without the system. Changing in place and in time (interventions come and go, entire intensities come and go, artists and designers come and go: these arrivals and departures themselves are mapped into the urban field), artweb is itself a multiplicity that has no essential reference to place but is yet specifically 'regional.' An adaptation of place to situation, artweb is an event, driven not by abstract laws or rules, but by a real responsiveness to temporality (school and community projects, for instance, of long and short 'duree') – drawing matter-energy into a process of becoming ever-different, an ongoing production of the new through an openness to the dynamic transformations of urban systems.

Conclusion

The ancient Greek tradition of nature, invented by the presocratic philosophers, codified by Plato, and passed down through the ages chiefly through the writings of Aristotle, became the basis for early scientific thinking. This was not the only philosophy of nature that was transmitted to the modern world however. Another, counter-tradition developed out of the writings of Heraclitus of Ephesus (fl. 500 BC), who argued that everything is in a state of flux. His maxim that you cannot step into the same river twice was taken to mean that everything – *everything* – changes all the time. Influenced by Heraclitus, Plato in the *Thaeatetus* refers to 'the matrix of all things,' and his successors the Neoplatonists developed a line of enquiry that lead ultimately to the work of Henri Bergson and Alfred North Whitehead early in the twentieth century. Both argued that form is only a snapshot of time, and that virtual processes are undergoing continual actualisation, that reality is continually making itself. These philosophies have largely been borne out in nonlinear dynamical theory. Artweb draws on this body of thought to investigate urban development from a dynamic point of view.

Working with urban and community planners, artweb utilises advanced computer-based systems to redefine the complex multi-dimensional network of structures and flows throughout the region, creating a platform for physical projects and offering countless opportunities for artistic and scientific intervention. The artweb project explores in practical terms the principles of nonlinearity and self-organisation as theoretical foundations for urban landscape architecture, design and planning. While nonlinear dynamical theory has been much discussed in recent times with respect to urban design, little application of the theories has taken place, certainly not in NZ. The project tests the idea of nonlinear environmental design in the field. Artweb is an approach to urban landscape architecture that draws on the idea that the city, like an ecosystem, is an open-ended system, a three-dimensional network of diverse forces into which the design of urban environments should plug. Mobile, heterogeneous, open-ended, the urban realm requires design strategies that reflect its dynamic nature. Artweb aims to deliver a new kind of 'product' both to local bodies and to the people of Auckland: a real time physical network of artworks and scientific research sites and processes linking the Auckland Region from within. The result is an open-ended system of ongoing transformations that all Aucklanders can participate in either by means of physical interaction or on-line.

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