

REVIEW ARTICLE

Evolution and urban form: staking out the ground for a more mature theory

Karl Kropf, Urban Morphology Research Group, School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B15 2TT, UK and Built Form Resource Ltd, UK. E-mail: karl.kropf@builtformresource.com

Philip Steadman (2008) *The evolution of designs: biological analogy in architecture and the applied arts*, revised edn (Routledge, London, UK, 302 pp. ISBN 978-0-415-44753-9)

Michael Weinstock (2010) *The architecture of emergence: the evolution of form in nature and civilisation* (Wiley, Chichester, UK, 280 pp. ISBN 978-0-470-06633-1)

Brenda Scheer (2010) *The evolution of urban form: typology for planners and architects* (American Planning Association, Chicago, USA, 129 pp. ISBN 978-1-932364-87-3)

Stephen Marshall (2009) *Cities, design and evolution* (Routledge, London, UK, 342 pp. ISBN 978-0-415-42329-8)

What are the basic building blocks, the alchemical elements of cities? What do we get when we boil down the complexity and diversity that we see in Ur, Troy, Tokyo, Bombay and Salt Lake City, or any other city for that matter? One of the more enduring answers to this question is the primitive hut. It is a powerful and resilient idea that has exerted its attractive pull over several millennia as witnessed by writers such as Vitruvius, Alberti, Laugier and Semper. Its appeal seems to lie in the combination of a simple iconic image and the possibility that it tells a story: the just so story of architecture. By extension, it tells the story of human culture and feeds the perennial desire to find our origins.

Following this lead it becomes clear, however, that the primitive hut is not so much an answer as part of the question. In a way it encapsulates the question with the suggestion that buildings have *evolved*. We started with something simple and have ended up with something very diverse and complex: from hut to metropolitan region. And as a number of recent books show very clearly, the idea of the evolution of built form is not just an evocative metaphor. Four books in particular stand out for the rigour and detail they provide in exploring how the idea of evolution can help

us understand the diversification of architecture and urban form and its relation to the social processes of human culture. This article examines the thinking embodied in these four works and in doing so seeks to assess the extent to which they work together and begin to stake out the conceptual ground out of which a more mature and coherent theory might grow.

Evolutionary conceptions of the built environment

One book out of the four – Philip Steadman's – is unusual as the subject of a review for the fact that it is nearly 35 years since it was written and 5 years since a revised edition was published in 2008. The fact of its republication after such a long gap is one of the reasons it is worthy of review. Interest in biological and evolutionary thinking has mushroomed recently, as witnessed by the three other books under review here. Steadman's remains, however, an essential guide and still fulfils its original purpose of making up for the surprising lack of any thorough historical investigation into the use of biological analogies in architecture and the

applied arts. It is also worth revisiting because the year of its original publication, 1979, was of particular interest for evolutionary thinking as will be explored later.

Here, it is appropriate to start with Steadman's superb historical account because it provides the background to evolutionary conceptions of the built environment and human culture. It is abundantly clear from even the first few pages of the main Introduction that there is a long history to the use of evolutionary ideas in architecture and urbanism and the way through the analogies is a perilous one, littered with traps for the unwary and for anyone too light and loose with language. The number and range of the hazards only becomes evident chapter by chapter, but what is equally evident is that the path through them is being picked out by someone with the calm confidence of sustained effort and experience.

Despite diffidently downplaying his own contributions, Steadman clearly brings an enormous richness of understanding to his discussions as well as an acute critical skill. He also has the rare ability of giving quite dense material a sense of lightness and narrative drive. Exploration of the different versions of biological analogy brings with it awareness that this is not just a 'history'. Progressing through the classificatory, anatomical and ecological to the evolutionary analogies, Steadman provides not only a critical account of historical interpretations of biological analogies but also quietly creates a kind of manifesto in reverse. He highlights the fallacies and misunderstandings and leaves behind key, cogent principles that can be taken forward in planning and design.

In the context of a focus on application and development of the ideas, Steadman's words of caution are particularly relevant. His account reveals how historical debates have had a lasting effect on our own contemporary discourse, not least because of the terms we have inherited. These can act as drag weights that skew and polarize the debate in particular and limited directions.

A prime example is the Darwinian/Lamarckian dichotomy. To summarize very

briefly, in the century before Darwin, J. B. Lamarck set out an evolutionary theory in which he suggests that 'all that has been acquired, imprinted or changed in the organisation of the individual during the course of its life is preserved by generation and transmitted to the new individuals that descend from the individual so modified' (Steadman, p. 121). Lamarck was trying, as Darwin and Wallace did after him, to explain the adaptation of organisms to their 'conditions of existence' and the diversification of form corresponding to the diversity of environments. Darwin and Wallace instead put forward the idea of natural selection, involving three essential elements: 1) reproduction with heritability of features; 2) random variation; and 3) selective mortality. Adaptive changes can accumulate because organisms produce more offspring than needed to maintain a population and not all survive, in part due to competition for limited resources. The offspring whose random variations are least suited to the environment do not survive to reproduce while the offspring with beneficial variations do. The result is the possibility of change in the characteristics of the species (and formation of new species) over many generations.

The detail of all this matters because it is central to the whole endeavour of making the biological analogy anything more than just a literary conceit. While Steadman remains circumspect, carefully surveying the perimeters of the places where angels and fools take their different paths, he is quite staunch and resolute in making the case for a 'science of the artificial' and in particular, the scientific study of the *products of design* as distinct from the design process. His efforts towards clarity are fundamental to that overarching objective.

To return to the detail, the distinction between the Darwinian and Lamarckian theories is central to Steadman's position: 'there is one central fallacy, I believe, at the heart of the historical analogies made between architecture and biology which arises principally out of the improper equation of the Darwinian mechanism of organic evolution with the 'Lamarckian' characteristics of the

transmission of culture and the inheritance of material property' (p. 5).

The inverted commas on Lamarkian but not Darwinian are telling. It hints at a lingering dissatisfaction with the extent to which Lamarkian ideas provide an accurate model of cultural evolution as well as discomfort with the drag weights hanging on the term Lamarkian. Steadman highlights this latter issue in his Afterword, written for the revised edition, saying,

there is a strong implication, sometimes even explicit, that cultural evolution *cannot* have Spencerian or Lamarkian characteristics because the theories of both of these men have been discredited as explanations of biological evolution. This is surely a *non sequitur* ... I would be happy myself to drop the term 'Lamarkian' from descriptions of cultural evolution if it causes confusion but I would still want to argue strongly for the proposition that cultural and technological change are 'instructive' processes ... and that they are characterised by intention, foresight and the conscious attempt to achieve some desired future state (p. 247).

Further passages in the Afterword point to a more equivocal position on Lamarkism.

The question of whether technological evolution is a Darwinian or a Lamarkian kind of process crops up repeatedly, and is answered in two different ways. It is neither of these, but belongs to a larger class of evolutionary processes of which Darwinian natural evolution is (another) special case. Or else it is both at once (p. 266).

So, as Steadman suggests, perhaps the problem is the label. That is, in continuing to use the label we are forced to construct our own model in a way that does not fit the evidence. Before looking more closely at the elements that make up the models and the evidence and ideas offered by the four authors it is worth pointing out that in a strict sense, in terms of language, Lamark was right and Darwin was wrong.

As openly acknowledged by Darwin, the

theory of natural *selection* explicitly takes as one of its central ideas a notion borrowed by analogy from human animal husbandry: selective breeding. And while it may be considered a matter of semantics, put simply *there is no selection in biological evolution*. Selection assumes a conscious, intentional agent, something Darwin was at pains to demonstrate is not part of the *natural* process. The mechanism described by Darwin (and Wallace) is fiendishly difficult to describe in simple terms, so, being a good communicator, Darwin used the tried and tested method of describing something unfamiliar and complicated in terms of something simple and familiar. This is understandable because the process looks 'as if' it were intentional. And thus numerous notable authorities on evolution have followed Darwin's lead. Richard Dawkins (1976) invokes the human notion of selfishness, Stephen Jay Gould (1982) refers to the creative power of selection and Daniel Dennett (1995, 1997), though arguing strongly that there is no intention, still uses the heuristic device of 'as if' intentionality.

So while the structure of Darwin's and Wallace's mechanism may have come through as the core of current evolutionary theory, Darwin's choice of descriptive language has coloured the debate and in all likelihood influenced the direction and timing of developments along the way. If there is no selection and certainly not *for* anything, is there an alternative description? A better analogy would be the idea of *refutation* as put forward by Karl Popper (1963). Evolution at the level of the population is fundamentally positive by a kind of negative retroaction. What survives is what is *not refuted* by interactions with its environment. There is no 'correct' or 'right' answer in evolution, just as there is no positive proof in science, only refutation. It would seem that both science (human culture) and natural evolution go forward by a double negative. There is no right, only not wrong. Within those limits, however, there is obviously scope for 'worse' and 'better' (more or less wrong).

An issue that is inextricably tied up with the mechanisms of evolution is the now well

established fact that the ‘unit’ of evolution is the species, not the individual (nor, strictly speaking the genotype). The unit of evolution is the population. And, as has been demonstrated, if you look at the relationship between the individual and the population (rather than just the offspring of an individual), in the long term species (populations) change ‘as if’ there were inheritance of acquired characteristics. ‘At the population level, with appropriate selection of phenotypes, environment and experience will generate better-adapted individuals on which selection can work. To this extent, the population behaves as a Lamarkian unit’ (Bateson, 1980, p. 176).

Darwin, as is well known, shifted his views about Lamarkism in the belief that geological time was insufficient for a process of evolution which would operate without Lamarkian inheritance. He therefore accepted a Lamarkian position in later editions of *On the origin of species*. Theodosius Dobzhansky’s discovery that the unit of evolution is the population and that the population is a heterogeneous storehouse of genic possibilities greatly reduces the time required by evolutionary theory (Bateson, 1980, p. 199).

Perhaps the best option is to allow *both* Darwin and Lamark their ‘as if’ formulations and, as Steadman suggests, jettison the labels. In the spirit of Steadman’s book the whole point is to identify what, in Popper’s terms, remains unrefuted and might serve us in seeking to understand the transformation, diversification and evolution of built form. The aim should be to bring together the appropriate objects, concepts and strategies to spell out the terms for a more abstract and transferable conception of evolution. Important steps in this direction have been made by two clusters of books. Setting the scene as it were and providing some of the essential terms of reference are four key texts on urban form of 1960–61: *The image of the city* by Kevin Lynch (1960), *Townscape* by Gordon Cullen (1961), *Alnwick, Northumberland: a study in town plan analysis* by M. R. G. Conzen (1960) and *The death and*

life of great American cities by Jane Jacobs (1961). Four books focusing more specifically on evolution were published in 1979. In addition to Steadman’s original version of *The evolution of designs* there was *Lettura dell’edilizia di base* by Gianfranco Caniggia and Gian Luigi Maffei (1979), *Gödel, Escher, Bach* by Douglas Hofstadter (1979), and *Mind and nature* by Gregory Bateson (1979).

The concept of emergence

Hofstadter and Bateson in particular brought into clearer focus a concept rooted in the distinction between individual and population: the concept of *emergence*. To hazard a definition, emergence occurs when there is an interaction between a number (population) of individual elements such as particles or compounds and the interaction results in the formation of stable patterns of interaction. If sufficiently consistent, those patterns can themselves be identified as ‘elements’ but at a level up from the individuals involved in the interaction. These in turn can interact to form higher level patterns of interaction. Sub-atomic particles interact to form atoms, atomic elements interact to form molecules and molecules interact to form substances and objects of various kinds. Immanent in the interactions and patterns is a hierarchy of levels. Hofstadter elaborates the mathematics and logical underpinnings of levels and emergence while Bateson suggests there are common patterns of emergence in both biological evolution and learning. Bateson puts forward the idea that both are recursive and emergent and argues the two are not only analogous but intimately interconnected. Both Hofstadter and Bateson invoke the hierarchy of levels arising from the distinction of elements and emergent patterns of interacting elements. More recent publications such as *Evolution and the levels of selection* by Samir Okasha (2006) demonstrate the extent to which the ideas of emergence and the immanent hierarchy are central to current discussions and debates about evolution.

Caniggia and Maffei’s work of 1979

extends the tradition of biological analogy in the field of architecture as charted by Steadman and incorporates as a fundamental principle a hierarchy of levels and notions of emergence similar to that of Bateson and Hofstadter. As detailed elsewhere (Kropf, 2001), the principle of the typological process set out by Caniggia and Maffei is essentially another variety of evolutionary process but set out in terms specific to the built environment.

As has been noted many times, however, the connection between the ideas of emergence and urban form goes back to *The death and life of great American cities*. In the latter part of this book Jane Jacobs identifies the city as a problem of 'organized complexity'. She borrowed this term from the article 'Science and complexity' by Warren Weaver (1948). Weaver's work in communication, probability and statistics, along with that of Claude Shannon, Norbert Weiner, Ross Ashby, and others was seminal to the gestating field of complex adaptive systems and the concept of emergence (see Johnson, 2001, for a general account).

This connection extends into Michael Weinstock's book *The architecture of emergence*, which cites Weaver and builds on the ideas that have been developed since Weaver and Jacobs first entertained them. The title of Weinstock's book is deliberately ambiguous. His intention is to take the likely conventional interpretation and invert it. It is not a book about architectural design inspired by emergent phenomena or generated by algorithmic transformations. It is about the *structure* of emergence as a general process.

In essence Weinstock has taken the idea of jettisoning the old labels and concepts of evolution as the core principle of his endeavour and recast the content of physical geography, ecology, biological evolution, cultural geography and cultural evolution in terms of emergence. At first this appears to be either redundant or a grandiose extravagance. The book is neither, both because of the matter-of-fact and unpretentious way in which it is written and for the fact that it connects with ideas of emergentism that extend back further than might be expected. As noted by

Hacking in *The taming of chance* (1990), emergentism was identified as early as 1874 by Emile Boutroux (see also the work of G. H. Lewes, 1875). Hacking (1990, p. 157) says of Boutroux's work, 'the fundamental tenet is emergentism and a hierarchy of structures'. Boutroux saw that 'laws of complex forms were not determined by laws of simpler forms, but came into being as those complex forms emerged in the history of the universe' (Hacking, p. 214). This is an argument against Laplacian determinism and necessity. While the interactions at one level show limits, conditions and regularities described by 'laws', those laws do not determine or fix the emergent patterns arising from the interactions. There is contingency in the move up from interaction to patterns of interaction.

The recasting of current knowledge by Weinstock in the terms of emergence is not trivial and is an essential step in moving out of a paradigm that remains pegged in one part of the nineteenth century. At the risk of an overstatement, the shift that might be crassly summarized as a move from 'survival of the fittest' to 'the emergence of complex adaptive systems' is as close to a Kuhnian paradigm shift as is likely to be identified in the century since relativity and quantum theory. Nor is Weinstock's a singular view. He has made a significant effort in compiling evidence from a wide range of sources, with the result that the book functions as a snapshot reference of current thinking. One might see companions to this book in works such as those of Cavalli-Sforza (2000), Wrangham (2009), and Diamond (1998).

In the context of Steadman's historical analysis and his identification of different types of biological analogy, Weinstock's work is a broad survey that views the emergence of architectural and urban form as a general phenomenon that is one of a family of evolutionary processes. Indeed, the discussion of human structures and settlements occupies a relatively small part of the book. It is no less valuable for that, particularly when seen as part of a larger effort to shift the terms of the discussion and establish a field of view that sheds light on and brings new significance to

evidence and detail that might otherwise have remained obscure. In a very direct sense, Weinstock goes a significant way in picking up the point hinted at by Steadman and made more explicit by Bateson that cultural evolution should be seen neither as completely different from nor merely an annex of biological evolution but rather one kind of evolutionary or complex adaptive system that works *along with* biological evolution. One might add the views of Daniel Dennett (1995, 1997), in particular his discussion of internalising the evolutionary mechanism (what Dennett calls 'Generate and Test') through language and other 'mind tools'. In this view cultural evolution appears as a kind of *intensification* of biological evolution made possible by the emergence of conscious intentionality and the significant scope for recombining ideas in different ways. This is, in essence, what Boutroux was saying as a general principle in the nineteenth century and the idea that C. S. Peirce (1958) began formalizing with his developments of logic, semiotics and statistical reasoning. Bateson integrated these initial steps with developments in evolutionary theory, cybernetics and systems theory and posited a formal structure that incorporates biological evolution and learning as interlocking processes. Bateson's structure suggests that we have had a model for cultural evolution right in front of us for some time, a model that is fundamentally social, allows for growth, emergence and diversification and avoids the pitfalls of Lamarckism and Darwinism. That model is *learning*.

The typological process

The nexus of ideas embodied in the four publications of 1979-80 and advanced significantly by Weinstock points us squarely in the direction of Brenda Scheer's book, *The evolution of urban form: typology for planners and architects*. In essence, Scheer has taken as a starting point building typology, in particular the typological process of Caniggia and Maffei, and elaborates the concept with evidence and case studies from the United

States.

Scheer's book (like Caniggia and Maffei's) is very openly aimed at practising planners and architects. The result is not just an extremely clearly written and straightforward definition and explanation of building types and the ways in which they are transformed. It also weaves into the explanation pragmatic detail and experience that gives the concepts greater depth and scope for greater elaboration.

Scheer's account is particularly incisive in setting out the context in which types succeed or fail. The issue is highlighted by contrasting the aims, objectives and 'type solutions' of the New Urbanists with the pervasive 'standard models' of suburban offices, strip retail and extensive suburban residential development. Basically, one of the questions she is asking is, if the New Urbanists' solutions are so much 'better' why is it so difficult to get them built? In answer, she points directly at context or the 'conditions of existence' of a building and building type (perhaps better expressed as, the conditions of coming into being).

Some types are very resilient. The sub-urban office type appeared suddenly and has changed very little in the past 50 years. One would expect it to continue as long as the conditions that produced it stay nearly the same, but conditions can sometimes change dramatically without affecting a type very much. Partly this is because types represent a customary way of doing something, a way that is familiar for builders, predictable for lenders, and expected by businesses. Customary types exert a very strong resistance to change (p. 34).

This and other passages cast a particular light on ideas such as selection and transmission of characteristics. Who does the 'selecting' in such a case and from whom to whom is the idea transmitted? In this and other respects, relative to the starting point of Caniggia and Maffei's typological process, Scheer opens out the range of possibilities for the origin of the elements that contribute to a type as a basis for design. In her account it becomes clear that the component ideas might come from anywhere but to be realized and

progress from an idea to an actual building those ideas are subject to fairly rigorous ‘tests’ in the form of limits and conditions imposed by other agents (for example, the ‘market’, lenders, insurers and clients). As a process this looks more like a ‘chance’ recombination of elements combined with an ‘epigenetic’ process of viability testing than direct transmission of acquired characteristics. Like Caniggia and Maffei, Scheer sees the small-scale, incremental modifications of forms as a source for new types but the transmission of those changes is far from direct. Looking at the processes described by Scheer allows a final reflection on Lamarck. The true equivalent of the inheritance of acquired characteristics in cultural evolution would be if the modifications to a particular physical artefact (somatic changes over the life of the artefact) were *necessarily* transferred to the next artefact of that kind to be made. This is clearly not what happens because of the nature of cultural reproduction and the fact there is always a *choice* in what is carried forward. As pointed out by Steadman, and reinforced by Scheer as well as Caniggia and Maffei, what evolves is the type, that is, the idea that forms the basis for the production of a population of artefacts.

A crucial point made clear by Scheer is that the type resides not in the head of a single person but in a community. One person’s idea of the type will necessarily be a ‘variant’ more or less equivalent to others in the population. That artefact may be a gesture, a sound, a story or a building. Any variation in the production of the artefact or, if the artefact is long-lived, any transformation of the artefact, is not transferred directly to the next artefact. The next artefact is mediated back through the idea, which necessarily involves interpretation, always a potential source of error or variation. And as noted, the mediation also involves choice. As Scheer’s account of the process of typological transformation shows, that choice is not often down to one individual but a group. It is this part of the process, like epigenesis, that results in the strong conservatism in the evolution of types.

These considerations point in two

directions. One reinforces the sense in going beyond the Darwinian/Lamarckian dichotomy, the other reinforces the necessity of detailing the evolution of urban form in its own terms – while still seeing it as a variety of complex adaptive system sharing a common set of principles with others in a family.

In pursuing the latter direction, Scheer rightly and very effectively emphasizes the potential pitfalls in something as seemingly simple as defining the building type. For example, she argues that if we are to get a clear picture of the processes of the built environment, it is essential to distinguish between *form* types and *use* types. She notes how preconceptions about one or the other can confuse efforts at understanding the nature of development and change. *Form* types can become habits and in effect exert an inertial force even in the face of changing conditions. Scheer also highlights the profoundly social roots of the type and the conditions in which types arise and survive.

Similarly she looks closely at the interconnections between forms at different levels of scale. In this regard she makes an extremely insightful contribution by defining several general types of urban tissue characteristic of the US: *static*, *elastic* and *campus*. Static tissues are characterized by regular, repeating forms of street, plots and buildings, generally with minimum standard dimensions suited to the prevailing building type. The tissue is ‘static’ because the regularity, uniformity and tight dimensions (in particular with respect to ownership) tend to resist change. There is essentially a higher threshold of effort, energy and resources necessary to effect significant transformation than with other types. Elastic tissues tend to be irregular with a wide range of forms and sizes that present a lower threshold for change. In terms of process, static tissues tend to be the product of a single design effort while elastic tissues are generally the result of a longer process of incremental change. Campus tissue is typically made up of a large area with routes and a range of building types set in the open without individually defined plots. Examples are university and hospital campuses.

Scheer examines these different types and their characteristics both in terms of geometric patterns and use and, importantly, the social roots of their formation and variable resistance to change. In exploring the specifics of type and transformation, urban tissue and the mechanisms of social legitimacy and control, Scheer not only paints an unflinching picture of the North American landscape but also articulates the terms for a different way of looking at and dealing with that landscape.

However, there is a certain resignation in her analysis.

The twentieth century saw the rise of two grandiose urban design concepts that require an outright rejection of evolutionary processes in the city. The immediate comparison between modernist city planning and new urbanism may seem ludicrous, given their different origins and goals, but they spring from the same kind of impatience with the slow-moving evolutionary processes of urban transformation.... In each, the architectural formula is the most compelling branding of the movement, and in each, it has been easily distilled, commodified, and ultimately degraded by appropriation for banal economic goals that have little to do with the ideals of the movements themselves (p. 107).

Yet this view is not cause for despair.

A different idea of urban design, one that returns to older processes rather than older forms, could be more effective. By conditioning ourselves to accept *what is* as the major frame of the urban field, we can *project* and plan the future from lessons and patterns of the past (p. 107).

As will be explored later, Scheer goes on to set out the notion of *projective urbanism* built on the lessons of her detailed investigations of evolutionary processes. But there is a lingering catch in the analysis, something unresolved that is difficult to pin down. The catch is a fundamental feature of 'the system'. It is the *reflexive problem*. The problem is that in examining the evolution of urban form we are attempting to describe a process in which we, as humans, participate. In the quotation

above, Scheer suggests Modernism and New Urbanism 'require an outright rejection of evolutionary processes in the city'. But is it possible to say that a particular form of development is *not* part of the cultural evolutionary process? Surely if it is made by humans it is part of the process. How can we say one form of development is more 'natural' than the other? Is it down to us humans or is it out of our hands? Are our decisions 'natural' or 'intentional'? Or is that a false dichotomy? And as in the related spheres of economics and politics, it is important to be aware that the use of the term 'natural' can be used as a cloak to justify a (political) preference and arguing that 'there is no alternative'. The reflexive problem therefore presents two challenges. One is to look closely at the process to see if there are in fact unintentional, emergent patterns in the built environment. The other is to ensure the evolutionary model is flexible enough to accommodate all forms of development but reserve judgement on how well any particular form fits with the social and cultural habits and values it is supposed to be serving. It is possible to maintain both an objective and a subjective view, a description and a preference, but, if we want to be clear, they should always be separate.

Another possibility is that dissatisfaction with results can prompt a closer investigation of the process. To a large extent this is the case with the evolutionary model of the typological process as put forward by Muratori (see Cataldi, 1984), Caniggia, Maffei and others, such as Cataldi (1981). It was an explicit reaction against what was perceived as the negative and destructive acts perpetrated in the name of Modernism and progress. Scheer takes a similar stance as a starting point but extends her position in a number of directions. First and foremost she widens the evolutionary approach and typological process to cover the contemporary vernacular of North American strip development, big box retail, suburban office parks and more broadly 'edge city' type development. And while she sees it as essential to understand how these places emerge and evolve and in particular their resistance to change from the top down, she

also sees the evolutionary process as a potential source of alternative solutions coming from the bottom up. This is what she accuses the Modernists and New Urbanists of rejecting. The reflexive problem by no means vitiates an evolutionary approach to design. The key is to know that there is a catch and understand the extent to which any given form is the product of direct control or an indirect, emergent pattern resulting from interactions at another level.

Conceptual implications of an evolutionary approach

Stephen Marshall's book *Cities, design and evolution* goes a significant way in spelling out the basis for getting to that point. Marshall takes twentieth-century Modernism as a jumping off point. Throughout the book he returns to the subject and the specific case of Glasgow. In many ways Marshall's book is a complement to Scheer's. There is a common grounding in evolutionary theory but whereas Scheer looks in detail at the phenomena and processes specific to a particular time and place – twenty-first century North America – Marshall explores some of the more detailed conceptual and theoretical implications of an evolutionary approach.

At the outset he is concerned to establish the basic elements of urban form to clarify what exactly is 'evolving' and also how it evolves. That is to say, his aim is to articulate evolutionary ideas in terms of urban form from the start. This involves acknowledging that elements can be identified at different scales in a hierarchy and that there are distinct differences between elements at different scales.

As he puts it, 'our task here is to find out what the similarities and differences are at the different scales with respect to the *urban* context' (p. 60). Exploring a range of potential candidates for elements, from centres and neighbourhoods to zones, he argues the case in the end for three basic elements: the building, the plot and the route. This both parallels and reinforces the selection of

elements within Conzenian and Muratorian urban morphology and typology. And like Caniggia and Maffei, Marshall sees the street – a route lined on either side by plots containing buildings – as the main building block of urban form: the integration of building, plot and route.

Reflecting on this issue of building blocks in the context of an evolutionary process raises the question: what is the role of evolution in identifying the basic units of urban form? As suggested at the outset of this review, an idea that encapsulates this question is the primitive hut (illustrated in Scheer's introduction to the concept of type). Looking at the idea of the hut again in the light of the ideas of emergence and cultural evolution as an intensification of biological evolution puts the question of 'building blocks' into greater relief. The hut is only part of the story in more than one way. As Bateson points out – and Weinstock reinforces – the whole idea of emergence makes no logical sense without the element of time. Bateson's half throwaway answer to the old paradox of which came first, the chicken or the egg was to say, a different kind of egg – with time they iteratively change each other. This resonates with Hofstadter's discussion of recursive definitions: a recursive definition never leads to infinite regress or paradox because 'it never defines something in terms of itself but always in terms of *simpler versions* of itself' (2000, p. 127).

All of which emphasizes that the hut is not an origin but an iteration in an ongoing recursive definition. Nor does the hut make sense in isolation from other forms, underlined itself by Caniggia and Maffei's simple but profound observation that a route is a necessary complement to a building in order to get to and from the building. The hut and track necessarily evolved together and can be seen as emergent forms defined recursively. And the iterations of the definitions extend into the pre-human activities of a range of other species. Many species of mammal make nests, dens or burrows and tend to structure their territory through habitual patterns of movement to and from the nest, leaving persistent tracks. This brings in the third

fundamental element with a non-human precursor: territory. The plot is a later stage in the recursive definition of mammalian 'core territory'. As importantly, and pointed out by both Weinstock and Marshall, these elements in human culture are the result of social action. Evidence suggests early human shelters were made and used by social groups, not lone hermits. The three elements co-evolved with the social interactions of humans.

The foregoing unequivocally blurs the boundaries between what might be considered natural and artificial and brings us back to the question of intentionality. And it is with these issues that Marshall makes a very significant contribution.

He demonstrates that each of the three fundamental elements has distinct formal geometric and structural as well as generic functional characteristics that limit the ways in which the elements can be combined into aggregates and patterns. This is an approach that follows from Steadman's other great work, *Architectural morphology* (1983). Marshall also shows that because of these limits there are some forms of aggregate that are statistically more numerous (in terms of possible combinations) and therefore much more likely to arise.

With respect to the resulting patterns, Marshall also makes a distinction between different kinds of order: *systematic* order and *characteristic* order. To explain the difference he says that systematic order is

like a stepped pyramid, where all the stone blocks need to be in a particular arrangement in order to create the macro-scale pyramid. In contrast, characteristic order is like the roughly conical shape of a sand pile The 'rules' that make the roughly conic shape are to do with gravity and frictional resistance of the sand grains (p. 80).

Paraphrasing, systematic order is the direct result of intentional acts of construction/modification to create a whole object at a given level, for example a single building or a street grid. Characteristic order is an indirect result of a number of acts in which the order emerges one or more levels up from that of the

individual elements being created. Thus a characteristic order of street *patterns* arises when individual streets are created at different points over time.

This gets to the heart of the question of whether the built environment is natural or artificial. It is both. It is quasi-natural because of the fact that the built environment has a complex hierarchical structure of levels of scale and involves a population of agents. A given agent can therefore create intentional order at one level, for example a large scale plot on the edge of a settlement that combines with similar but independent actions by other agents to create emergent (unintentional/natural) order at one or more levels up the hierarchy, for example a fringe belt.

One of the aims of an evolutionary approach should be to distinguish the two – the intentional and emergent – and establish the extent of each. How much of a city is emergent and how much intentional and what is the relationship between the two? Are there repeating emergent patterns – regularities – that arise irrespective of the specific forms created at the lower levels?

To this end Marshall sets out a number of tools we might use in this endeavour: combinatorial/statistical analysis, geometric analysis and the analysis of the social logic of structures.

Marshall also uses two terms in distinguishing types of process: 'city design' in opposition to 'urban ordering'. City design is 'the design or planning of a city in a definite form at a given point in time as a whole, finite unit'. If I interpret the term correctly, this is systematic order applied to the city as a whole and at all the lower levels. In contrast, 'ordering' can be intentional but not extend to the comprehensive 'design' of a whole unit. For example, buildings might be deliberately set on a consistent building line along a street without designing every other detail of the whole street.

Under scrutiny the distinction between these two types of order and process in Marshall's text can blur to some extent but that does not undermine the principal observation that the opposite of intentional design is not total,

chaotic disorder. Nor does it undermine the value of trying to understand what contributes to emergent order and how we might work with it and avoid working against it to achieve our own aims at a given point.

From this foundation Marshall goes on to explore the kind of thing a city is and the ways it might be said to evolve. Using the conceptual tools developed in the previous chapters he examines the evolution of urban components, of ideal city designs and urban ordering. With respect to evolution and design, Marshall defines and compares three key analogies: the creationist, the developmental and the evolutionary, as a means of establishing the logic of evolution appropriate to the specific forms and processes of the built environment. In this context he seeks to understand the place of twentieth-century Modernism. How do we explain the phenomenon of Modernism, its sudden advance and popularity and equally sudden failure and rejection?

Not surprisingly, it is not that simple. As he rightly states, Modernism is still with us but in an ad hoc rather than comprehensive form.

Modernism continues everywhere with modern architecture, modern technology, modern cars and roads The result is a familiar combination of continuity and change. The ad hoc sprawl can be seen to evolve not so much from Modernist city planning but from Modernist components, evolving without City Design (p. 243).

In these explorations Marshall is usually careful to follow the distinction between the concepts of development (the growth and change of an individual) and evolution (the adaptive changes in a species over time). There is, however, a degree of slippage between the two and on reflection that slippage points to another consideration rooted in the urban morphological principle of persistence stated early on by Giovannoni (1913) and Lavedan (1926).

To be consistent with biological evolution, we rightly speak about the *development* of any individual settlement and the *evolution* of types. But because of the physical persistence

of built form and the speed of cultural evolution, any individual town as a whole is very likely to 'outlive' the particular type (generating idea) that gave rise to it. In other words, a given settlement is likely to be the result of a series of generating ideas, each idea responsible for the formation or transformation of different parts of the whole at a given time. As Conzen's work amply demonstrates, towns are 'composite' in character. In the UK, for example, many towns typically have a medieval core, with Georgian, Victorian and Modern extensions.

If each distinct part is the result of a separate run through the elaboration / recombination of a generating idea and its realization through the process of development, urban form is not just composite in Conzen's sense but *polygenetic*. That is, the clear, two-part distinction of development and evolution in organisms is too simple a model for the built environment so long as we identify settlements over time as the same individual settlement. In the life of an organism, there is only one run through development. In the life of a town there are many cycles and at various scales. On further reflection, we must also make this distinction within the sphere of cultural evolution. Some artefacts such as towns persist while others are designed once, used and then thrown away or recycled. If we are going to make sense of evolutionary ideas in the study of the built environment we have to acknowledge as a starting point the fact of its continuity and persistence.

This suggests that however attractive the simple biological analogies might be, certainly from the standpoint of communication, none is sufficiently accurate to bear much weight as the foundation of a rigorous theory. The fundamental facts of the persistence of urban form, its multi-level hierarchical structure and the relative speed of the evolution of ideas mean that urban form is best described as the product of *multi-level polymorphogenesis*.

The persistence of urban form also means that the generating ideas are embodied in the physical fabric of the settlements (with varying degrees of integrity). There are thus two 'idea pools' for urban form: the range of current and

‘unexpressed’ ideas in the heads of the population and the range of forms embodied in the fabric.

As already noted, it is well established in biological evolution that the flexibility and adaptability of species and the speed of adaptive response is largely a function of the diversity of the gene pool (and the diversity of epigenetic potential). The immediate adaptive response to an external change is not to start a process of generating and testing ‘from scratch’ to ‘find’ the right form but rather, the latent forms within the gene pool best suited to the new circumstances will come to be the basis of the common or predominant genotype/phenotype.

If flexibility and adaptability are seen as positive attributes of society and its ‘equipment’ then an obvious lesson from biological evolution (with the caveat of being careful with straight transfers) is to avoid monoculture and to maintain a diversity of types, both in the form of ideas and embodied forms, including ‘wild types’ (generated from the bottom up).

Both Marshall and Scheer suggest this basic principle in their exploration of evolutionary ideas and how to work *with* rather than against the processes of the built environment. For Scheer this is part of an approach she calls Projective Urbanism. The underlying premise is that the current leading types are the ‘best response’ to current conditions and will only change if the conditions change. New types cannot be, or are very unlikely to be, successfully forced into the system. The options are to change the conditions (social, political and economic action) or to project emerging conditions, for example by scenario planning, and identify the attributes and/or modifications of types likely to suit emerging conditions. As Scheer suggests, that search can be done through projective design exercises or observation of ‘wild types’ emerging in the interstices or fringes of the system. ‘Within existing patterns, projections of typological transformation can inform the incremental decisions and policies that drive large changes and allow the physical city to be infinitely responsive. This requires close

professional observation and analysis – connoisseurship – and a keen sense of narrative’ (pp. 110-11).

The most important role for urban design is ‘not so much to tear the old down and build anew but to offer a different view of the future based on what is already happening, to develop alternative scenarios that are both plausible and exciting, to incite change through imagination’ (p. 112).

In the same vein, Marshall sets out five principles of an evolutionist approach to planning and design (p. 278):

- make each step viable now
- proceed by small steps
- avoid suppressing ‘unsolicited novelty’
- discard moribund models
- devolve decision making

‘Too often the Modernist city planning focused on the macro-structure, and in doing so destroyed the intricate physical, functional and social micro-structure, that has taken so long to heal’. Look after the micro-structure and the macro-structure will look after itself (p. 278). This might be seen as a kind of ‘non-plan’ and deserves pursuing further in light of other ideas and phenomena such as informal settlements, the ‘support and infill’ of John Habraken (1972) and the current debates about ‘master planning’ (see Scheer, 2013).

In addition to theories of evolution, the background to Marshall’s principles is the view that the failure of Modernism was not due to Modernism being non-evolutionary but because it combined a high speed of change, change over large areas with large, monolithic forms and changes on many levels at the same time. Modernism did not ‘break’ the evolutionary process, it just produced forms that for these three reasons (amongst others) had a very low probability of suiting their social, economic and environmental conditions of existence.

In this respect it is well to remember that any complex adaptive system is prone to a variety of pathologies, a point made by Scheer. This is in fact an area of evolution and complex adaptive systems that deserves more

serious attention. Too often there is unwarranted optimism about 'natural' processes (such as markets and crowds) as if they can never go 'wrong'. In particular when you add the very sharp tool of conscious intentionality, the benefits come with a range of hazards.

Developing more vigorous theories

This quartet of books by Steadman, Marshall, Scheer and Weinstock represents a significant confluence of ideas. In setting out complementary concepts and principles rooted in the specifics of urban form as well as identifying traps and fallacies, they clear the way for developing much richer, rigorous and coherent theories of the built environment within a common framework.

To summarize the principles that stake out this ground, the built environment can be seen as the product of one or more in a family of emergent, complex adaptive systems. Those systems work by a process of evolution that operates at the level of the population and can be characterized as proceeding by a negative retroaction – a double negative. What survives is what is not refuted. The systems can also be seen as recursive, with entities being defined in terms of simpler versions of themselves. Immanent in the system is a hierarchy of levels rooted in the relationship between individual and population, between iterative, recursive interactions and patterns of interaction.

More specifically, the built environment is the product of cultural evolution, which can be seen as an intensification of biological evolution through the incorporation of the emergent feature of conscious intentionality and significant scope for recombination of generating ideas. The most appropriate model of cultural evolution is therefore learning, proceeding by processes that can be characterized by the ideas of conjecture and refutation and generate and test (amongst many others).

Principles necessary to make sense of emergence in terms specific to the built environment and its particular characteristics include a social process of interaction in creating the built environment; a multi-level,

hierarchical structure allowing for intentional action at individual levels and the emergence of patterns at higher levels; the general persistence and continuity of physical form; differential rates of change at different specific levels; the distinction between generating idea (type) and physical artefact; the high speed of change in ideas relative to the persistence of physical artefacts; the genesis of a 'single' form (for example, a town) by multiple runs through evolution of the generating type and development of distinct parts of the physical artefact. This process can be characterized as *poly-morphogenesis*.

Looking forward, these principles offer an extremely fertile ground on which to cultivate vigorous theories. Looking back, we appear to be continuing the process strikingly described by Alberti in 1450: 'the arts were born of Chance and Observation, fostered by Use and Experiment, and matured by Knowledge and Reason' (1988, p. 157).

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Cutting into the substance of urban form

On the occasion of the 200th issue of the professional journal *Architecture Today* a number of noted architects were interviewed to give an assessment of the state of their profession. Richard Rogers in his interview said, amongst other things,

Another major development in the last 20 years is a much greater consciousness of the morphology of cities – that buildings need to fit in, and even if they contrast, you have to be conscious of what they contrast with.

This served as a starting point for a talk delivered to the Urban Design Group by Karl Kropf of Built Form Resource Ltd and the Urban Morphology Research Group, University of Birmingham. The general theme of the talk was urban morphology in practice, and Kropf took it as an opportunity to present both a survey of recent work and a polemic on the role of urban morphology in urban design practice.

The survey of recent work illustrated the common use of the core morphological concept of urban tissue or character areas. Examples included conservation area appraisals, urban historic characterizations, as well as urban character studies,

research into methods of assessing environmental performance of urban form, the French application of urban morphological analysis to the Plan Local d'Urbanisme, and the use of morphological analysis in design.

The examples were interwoven with an argument about the unrealized potential of urban morphology in design, by way of thoughts from the likes of Walter Benjamin, Kevin Lynch and Richard Sennett. It was Sennett's exploration of craftsmanship that provided the focus for Kropf's main argument. Sennett's thinking suggests an interpretation of 'urban grain' that has much more depth and substance than its common usage. Urban form is the material that urban designers must learn to master and understand the way a joiner understands wood, not just as a formal exercise but to serve life.

A video of the lecture is included in the archive of previous talks recorded as part of the UrbanNous initiative that provides access to digital multimedia focusing on urbanism.

The lecture can be viewed in a browser at: http://www.urbannous.org.uk/urbandesign_group/UrbanMorphologyKarlKropf.htm
