EXTENDING THE SCOPE OF URBAN MORPHOLOGY

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Urban morphology - the study of urban form - has a long history dating to at least the late nineteenth century. Early publications were descriptive and lacked detail. In the mid-twentieth century a historico-geographical layer was added, and from architecture came a typo-morphological approach. In the later twentieth century came consideration not just of the physical form but of the processes by which it is formed: agents and agency. Most recently added are technological approaches using tools such as space syntax, GIS and simulation. All these approaches have strengths and weaknesses. This paper presents an overview of the development of urban morphology, with particular examples from the pages of the first quarter-century of the journal Urban Morphology. Of particular importance are trends towards multiple authorship; multi- and inter-disciplinary approaches; comparisons between approaches; and a general move towards a much richer and more complex urban morphology. Yet gaps and opportunities remain, and this paper identifies potential developments in urban morphology for the next decade.

The Nature of Urban Morphology: Focus, Scale and Complexity

In thinking about this subject, I take inspiration from the UK's Royal Town Planning Institute, which focuses on what it has for decades called "the art and science of town planning" (RTPI, 2020). Both artistic (ie humanistic) and scientific approaches are, to my mind, both useful and necessary in studying urban form. In fact, in looking at cities, which are increasingly large and complex artifacts, it seems that an artistic, or humanistic, perspective alone is insufficient – though many have used it (eg Olsen, 1986). The increasing scale and complexity of our subject matter – even for a relatively small city – should lead us to consider a scientific perspective. So how we think about "urban morphology" needs to change.

In a wide-ranging exploration of the future city, Richard Skeates (1997, p. 8) writes of "the formless mess that is produced by urbanisation", and the geographer Mike Crang, seeking to move away from "the stuff of cities, their built form, the

classical territory of urban morphology" writes that "the city is becoming an all-encompassing infinite space … the urban arena is made of fragmented spaces and [various] objects without a coherent totality" (Crang, 2000, pp. 303, 304). So clearly there is a conception that cities are large, changing / growing, formless, and incoherent. Yet some (or parts of them) are very structured, very coherent, but perhaps not always very pleasant – the planned sections of Mexico City or Barcelona are examples! So we need to be wary about generalising.

If we consider Tokyo, which in many ways of measuring can be said to be the world's largest city (with a metropolitan area population of over 37.3 million, an area of over 13,500 square kilometres, and a city core density of about 6,220 persons per square kilometre: worldpopulationreview.com, 2021) then the sheer scale and complexity of the urban object are made unmissably clear. But that is just today's situation, and just one of many fast-growing cities. The world's population, and the rate of urbanization, continue to grow, with the median forecast of about 11 billion by 2100 (United Nations, 2019); the problem will continue to become more intractable. However, I would also say that even studying small, isolated, rural settlements is not without problems. Complexity is not *just* a scale issue.

Yet there is a great range of tools to help deal with urban scale and complexity, particularly of urban form. These have been developed piecemeal over several decades and draw from a wide range of disciplines, research traditions and philosophies. At a time when interdisciplinarity is being heavily promoted as the new dominant research paradigm – particularly for government research funding in Europe and beyond (see, for example, UK Research & Innovation, 2021) – it is timely to explore how some of these traditions could work better together, and some of the issues arising for urban morphology. Before doing so, however, a few words of caution are worth considering. Interdisciplinarity certainly has benefits, but it also carries risks, and we should be aware of these before jumping on this bandwagon (Table 1). One of which we should be aware is the implication that research has to comprise larger teams, with issues of roles and management, and increasing project complexity, amongst others. Yet thus far much urban morphological research, even that of the highest quality, has been very individual. Of the 164 papers published in the first 25 years of *Urban Morphology*, 59% are single-authored, with true multi-discipline team authorship only noticeable in very recent years. Nevertheless, with the growing complexity of the subject matter of urban morphology, we face a situation, as Sardar identified a decade ago in another subject area, where "[A]lmost all the problems we face nowadays are complex, interconnected, contradictory, located in an uncertain environment and embedded in landscapes that are rapidly changing" (Sardar, 2010, p. 183), so we should expect the future of research to be increasingly interdisciplinary. Urban morphology must find ways of not merely coping with this, but squeezing the maximum benefit from it.

Table 1. Risks and benefits of interdisciplinarity

Risks	Benefits
Methodological confusion Lack of focus/clarity, danger of losing focus Absence of common goal Inability to agree on quality evaluation Lack of theoretical rigour Lack of integration Fewer outputs of agreed high quality Disagreements over ownership of intellectual property Higher risk of failure Bottlenecks due to inter-dependencies among team members More time spent on management and administration Mission drift	Interesting, exciting and satisfying work Flexibility Diversified, larger portfolio of methodological tools Multiple, creative approaches to any problem New perspectives Good exercises in communicating with wider audiences Improved understanding of complex phenomena Novel, exciting breakthroughs, achievement of complementarity Over the long term, cost-effectiveness due to synergies saving time and energy

Source: adapted from Lyall *et al*. (2015).

The Nature of Urban Morphology: What Is Morphology?

It seems fundamental, and was recognised by the German geographer Bobek as early as 1927, that urban morphological research should recognise the essential trinity of function, form and change through time: cities are artifacts in both space and time, and they inevitably change. Unfortunately there is still some perception otherwise, as Crang commented about a "morphological definition that sees the city as stable and fixed" (Crang, 2000, p. 303). Most cities are neither stable nor fixed, certainly in the medium and long terms – although there might be periods and pockets of stability. Recently Venerandi and colleagues note that, amongst built environment disciplines, urban morphology has "peculiarly" – their word – made change a central focus (Venerandi *et al.*, 2017).

There are, as might be expected, confusions in 'urban morphology'. If 'morphology' is 'the study of form' as its Greek suffix implies, and this is how it is used in disciplines such as biology and medicine, as we see from D'Arcy Wentworth Thompson's classic book (1917), then 'urban morphology' is just 'the study of urban form'. However, 'morphology' is commonly used in the urban context to mean 'form': although technically misleading, this has now become generally accepted – including amongst some urban morphologists. There are many other examples that could be interpreted as misuse of terms. Does this lack of precision hinder our understanding or facilitate discourse? (Larkham, 2002). Some have

long sought precision in terms (as we can see with M.R.G. Conzen's extensive glossary to the second edition of his Alnwick study (Conzen, 1969: and note the extensions by Larkham and Jones, 1991 and M.P. Conzen, 2004), though there is a danger of producing "profuse nomenclature with little meaning", for which some early work was criticised (Whitehand, 1981, p. 4). A very recent paper also highlights problems of terminology (Marat-Mendes *et al.*, 2021). Amongst two disciplinary users of urban morphology, Ivor Samuels (himself originally an architect) noted that,

> *"if architects seem to use morphological terms loosely, without precision, then geographers must be tolerant [and, by extension, other morphologists too I suppose]. It is one of the attractions of the nexus of concepts, ideas and approaches that occupy the field of urban morphology that they are capable of being appropriated for use by different professions in different contexts who seek to use them for their own purpose ... [Morphology] is open to approach by various disciplines with their own methods and any attempt to restrict or straight-jacket the discourse could stifle it*" (Samuels, 1990, pp. 433-434).

Much early work – that is, late-nineteenth and early twentieth century – on urban form was essentially descriptive and classificatory – we could call this morphography, and it uses fairly crude mapping which does not allow the level of detailed analysis that Conzen felt necessary even in the 1950s – although he worked in a country with good cartographic resources (see the maps in Conzen, 1958). Some of this early work fell into a German tradition of spatial art history (*Kunstgeographie*) (Shaefer, 1928), which still endures today. Topography was also recognised as important in early German work, leading to its use especially where traditional documentation was absent or incomplete – an approach called 'urban constitutional topography' (*städtische Verfassungstopographie*) (Frölich, 1938). A *developmental* perspective was also incorporated – a morphogenetic approach, recognising the detailed town plan as, in essence, a historical document in its own right (cf Strahm, 1950). Work in recent decades, beginning with Whitehand and Whitehand (1984), has substantially extended this from the more descriptive aspects of form to a critical exploration of the processes (agents and agency, focusing especially on decision-making) that create, shape and reshape the physical form itself. For, as Pesaresi and Bianchin stated, urban form is "the physical appearance of social reality" (Pesaresi and Bianchin, 2001, p. 56). This does sound very much like Conzen's comment four decades earlier that a town is the "objectivation of the spirit" of its inhabitants (Conzen, 1966, p. 59; after Schwind, 1951). The form of a city – its spatial arrangement and buildings – is a product of generations of ideas, aspirations and investment, layered upon each other, and with different rates of survival. In fact much of the work in the tradition that has promoted urban morphological research, founded the International Seminar on Urban Form and its journal, *Urban Morphology*, has been broadly historico-geographical (in the Conzenian and Whitehand manner, cf Whitehand,

1977), and historico-architectural (the Italian process-typological tradition, of Muratori and Caniggia, cf Cataldi, 2003). An important strand of French work, again largely historical, has proceeded albeit with less direct contribution to ISUF in recent years (Allain, 2004; Panerai *et al*., 1977). Anne Vernez Moudon identified these three national 'schools' in 1997, in the first issue of *Urban Morphology* (Moudon, 1997): though I suspect that in recent years, especially with far more, and quicker, communication especially via email and online, national distinctions have and will become much less significant. Although there have been suggestions that historical work has dominated the activities and output of ISUF, this historical dimension is now seen as significant in informing a range of public policy from urban design to planning for urban resilience: as Verenadi and colleagues recently said, "a rigorous approach towards analysing urban form from an *evolutionary* perspective is now, more than ever, relevant in interpreting its future trajectories" (Verenadi *et al*., 2017, p. 1057, citing Batty, 2009). Moreover, a substantial and significant range of other work has emerged, from disciplines and researchers that may well not consider themselves as 'urban morphologists', including mathematics, computer science, remote sensing, climatology, and others. The relationship between urban form and design has become evident in the professions of urban planning and urban design – for example being identified as one of the significant areas of knowledge contributing to what Anne Vernez Moudon, in another classic paper, categorised as 'what an urban designer should know' (Moudon, 1992).

Given the variations in 'morphology' and its constituent national and disciplinary parts, it is also relevant to examine 'what is an urban morphologist' – a question posed by Karsten Ley in 2012. The answer is not as obvious, nor as simple, as it may seem. Those who study and publish on urban form come from so many distinct professions and academic disciplines, and publish in so many diverse journals, that it may indeed be perceived as too disparate, not a unified field of knowledge at all. Certainly some papers do not explore urban form *per se*, but rather the influence of urban form on variables such as urban microclimate, energy use, behaviour, transportation, and the long list goes on. Yet these works can shed welcome light, even if indirectly, on urban form, and the complex inter-relationships between such factors, the physical form itself, and the means of production and consumption. Yildrim *et al*. (2021) provide an example in their study of the link between form and noise in a specific type of development. Ley concluded that "Urban morphology gains much, especially methodologically, by encompassing so many kinds of researchers. Indeed it may be seen as a vanguard scientific field, in which interdisciplinary and transnational work was characteristic long before it became fashionable more widely" (Ley 2012: 78).

This discussion of the constituent parts, or traditions, of urban morphology raises an interesting question: is urban morphology a science? This is an important question in some countries whose academic tradition and administration are

dominated by a "scientific" tradition and mindset. Much of urban morphological work seems more rooted in the qualitative approaches of the arts and humanities. Yet there seems to have been a widespread move since the mid-twentieth century at least for such disciplines to seek to adopt the mantle of science, hence the rise of 'social science'. By this I mean more than sociology; though settlements are, of course, social constructs hence sociology has a place, probably under-recognised, in urban morphology. Developments in science and technology are boosted by war (see, for example, the rise in patents immediately after 1945: Dienner, 1963) and their perceived success and predictability leads to these more quantitative approaches, based on measurement and replicability, being used for resource allocation – ie research funding and the employment and promotion of individual scholars. The *Oxford English Dictionary* definition of science is "the intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment". I would pause here to note that 'observation', physical engagement in the field, is a valuable constituent of much morphological research – and is surprisingly hard work if done thoroughly! But if you broaden the definition of 'observation' to the systematic collection of data, most morphology would be included. Experimenting, however, is a different matter: the expense of urban experimentation would largely relegate this to the virtual sphere, or to the ultimate in blue-sky thinking, space exploration – where the form of space settlements has indeed been considered (Millward, 1979, see pp. 119-120; Greason, 2011). A further suggested definition of 'science' is "a process of constructing predictive conceptual models" (Gilbert, 1991, p. 73). Much urban morphological work is concept-rich (see Whitehand's discussion of M.R.G. Conzen's historico-geographical study of Alnwick: Whitehand, 1981, pp. 15-16). Some of these concepts have been of enduring and international relevance; for example the fringe-belt concept (the *stadtrandzonen* of the geomorphologist Louis in 1936) was developed by Conzen in his Alnwick study (1960), its economic grounding explored by Whitehand (1972) and their international relevance discussed by M.P. Conzen (2009). This was described by Openshaw in 1974 as perhaps "the most important development in urban morphology so far" (Openshaw, 1974, p. 10). (Interestingly, given the focus of this paper, the geographer Stan Openshaw moved from explicitly urban morphological research to computation, automated geographical analysis tools, GIS, artificial intelligence and fuzzy logic applications.)

Yet few of the concepts have resulted in 'models', fewer still have been 'predictive'. It is in the recent, more quantitative, applications that an extended urban morphology would seem to fit this definition.

Contributions to A "New Urban Morphology"?

In exploring a possible "new urban morphology" I am thinking of the parallel with western geography half a century ago, and the impact of what became known as the "quantitative revolution" – though, ideally, without the negative connotations of an artificial "old/new" dichotomy, for there is still much of value in traditional, qualitative, critical urban morphology. To paraphrase Kwan and Schwanen (2009, p. 283), "antagonism between critical and quantitative [morphologies] is not beneficial to the discipline … quantitative [morphology], when integrated with a critical sensibility and used appropriately, can be a powerful tool". Some have suggested that "there is still no established agreement on a method for the analysis of urban form" (Venerandi *et al.,* 2017, p. 1057) and that there is an evident lack of a quantitatively rigorous, comprehensive and systematic framework for that analysis (Dibble, 2016). The range of quantitative approaches now being developed and used in morphological contexts is likely to move us closer to this goal, simultaneously facilitating complex and meaningful comparative study. Yet it is the *interpretation* of such findings that will tell us more about the inter-relationship between cities, form and function; so what I am going to discuss in the rest of this paper explores a (very selective) range of applications rather than the techniques themselves.

First, it should be acknowledged that quantification, in terms of measurement, has been central to 'traditional' morphological approaches such as metrology at the plot (Sheppard, 1974; Slater, 1981) and block (Siksna, 1997) scales. But surely we need to move beyond 'quantifying and describing' urban landscapes (Civco *et al*., 2002), although that is a very necessary starting point. It is worth remembering two famous quotes at this point: "all science is either physics or stamp collecting", and the quantifying, categorising and describing could well fit into the second category; and "that which is not measurable is not science". While these are amusing, and we should consider their relevance, as an academic (I won't say scientist) I find it frustrating that these are popularly and frequently *attributed* to Ernest Rutherford and Lord Kelvin, but we can't find actual proof that either said or wrote them!

Understanding the geometric properties of urban forms can contribute to understanding – even if, in the absence of documentation, this is by inference – the processes of shaping the urban form. Hence we can differentiate areas of distinct form characteristics, and infer that these plan units were laid out at different times, or that they should be subject to different management regimes (Baker and Slater, 1992). Measurement remains a popular activity (cf Fleischmann, 2018), and there are multiple-measure approaches that seek to provide a better understanding of urban physical form (for example the 7-variable 'Morpho' approach of Oliveira and Medeiros, 2016).

However, one aspect that quantification and computational approaches facilitate is modelling. "Computers act as the laboratory for experimentation on phenomena which is represented digitally with its manipulation being virtual" as Mike Batty said as long ago as 1976. Yet the gap between urban morphology and urban modelling identified by Stanilov a decade ago still remains (Stanilov, 2010). At the larger scale urban growth patterns can be modelled, and these models can offer the possibility of predicting the global properties (such as scaling behaviour) of urban forms. Many have explored urban growth patterns using various modelling approaches such as cellular automata and similar approaches can be applied to examine, for example, urban decline. Likewise, land-use change can be modelled. With a focus on just one component of urban form, Barthélemy and Flammini (2008) have modelled urban street patterns. D'Arcy Wentworth Thompson's 'laws of growth' and 'theory of transformations', a fundamental approach to morphology, is of enduring value wherein computer modelling is held to be "growing today, essential tomorrow" (Sharpe, 2017). It seems likely that this is equally true for *urban* morphology.

Ideas of emergence and applications of complexity theory, the latter often expressed through fractal analysis, have been applied to the complex, adaptive systems of cities and their varied and changing forms. But – again as Mike Batty says –

> *"complexity implies unpredictability, relativism of a kind that classical science and indeed social science find hard to deal with. It is further compounded by the fact that most complex systems span the physical – human divide, uniting the two cultures, thus opening up a veritable Pandora's box involving free will and self-determination. Cast within an evolutionary framework in which systems like cities, economies, and societies evolve from the bottom up, this implies that their future is unknowable, hence unpredictable"* (Batty, 2009, p. 955).

This does rather contrast with the many modelling studies which have claimed, in one way or another, to be predictive. As with much prediction, from town planning to lecture plans and military strategy, reality doesn't always follow the prediction.

At the largest spatial scale, computational approaches and 'big data' – to use the current fashionable expression – allow representation and modelling of urban patterns at the city, region, national and even international scales. Much of the modelling work discussed below has been at this larger spatial scale. This raises the issue of the scale of 'traditional' urban morphology, suggested as the small scale of 'ordinary' urban components (streets, blocks, plots, buildings): "it is the interest on this *scale* which distinguishes the tradition of Urban Morphology from others which ... have predominantly observed cities at a much larger scale" (Venerandi *et al*., 2017, p. 1057, their emphasis). The terms 'macromorphology'

and 'micromorphology' that have been used in studies of urban form seem often to have been used rather loosely, without specific delimitation of scale. Karl Kropf (2014) also emphasises the smaller scale of spaces within buildings and elements of architectural form, especially in the context of parts and wholes. But urban morphology *per se* has scarcely looked at wider scales, the urban as a whole, or 'town and country' or 'urban and regional' planning (or, more recently in Europe, spatial planning).

At the smaller scale, Venerandi *et al.* (2017) have recently developed a systematic and quantitative (though, as they say, "not yet comprehensive") method of analysis of the form of places (five areas in London) which have undergone significant change in both physical form and social composition at various times since the end of the Second World War. This allows them to identify links between form and social change at the neighbourhood scale – and scale emerges as a significant aspect. This, therefore, becomes a study of gentrification, and its physical consequences. The physical variables measured are demonstrated on the illustration. They demonstrate that "features of '*traditional*', fine-grained, perimeter block-based urban form" are clearly correlated with gentrification, providing quantitative evidence for qualitative discussions of theorists such as Ruth Glass and Jane Jacobs. Interestingly they use street width as part of a measure of 'centrality' (they say "gentrified areas are found to sit *between* urban main streets, which constitute their boundaries"). Street widths in built-up areas are difficult to change, although the nature of the surface and its use could be changed (the Dutch *woonerf* concept, for example); and other smaller-scale physical changes could equally link with social change (for example the journalist Jonathan Raban (1974) characterised gentrification as "the knockers-through are here" – creating larger, fashionable 'open plan' living spaces by knocking out internal walls). So Venerandi *et al.* do provide a useful morphometric approach, but are careful to state that their results do not imply "any causal or universal relationship between morphological and social dynamics" (p. 1956). A qualitative approach could examine causality.

The variability/homogeneity of an urban fabric is often an issue for decision-making in planning, especially in the context of conservation. How much change will a building alteration or insertion make to an urban fabric, particularly if it is felt desirable to preserve certain characteristics of the area? Quantitative techniques can produce precise responses, replicable in different areas, potentially allowing replicability (better known as consistency) in decision making. Hijazi *et al.* (2017), for example, use a GIS-based method to analyse data extracted from 2D building footprints obtained from open source data (OpenStreetMap), which they applied in Zurich in areas "with obvious discrepancies in their spatial configurations" (p. 1107). Measuring building edge angles and footprint areas they can identify patterns that could characterise "historical quarters with denser and smaller buildings [which] tend to have more organic urban fabric with winding

street systems" (p. 1117). Different cities could, of course, have more rectilinear historic quarters. They suggest that their system "could be trained to analyze historical quarters and learn from past examples about how to achieve or preserve the organic arrangement of the urban fabric. This measure can also be used as a goal function for a computational synthesis method… to automatically create new spatial configurations with a defined level of homogeneity" (p. 1118). Other methods of calculating homogeneity have been developed; Haghani (2009), for example, uses a fractal analysis approach, calculating a 'fingerprint' for specific areas from air photograph data. With a sequence of air photographs spanning several decades he can measure the extent of change over time. The procedure is a little complex, though, and the measure of fractal complexity is affected by, for example, tree foliage cover and is therefore seasonal. And it is interesting to consider how a decade of advances in image processing could have automated this task. Rashed *et al*. (2006), in contrast, use "a 'soft' approach … to identify and measure the composition of changing morphology from multi-temporal, multi-spectral satellite images … capable of deriving spatially continuous variables quantified at the sub-pixel level". Hijazi *et al.* (2017) recognise that their approach could be used "to analyze correlations between people's emotional responses to urban environments with the measured homogeneity levels of the corresponding spatial configuration" (p. 1118).

A wide range of studies attempts to make links between urban form and other variables. Here are just four examples ranging from network accessibility affects on property prices to the effects of micro-morphology on bicycle use (Table 2). Much research of this type demonstrates correlations between form and other variables, but are these *causal* links? And few explore the urban form dimension in the level of detail that morphologists would like, which in part explains the high rejection rate from the journal *Urban Morphology* – 75-80 per cent in recent years.

Table 2. sample of links between urban form and other variables.

Xiao et al. (2016)	Links urban form (in terms of urban configuration, specifically "network accessibility matrices") to property prices
León and March (2016)	use urban configuration models and GIS to explore evacuation routes and sheltering for tsunami evacuation
Rose et al. (2014)	relate urban form ("dominant residential building typologies") to residential heat-energy demand
Rybarczyk and Wu (2014)	use a discrete choice model to explore how micro-morphological features affect bicycle mode choice decisions

Typological approaches have been extended by more quantitative, multi-variable approaches. The architectural building typology of Thomas Markus (1993) and the typo-morphological studies of the Italian school, both of which related the historical production of spaces in buildings to people and decision-making, have been expanded in computational studies, for example to archetypal buildings, streets and block layouts (for example by Steadman and Marshall, 2005) and to urban-scale typomorphological models (Shayesteh and Stedman, 2015). Shayesteh and Stedman's model of Tehran "approximates reality", as they say (but, as always, the key question is 'how closely'?) and, as with other quantitative approaches, is held to be able "to generate various options and test what the overall built form would look like and how it would perform", thus providing "a powerful planning tool" (Shayesteh and Stedman, 2015, p. 1145). The problem is that planning agencies have rarely adopted what academics consider to be 'powerful tools', as has been noted with the morphological concept of fringe belts (Whitehand and Morton, 2004).

Space syntax has developed into a popular analytical approach for a variety of purposes, incidentally generating lively international conferences and an online journal. It seeks to explain, in Bill Hillier's words, "how cities work – how space, movement, land uses, human activity and psychology combine to create the complex forms we occupy and experience" (Hillier, 2016, p. 199). For example, Stöger generates "novel insights … regarding the physical environment in which Roman city dwellers lived their daily lives" (Stöger, 2015, p. 61), thus demonstrating the relevance of space syntax analysis to historical urban forms where archaeological data allows. Peponis *et al*. (2015), in contrast, explore supergrids in a range of contemporary cities. Both of these papers explore concerns central to qualitative or 'traditional' morphology in new ways. Amongst other things, space syntax depicts streets not as spaces but as networks, a useful additional perspective to the 'traditional' morphology. Di Bella *et al*. (2017) relate spatial configuration to urban crime environments using space syntax, typical of a large number of examples of 'applied' morphology using this approach. More broadly, Bill Hillier (2016) challenged space syntax users to explore interrelationships between spatial and social networks, posing the fundamental question of "what are cities *for*?"

All these are indeed new perspectives on urban form that qualitative research alone could not begin to explore.

Conclusion: Moving Forward from Unhelpful Dichotomies

Moving towards conclusions, I want to think outside the common academic mindset of dichotomies. We need to consider that

> *"... the importance of knowledge is increasingly being recognized in society today. We are living in a society which is as much characterized by the production of knowledge as anything else. Never before have there been so*

> *many systems of meaning requiring institutionalized cultures of experts and their professional discourses"* (Delanty, 2005, p. 5).

Overall, despite the range of approaches briefly discussed here (and there are many more that could have been included), there is a tension between 'old' and 'new' urban morphology, and/or between disciplines, that still needs to be overcome. Ley (2012, p. 79), for example, states that

> *"there is not a satisfactory simple categorization or evaluation of cities. To attempt to render them in such ways is bound to end in shortcomings. It is necessary to set out clearly the scientific aim of the endeavour and make clear that the categories and criteria involved are inherent in the study rather than the study object ... urban form cannot be satisfactorily reduced to numbers. Even a combination of various arithmetic or statistical parameters will not reflect its complexity".*

I suggest that they *are* a reflection of complexity, albeit simplified; and these approaches are sufficient for the purposes for which they are designed. It is the *nature* of the approximation of reality (cf Shayesteh and Stedman, 2015) that may cause concern – we need to be wary of over-claiming, over-simplification and over-worrying. We might also think of how *parts* can be used to reconstruct *wholes* (for a commentary, see Batty, 2017) – and this also raises the issue of how far we can legitimately infer the unknown from the known. In particular, in terms of further developing the study of urban form, any either/or depictions (old/ new, quantitative/ qualitative) I suggest are unhelpful, even if used for rhetorical impact: they tend to fossilise established institutionalised cultures and diminish opportunities for innovation.

Interdisciplinarity has increased in many research fields especially in the past couple of decades, sometimes deliberately promoted by the allocation policies and priorities of funding bodies. The argument is, as Bridle *et al.* (2013) suggest, that this is "a means to address complex problems that cannot be dealt with from a single disciplinary perspective alone", and the research results are more innovative and have higher impact. An interesting aspect is whether the collaborating disciplines are distant (for example natural and social sciences; perhaps even quantitative and qualitative) or close (Morillo *et al*., 2003). However, the benefits of interdisciplinary research have been questioned, perhaps because the concept is ambiguous, because of the range of perspectives and of potential results (Huutoniemi *et al*., 2010). It does appear that a degree of interdisciplinarity can produce higher citation impact, while distant disciplinary collaboration may be perceived as risky and more likely to fail. And those of us working in universities are having to be ever-more conscious of our citation rates! Looking at the institutional affiliations of authors of recent morphological papers (broadly based, including those cited here and all papers in the journal *Urban Morphology* – admittedly a biased sample!), interdisciplinarity seems relatively

limited and close (for example between built environment disciplines and geography or history). Clearly, wider collaborations could be explored; although the rationales for collaborations need to be clear from the outset. We should be seeking to transgress disciplinary boundaries, rendering them more permeable, synthesising disciplinary knowledge in new ways rather than simply 'bolting on' new perspectives. And yet, in the UK at least, research funding bodies are stressing the need for research to be 'novel'. Surely we should be wary of novelty for its own sake – just to secure the funding – but instead ask "what does this add to our understanding of these complex problems?" Interdisciplinarity needs the right sort of disciplines and collaboration to be constructive.

One of the problems of multiple disciplines working in isolation on the same topic is that of communication. Today, the very range of disciplines involved, with their own terminologies and approaches, suggests that we should beware of mis-communication and lack of communication. At the very least, and to reiterate the point, morphologists may need to read more widely, out of the 'comfort zone' of their home discipline's journals. I found it possible, for example, to apply the evolutionary biology concept of 'punctuated equilibrium' to the growth of cities, with the very rapid points of change being catastrophes of various sorts (Larkham, 1992).

There has been some recent and positive evidence of comparing disciplinary approaches, or at least 'schools', combining/contrasting them (see Cataldi, 2013; Allahmoradi and Cömert, 2021; Li and Zhang, 2021) and combining quantitative tools (for example Jiang and Claramunt, 2002; Ye and van Nes, 2014). All appear to have been constructive and productive, but much more could be done in terms of creative interdisciplinary work. There are some advantages to identifying "disciplines". They place boundaries around bodies of knowledge. This confers many advantages: it facilitates efficient teaching and provides guidance on research norms (such as an essential set of standards, an established way of framing problems, key theories and methods) but the model of the lone scholar working in one narrow discipline is now much less common: within *Urban Morphology* the number of joint-authored and cross-disciplinary papers has increased in the last decade, for example. The dynamic between discipline-based and interdisciplinary research is changing rapidly.

Finally, quantitative and qualitative urban morphology has developed a wide range of concepts, models and tools that researchers have suggested could be useful in urban decision-making at a range of scales. Yet it is clear that few decision-makers on the ground engage closely with such research products, as Whitehand and Morton (2004) showed for the idea of 'fringe belts' and despite attempts to bring it into debates on peri-urban land-use planning (Scott *et al*., 2013). Urban morphology *as a whole*, though scarcely a unified discipline, would

do well to explore the barriers to wider practical application of the results of urban morphological research.

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