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Reviewing the Science of Town Planning

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Abstract

On page 5 of the February 2020 issue of *The Planner*, the chair of the Royal Town Planning Institute's (RTPI's) board of trustees presented the institute's vision and mission for the next decade. Beyond its global vision, it is the mission that has technical resonance: "to advance the science and art of planning" (but notice the absence of the word "town"). For this author, the art of town planning is the majesty and intimacy of urban form as a three-dimensional concept (Cullen, 1961). The science of town planning is an entirely different matter. Is there a common understanding of the term? What is its nature and scope? To contribute to a possible interpretation, this paper offers a review. The ambition is to see if the "science of cities" is useful in the world of town planning practice.

Keywords

Science, Systems, Resilience, Complexity, Cities

1. Introduction

In the writer's undergraduate town planning education (1969-74), there were seminal texts that captured both the excitement of this new knowledge and the shaping of things to come. Examples were by Alexander (1965), Sennet (1970), Friend & Jessop (1969), Friedmann (1973), Cullen (1961) and of course, Geddes (1915).

Alexander was concerned with the structure of the city, advocating the "semi-lattice" concept as a key to urban resilience. Sennet argued for the psychological aspects of urban form in city life, applauding "the uses of disorder" in its creative functionalities. Friend and Jessop introduced an operations research approach to local government planning, this being a move from "towns" as a spatial concept to "planning" as technical problem-solving. Friedmann heralded implementation as a "journey of exploration" advocating a "light touch" when a town plan hits its urban reality. Cullen was an urban designer, seeking to pursue the majesty and intimacy of urban form as a three-dimensional concept. Geddes was the champion of understanding the place (survey) before proposing interventions (plan). He was railing against engineering-dominated solutions which ignored the living fabric of the city. He pioneered socio-economic and environmental perspectives to help make plans and advocated town planning exhibitions as "civics", to encourage greater understanding of urban change.

It was a time when town planning was moving away from the influence of architecture (as an offshoot of a design discipline) to one of governance (problem-solving and the policy-based budgeting of central and local government). Cuthbert (1974) captured the essence of this dynamic: "are we dealing with towns as a social way of life or planning as technical problem-solving"? In fact, is there an over-arching notion of the "science" that straddles both dimensions?

2. What Is the Science?

The UN's Economic and Social Council submitted a report to the Commission on Science and Technology for Development entitled *Science, technology and innovation for sustainable cities and peri-urban communities* (UN, 2013). The report goes through, what could be considered a conventional set of urban challenges: urban sprawl and rapid motorization; lack of infrastructure; depletion of resources; environmental deterioration; and the risk of natural disasters. In response, the central advocacy is for electronic geographical information systems (GIS) as forms of information and communications technologies (ICTs). As the text states: "Potential urban uses of ICTs include geospatial tools for spatial planning, simulation and visualization modelling, mobility tools, solutions for optimizing energy and water management, disaster monitoring and response, and social inclusion" (p. 7).

The first two of six practical examples are citied here: (a) Mapping underground utilities, mines, tunnels and other city infrastructure to identify issues, improve efficiency and design extensions; (b) Mapping areas at risk of earthquakes, floods, landslides and other natural disasters, and adjusting development plans (para.28, a/b). The advocacy continued. "Innovations for sustainable urbanization include a) integrated city-regional governance systems (p. 12), b) clever spatial planning and design (p. 13) and c) innovation for building including alternative approaches to housing supply and sensitive approaches to informal locations' upgrading" (p. 14). What is important is to applaud the centrality of its argument (and illustrations) to support urban GIS. From a practitioner's perspective, GIS marries both the spatial and informatics of the city. This must be tested by other perspectives.

The UK government presented a succinct statement on the science of cities: "(It is) using evidence to understand how cities work—(and) is forever expanding (UK, 2016, Foreword). The executive summary then presents its case for a systems approach to the analysis: 'We find that much of the available science base is not routinely applied to the tasks of policy development and planning in relation to the future of cities'. It goes on: Our first research priority is to recommend the application of systems analytics to both the UK system of cities and to particular city systems". This is the second concept and therefore, we are applying systems theory to the layers of urban GIS.

It then suggests that the emerging science of cities focuses:

> (on) people, organisations, resources (energy, water, food and materials), land, infrastructure systems and all forms of governance, spanning across a spectrum from the local to the national, and the international context in which we are located. It must encompass multiple scales from the micro to the macro… The science of cities will inevitably be interdisciplinary and interprofessional, though we need to be aware of what individual disciplines and professions contribute to the mix (p. 9).

It goes on: "In broad terms, decision makers at every level from the individual and household to the boards of firms and councils of state need to understand how cities work" (p.9). This is affirmation of one idea: "integrating all the players in the city building process" so that they have a common understanding and agreement on how urban development should progress (McGill, 1996, Figure A1[1] and McGill, 2018, **Figure 1**[2]). See **Figure 1**:

Here, the idea is of urban management "getting to grips" with the urban <u>challenge</u> and "sorting out" the institutional <u>response</u>. Put another way: "the challenge of rapid urbanization and its attendant demands for infrastructure and services confront every local government in the developing world. The weakness

<u>LEVEL 1</u> **(Urban Development "challenge")** **Physical or Spatial Development (Town) Plans (10-20 year horizon)** **<u>Geographically</u> defined** *(Integrating all the 'players' in the urban development process; "Town & City Building")*					
Private sector			**<u>LEVEL 2</u>** **(Institutional Development "response")**	**National government**	
Households	**Communities**	**Business**	**City / Local Government**	**Regional offices / Agencies**	**Ministries' HQs**
Investment decisions (<u>Organisationally, business, group</u> and household specific)			**Strategies and Budgets (5 year cycle) <u>Organisationally</u> Specific** *("Institution Building")* **Urban IDS**	**Development Strategies and Budgets <u>Organisationally</u> Specific**	**Development Strategies and Budgets <u>Organisationally</u> Specific**

Figure 1. Integrating spatial and organizational planning—integrated development strategy (IDS).

[1]Urban intervention matrix: integrating all the players.

[2]Integrating planning.

of that local government compounds the enormity of the challenge".

What remains unanswered is the structure of a systems based urban information system, as the foundation of urban science. The report advocates for a research programme on the architecture of information systems for urban research, planning and forecasting (p. 22). Thus, the report admits there is a long way to go to establish the structure of the science of cities.

As stated above, "GIS marries both the spatial and informatics of the city". This means to recognize and apply the layers of information required to make every city and town work. All cities are different in the patterns formed by the *function* of land-use and transportation, and the *form* of their three dimensions. Yet, they are the same in the sense of needing first, town planning and secondly, urban management, to provide, operate and maintain the spatially reinforcing water supply, waste management, energy, housing, transport, and its modern imperative, connectivity. These are all "conditions" to support economic growth and poverty reduction. Ideally, this is an integrating and holistic concept of urban management (McGill, 1998).

Townsend (2015) returns to first principles. He presents an outline of urban science research in his paper, *Making Sense of the New Urban Science.* He begins by acknowledging the start of conscious urban interventions through engineering solutions to public health issues. He acknowledges the contribution of architecture to new models for housing. Then he cites Munshi (2000) about, arguably, the founding father of the scientific town planning movement—see **Box 1**:

Thus, "Geddes used science to inspire and inform study of the city" (p. 4). Avowed practitioners know that he sought understanding of the particular and at the same time, introduced his synoptic vision by defining the city-region; his "regional profile" and his word, *conurbation.* Hence, the balancing—or is it the tension—between inductive and deductive reasoning.

Townsend then states, "Traditional methods of urban inquiry often stress an inductive, bottom-up approach to understanding the city through field work, site visits, and surveys. The goal is to focus on individual places as unique entities" (p. 5). He then cites Solecki et al. (2013): "[a] more critical review of the evidence on urbanization as a process and not on cities as places could lead to systemic solutions that address the whole rather than separate components"

Box 1. The first allusion to green urban development.

Influential British town planner Patrick Geddes was trained as an evolutionary biologist long before he began to work on urban social problems in the 1890s. Geddes' intellectual background led him to see the city less as an industrial machine—as many of his peers imagined (*including Haussmann, in the destruction of the social and physical fabric of swathes of medieval Paris;* author's addition)—and more of a great organism splayed out across an entire metropolitan region… he hoped to reintroduce the importance of the environment as a factor in the evolution of civilization, and to make sociology a tool for social change (p. 4).

(p. 5). This is interesting because they attempt to place the science of cities as a process, captured by systems thinking. Townsend then quotes an interview with the biologist Edwards (2015).

> The thing I know about rainforests is they are sustainable and they are highly decentralized—they have multiple redundancy systems in them. That's exactly the kind of industrial system we need… moving from a zoned sort of city, which depend on large, centralized services… to a highly decentralized system with much more interconnection between the individual buildings so that they function together to regulate the urban environment in a way that is not done at present (p. 7).

This is the plea for urban resilience and an allusion to a systems approach to achieve that end (McGill, 2020b). Townsend concedes to this envisioning of "smart city infrastructure" (p. 7). The big data is then returned to in definitions of *urban informatics* (p. 7). One central characteristic is that of electronic geographical information systems (GIS) (p. 8). It has a potential to not only harvest and understand big urban data but also, to present it geographically. This is essential because towns and cities are, first and foremost, spatial concepts.

Under the big science sub-heading, Townsend offers the following: "The Center for Urban Science and Progress has committed itself to a handful of flagship projects such as the Urban Observatory, a multi-decade sensor deployment at the Hudson Yards development project in Manhattan, and a massive data repository hosted on behalf of the City of New York" (p. 23). He goes on to suggest: "The implication—in its third or fourth iteration a decade from now, the Urban Observatory will basically be a Hubble Space Telescope—only pointed at the Earth" (p. 24). This is not fanciful and in fact, is not new. Geddes pioneered the *Camera Obscura* in Edinburgh and this was at the turn of the 20^{th} Century! It allowed urban thinkers to view, literally, from the specifics of the city's High Street (*The Royal Mile*), to view north, across the Firth of Forth, to Fife, or south to the city's enclosing Pentland Hills but both, to convey the extent of the city-region.

In short, the science of the city is physically described, geographically defined and, matching the exponential curve of smart technology in the early part of the 21^{st} Century, big-data rich. Yet again, "GIS marries both the spatial and informatics of the city" but something else is needed.

The NSF (2018) report articulates a vision and a compelling research agenda for developing the next generation of sustainable urban systems science. Of the three research perspectives and six key elements, one stands out: "Is there a fundamental science to identify city typologies and model their futures?" (p. 6). The paper goes on to state: "Scientists, as well as public and private sector actors, recognize that the science is yet nascent to address some of the most fundamental questions that can ensure that urban innovations yield the intended sustainability outcomes, both locally and globally" (p. 8).

The convergence of interests in a new science addresses two central issues. First, they contend that traditional urban disciplines such as urban planning are focused on their particular town or city; that institutionally, they are required to focus on their particular place. In turn, specific urban sectors such as water supply and transportation suffer a similar or silo restriction. This is reinforced by Williams (2014).

> Different infrastructure sectors have largely been planned and provided independently. They now have different governance and regulatory structures and, with the possible exception of transport, are not planned comprehensively in relation to their future spatial impacts. This leads to systemic weakening of the resilience of systems (para. 3.2.3).

NSF continues by arguing the need for intra-urban scales of analysis, advocating for "a transdisciplinary science that generates new knowledge, methods, and theories to advance fundamental understanding of the urban sustainability challenge and inform potential solutions" (p. 10). The paper then presents (in its **Box 1**) a research morphology of four layers, as in geology; each layer leading to the next. The first is multidisciplinary, the second, interdisciplinary, the third transdisciplinary and finally, a definition of the science itself:

> *Convergence Science*: This type of science relates to both definitions of trans-disciplinary research, in which new science and methods are generated as a function of deep integration across disciplines and the explicit consideration of how to transition from basic scientific discovery to practitioner application (NRC, 2014). NSF identifies convergence as exhibiting two primary characteristics: 1) deep integration across disciplines, and 2) driven by a specific and compelling problem… (p. 11).

This could be seen as a response to the UK (2016) plea (above) for "…a project to provide researchers and analysts with a common and comprehensive database". The convergence science is encouraging intellectually because first, it is targeted at problem solving. Secondly, it moves from scientific discovery to practitioner application. This is the ideal; the science of cities being made useful. The paper goes on to state: "To advance convergence science, researchers must collaborate with cities, multi-city networks and citizens in knowledge co-production, drawing upon the large number of real-world policy experiments already underway in cities" (p. 15). The UK then takes the research agenda further.

The concept of "knowledge co-production" is critical. It concerns the development of a new, if not improved urban discourse; the idea of a refined or innovative urban epistemology. While the NSF report is centred on a US narrative, there is a British version through UK Aid, with a focus on Africa, the world's fastest urbanizing continent. The African Cities Research Programme (DFID, 2019) is funding new, operationally relevant research on tackling multi-sectoral problems in African cities. Therein is the first challenge; making research "operationally relevant". The objective is then stated 'to produce new knowledge and evidence of African cities as systems… (para. 3.1). Its ambition for a new urban epistemology is considered by McGill (2020a).

3. From Science to Systems

McPhearson et al. (2016) offer an ecological paradigm towards a possible science of cities. In the section, "cities as complex adaptive systems", they state: "Efforts to understand the complex nature of urban systems is still quite recent" (p. 8). This is not so. The pioneering works of for example, Chadwick (1971) and McLoughlin (1969) belie that statement. However, what *is* true is to suggest that the science of cities, through resurrected systems theory, is enriched by smart urban data.

The McPhearson paper then presents its **Box 2**; principles of conceptualizing urban systems (p. 9). Ten are presented; see **Box 3**.

For this analysis, the following two seem the most pertinent: a) the structure of urban systems includes human and non-human organisms; abiotic components such as soil, water, land, climate, buildings, roads, and technological infrastructure; social institutions; politics and governance; and economic drivers—all of which interact to produce the observable functions of urban systems: b) Urban systems are spatially heterogeneous and temporally dynamic (p. 9).

If such is the understanding of urban systems, then the science of cities is moving inexorably to a practical outline. Urban systems theory is the language that converts the big data, ideally captured in GIS, into something useful. It is presented, ultimately, on maps. Moreover, its added value is that it is not restricted temporally; it is dynamic over time. The fact that "social institutions"

Box 2. Fighting "lifeless creations" in urban form.

In one of Edinburgh's university environments, the urban complexity, accumulated over 200 years was being threatened. George Square and its immediate environment was the Georgian precursor to the more famous Georgian New Town. Apart from a controversial new library (the new brutalism of Basil Spence), nearby there were sturdy Edwardian residential tenement buildings. They were demolished. The site then lay empty for over 20 years! Those apartments retained complexity in part of the city that would otherwise, be turned into a single function urban system; a university precinct. Eventually, a new university building was erected but the living complexity—the residential apartments, to break the functional and visual monotony of the university precinct—was lost. Nearby, Lauriston Place had a beautiful terrace of Georgian flats. It was a stretch of residential use in an area dominated by institutions: the Edinburgh College of Art, George Heriot's School and the Royal Infirmary. The college wanted to buy, demolish and build a new education function. If permitted, that whole portion of the city would have become a lifeless place; a single function (institutions) and thus with no semblance of urban—i.e. living—complexity. Happily, the art college was thwarted. More strategically, with a new general hospital built on the outskirts of the city, the former infirmary has been converted to residences. That portion of the city now remains vibrant because of the mix of land-uses; that essential urban complexity.

Box 3. Principles for conceptualizing urban systems.

- The structure of urban systems includes human and nonhuman organisms; abiotic components such as soil, water, land, climate, buildings, roads, and technological infrastructure; social institutions; politics and governance; and economic drivers—all of which interact to produce the observable functions of urban systems.
- Humans interact dynamically within social-ecological-technical/built system (SETS) components.
- Delineating boundaries and defining response units are crucial for empirical research, as is understanding the influences, material, and energy that cross boundaries.
- Urban ecosystem function emerges from the interactions, relationships, and feedbacks of system components.
- Urban systems are spatially heterogeneous and temporally dynamic.
- Linking urban system patterns with processes at multiple scales is a primary focus.
- Conceptual frameworks must work across multiple spatial and temporal scales.
- Conceptual frameworks must incorporate key, well-described drivers of urban system dynamics, including social, ecological, political, economic, and technical processes.
- The relationship among urban form, heterogeneous spatial structure, and system functions must be known to theorize and measure ecosystem services.
- Conceptual frameworks must be designed to enable comparative studies across cities.

and "politics and governance" are included is even more significant. If one accepts the McGill (2018) twin concept of the urban challenge (p. 5) and its institutional response (p. 6), then the urban system captures a fundamental requirement; to understand how city governments, through institutional development, respond to their rapidly growing towns and cities.

The International Expert Panel on "Science and the Future of Cities" (2018) is a comprehensive report on the subject. An early conclusion states that "there is no one urban science" (p. 14). As the report's emphasis is at the global scale, it reflects on both Sustainable Development Goal (SDG) 11 and the New Urban Agenda (NUA) under the heading, "the implementation gap". It contends that "the NUA and the SDGs have been extensively criticised, including by Panel members, for their emphasis on broad, sometimes unrealistic commitments and lack of specificity" (p. 17). McGill (2018) reviewed NUA in his paper *Making towns work: Habitat III—what relevance?* He argued for practical interventions at the local level which, by accumulation, would produce more empirical knowledge. This would yield general principles to enrich a new urban epistemology. That would help create the conditions for infinitely greater systemic urban resilience; the idea of bottom-up solutions.

The 2018 report goes on to say that the sources for urban understanding may be eclectic: "The term science itself needs to be cognisant of the multiplicity of the scientific community it is made up of" (p. 25). This is true. The yearning is therefore for a binding address that can carry the variety of scientific and indeed artistic perspectives on the city. The central point is that all should accept the primacy that first and foremost, cities are spatial phenomena. The text then offers an indication of a possible common language. "Quantitative assessments are however, often perceived to trump very small-scale ethnographic studies, and today, spatial data (e.g. geographic information from GIS) is deemed more valuable than statistical (e.g. demographic) data by several entities, in achieving an understanding of cities." (pp. 25-26). On what the final interpretation of an urban science might be, this section of the paper makes an important point: "…various issues currently hinder the building of a more integrated urban science. Those include differing epistemological and ontological traditions and the lack of funding for long term, interdisciplinary research projects as well as reforming existing academic training to better link training to practical needs" (p. 31).

Concerning urban science *per se*, an early statement is encouraging and nudges the science narrative forward: "…many of the currently successful urban scientists have the ability to transgress scale (vertical as well as horizontal), sectors, disciplines and institutional types and stakeholder groups. Most have a strong systems orientation, even though they may not have formally been trained in systems science" (p. 35). This "nudge" is not only to systems theory but perhaps and helpfully, linked to the previous section's comment about GIS. It then makes a telling statement about local government in the developing world: "Local governments operate within a regulatory framework that may not fully consider informal settlements and their needs…" (p. 39).

In Malawi, central government declined to countenance the provision of clean water and basic waste management services to its unplanned and therefore, un-serviced locations. The argument was that to do so was to acknowledge that informal settlements existed! After two years, government was persuaded to accept the fact that over one third of the functional (as opposed to the administrative) boundary of Lilongwe comprised informal settlements. The boundaries were therefore extended officially to incorporate these locations. In year three, not only was fresh water made available in these locations (whether piped or through boreholes) but also, hand cart-based waste management was introduced. One public health result was that a year later, there was no rampant cholera outbreak in the rapidly growing city (McGill, 1996).

What emerges from The International Expert Panel on "Science and the Future of Cities" (2018) report perhaps is three aspects towards a greater understanding of the general utility of urban science. One is systems thinking. Another is data management from the widest possible sources. The third is the suggested starting point for urban interventions; local government. The report offers an encouraging example from South Africa where all key players are working together at the metropolitan level.

> The Panel then recognised that other forms of science-policy links might be as valuable as a reform of science within local government. In South Africa, this type of system has proved to be highly beneficial for scientifically based

> urban management in the Gauteng city-region. This system built on co-production on knowledge and capacity, has constituted the Gauteng City-Region Observatory, the Universities of Johannesburg and Witwatersrand, as well as the Gauteng Provincial Government (p. 50).

This is exceptionally good at the metropolitan level. What about at the individual city council in relation to its rapidly growing city? A published case captures the idea (McGill, 1996).

A city council in Africa was pilloried by the country's president because an audit report, uncovered a litany of failures, abuses and general corruption. The chief executive and city treasurer were fired. The president approached the British government to provide a replacement chief executive. A project was therefore developed. The overall objective was "institutional development"… It sought to improve the efficiency of the city council, improve standards of administration and financial management and train staff in the operations of the new systems (p. 155). This was a conventional strengthening approach to local government. While valid in itself, "it was considered both dangerous and technically unsound to remain" within the project (p. 177). The city council needed to understand its development environment (its rapidly growing city) and respond accordingly. The project was therefore reinterpreted as the requirement to develop strong urban management leadership in the context of the council's rapidly growing city. The process of city building became central to the council's policy and budgetary deliberations.

Here was a situation where the city council was advised to become a forceful local development agency in order to respond to its rapidly growing city. In turn, the integrated development strategy was to be the instrument for achieving the urban management ambition. While this integration was seen initially at the city council level, in relation to its city's development, it was also the ambition to "integrate all the players in the city building process". This meant households and enterprises on the one hand, state agencies and central government on the other, and the city council with its fledgling holistic spatial perspective at the centre, channeling all the "players" according to its spatial plan and its supporting integrated development strategy (IDS). IDS was the instrument to achieve urban management. The case was Lilongwe city council in Malawi's aspiring Garden City capital[3]. In 1989-91, its population was around 400,000. Now it is 1.1m and growing at over 4 percent a year. The central point in this experience was that the city and its council were seen as a combined or integrated system, hence the mantra, *urban challenge, institutional response*.

Batty (2008) offers a predominantly mathematical analysis of the topic *Cities as Complex Systems*. One opinion is that he is addressing a central question in the quest to understand a possible "science of cities". He starts in his abstract:

[3]For the town planning purist, the Garden City is about the balance of primary city and secondary towns; town and country as one settlement system. In Malawi, it was simply the idea of a very dispersed and heavily landscaped settlement.

"Cities have been treated as systems for fifty years but only in the last two decades has the focus changed from aggregate equilibrium systems to more evolving systems whose structure merges from the bottom up." He states, "The notion too, that change is nowhere smooth but discontinuous, often chaotic, has become significant" (p. 8). Urban dynamics is therefore not about balance. The key to the idea is "…dynamic models of city systems which build on the style of nonlinear dynamics introduced here and these all have the potential to generate discontinuous behavior" (p. 33). Specifically:

> "The models…come from dealing with objects and individuals at much lower/finer spatial scales and simulating processes which engage them in decisions affecting their spatial behavior. The fact that such decisions take place through time (and space) makes them temporal and dynamic rather than through the imposition of any predetermined dynamic structures such as those used in the aggregate dynamic models…" (p. 33).

Batty (2011) goes to the heart of the matter in *Building a Science of Cities.* His abstract makes two important statements. "Here we review progress, sketching the background beginning with the systems approach which treated systems as being organised from the top down to that which now dominates where systems are treated as evolving from the bottom up"(p. 1). He goes on: "The switch in thinking we describe is best pictured in the transition from thinking of "cities as machines" to "cities as organisms".

The central argument of Geddes is just that; viewing cities as organisms (*as presented earlier*); ultimately, his treatise *Cities in Evolution*! Nevertheless, what concerns this author is to uncover a structure to the notion of the science of cities. The connection to Geddes is reinforced. Batty cites (Portugali, 2000): "In short, cities are more like biological than mechanical systems and the rise of the sciences of complexity which has changed the direction of systems theory from top down to bottom up is one that treats such systems as open, based more on the product of evolutionary processes than one of grand design" (p. 2).

Batty (2011) goes on to suggest the new focus for the science of cities: "…there is now considerable momentum in developing formal ideas about how cities are ordered and structured which are part of the rapidly expanding sciences of complexity" (p. 2). His conclusions offer indicators for the future. 'Models are being used increasingly to 'inform' rather than 'predict' as a new relativism sweeps the field" (p. 12).

Another conclusion offers an indication of the science of cities in a practical sense:

> In terms of theory, new data sets are coming on stream very rapidly and are enabling new theories to be tested. Much of this data is dynamic at the level of the individual and new techniques of model building, estimation, data mining, and pattern recognition not to say new ways of storing, retrieving and analysing massive data sets, are changing the context to the field. In

> one sense, cities are slowly beginning to be subject to the methods and approaches of 'big science' as data sets get ever larger and as teams of different experts are required to put together requisite models to engender this new science (p. 13).

The argument has run from science to systems. What remains is the idea of greater systems understanding, to apply to the resilience of towns and cities.

4. From Systems to Resilience

It remains for Batty's work to anchor the concept to what might be called the *real* science of cities. Sui (2014) review's the Batty (2013) book. The reviewer states: "according to Batty, to understand cities, we must view them not simply as places in space but as systems of networks and flows. Accordingly, to understand space and the cities, we must understand flows, and to understand flows, we must understand networks". Later he states: "I also believe that this book is a significant contribution to the foundations of GIScience." Two comments from a town planning practitioner perspective are warranted here.

When it is asserted that "we must view (cities) not simply as places in space but as systems of networks and flows", he confirms this writer's continued efforts to convey not only spatial consciousness but also networks and flows. The latter concerns all urban infrastructure, including water, energy, transport and now, connectivity. This idea was developed in the Kenyan Municipal Programme (KMP) as the urban score card (McGill, 2018, Table 1). It was designed as both a dashboard for the particular place (city or town) and as a bridge between land-use and budgetary planning. Investment decisions on trunk infrastructure were to be determined by the location, capacity and condition of the infrastructure. Threshold analysis was to be deployed (Kozlowski & Hughes, 1967). Infrastructure was to be planned to reinforce desired spatial form, particularly, where no current town plan existed. In addition, the environmental dimension was captured in its own sieve analysis (McHarg, 1967), thus marrying environmental and infrastructure analysis to help define spatially, optimum locations for new or redevelopment.

The concern here is to anchor the science of cities to a local government practitioner, especially for those in the developing world. As the review goes on to state, he highly recommends: "this book to anybody who is interested in the theoretical foundations of GIScience and geodesign". Therein lies the conundrum; researchers talking to researchers. Interestingly, Sui does not acknowledge Batty's scientific inspiration. The preface to the book quotes Geddes (1905): "a city is more than a place in space, it is a drama in time". Vindication indeed as the struggle to understand the science of cities continues. As to complexity, Alexander is the prime proponent in his work on the structure of cities.

Alexander's seminal work, *The City is Not a Tree*, is fundamental. Mehaffy (2019) states "A City Is Not a Tree is the beginning of a unified science of cities and of a dialogue between the city as a natural phenomenon and other complex systems" (p. 2). Already, the key words "science" and "systems" feature. His argument is on the concept of patterns, captured in the contrast between the structure of a tree and a semilattice. In his view, the semilattice "has overlap, redundancy, ambiguity, and interactive relationships. For a city, this was an essential feature of its dynamism, its complexity and richness" (p. 3). According to the author, Alexander extolled the virtue of ambiguity and overlap in urban form as an intrinsic characteristic of a city's nature. The mind, he noted, tends to default to these more easily managed mental categories—and for planners, this meant dealing too much with tree-like plans. The virtue of "ambiguity and overlap" was also recognized by Sennet (1970).

It is for this reason—because the mind's first function is to reduce the ambiguity and overlap in a confusing situation and because, to this end, it is endowed with a basic intolerance for ambiguity—"that structures like the city, which do require overlapping sets within them, are nevertheless persistently conceived as trees" (Alexander, 1965: p. 28). From a different angle, the same point is highlighted. "Since the earliest days of city-building, scientists and engineers have sought to rationalize the chaotic nature of urbanization" (Townsend, 2015: p. 4).

Even at the very beginning of town planning education, one wondered at what level of generality in urban form, could the idea of the semilattice be applied. Given that housing is the most common land use in cities, and new urban layouts in particular, are dominated by residential areas, the conceptual wrestling with the urban advantage of complexity could not be reconciled with the common approach to housing layouts. One just was not clever enough at the time (1970s). The paper emphasized the point:

> We might well pause here to ask whether the deeper lessons of A City Is Not a Tree were truly learned by planners and architects, then or since. Certainly, we can see many developments around the world today that continue to be segregated into tree-like components, that are rather lifeless creations of their architect-artists, meant to be admired as gigantic sculptures, but *hardly lived in, shaped by transformative acts of overlap, ambiguity, and vitality in self-organisation* (author's emphasis). Mostly we are supposed to passively admire the static works of a technical and artistic priesthood of makers (p. 5).

Mehaffy's paper reverts to the core question: Potential Contribution to a Science of Cities. It presents six topics. For this author, the test is to see if something practical is triggered by each.

Evolution as a Comprehensible (*and Modifiable*) *Emergent Outcome of Complex Adaptive Systems*. The terms Cities (in) Evolution is the title of Geddes' 1915 book. Arguably, he is the founder of the scientific town planning movement. He was influenced by his original biological training. His town planning interventions were founded upon observation (survey) before intervention (plan).

There is no mention of Geddes in the cited Alexander texts or concepts.

Building Process as the Interaction of Multiple Distributed Agents. This is the concept of integrating "all the players in the city-building process"—from the individual household (upgrading the family home), on to business, local and finally, central government capital investment in both major infrastructure and superstructure (McGill, 2018, **Figure 1**). It is a plea for understanding the city as a system (the urban challenge) and organizing all the players in the city building process, ideally, through the lowest level of competent city government, to plan and implement accordingly (the institutional response).

A Dysfunctional Relationship between Art and Science in Modern Cities. The interesting passage from that section is "a science of cities that is concerned with the actual structure of form-generation and its measurable outcomes, including its impacts on human beings. Such a science has interests far beyond the parochial scale of specialist artist-architects and their efforts to create "newness" for its own sake…" (p.13). The indication here is a science of cities that openly reconciles the art and science of town planning.

Aesthetics as a Non-Trivial Indicator of Life-Supporting Order in Cities. Alexander argues for the aesthetics of well-being. This author-practitioner certainly recognizes this by citing Cullen (1961) above. The Alexander advocacy is more scientific. "It would be interesting indeed if these insights could be developed to apply more broadly to the city as a complex adaptive system, integrating its cognitive and aesthetic aspects" (p. 14).

A More Human-Centred Application of Data and Metrics. "Alexander's tools sought to generate global connectivity (and other forms of larger-scale order) by employing local iterative, agent-based processes. The goal was to mimic the same self-organising capacity seen in other complex adaptive systems—including the "unself-conscious processes" of past human city making" (p. 14). Whether this is science or not, what comes to the fore is the notion of adaptive urban systems.

The Current Incomplete Stage in the Evolution of Technology, Design, and City-Making. A straight quotation captures the essence:

> People used to say that just as the 20th century had been the century of physics, the 21st century would be the century of biology... We would gradually move into a world whose prevailing paradigm was one of complexity, and whose techniques sought the co-adapted harmony of hundreds or thousands of variables. This would, inevitably, involve new technique, new vision, new models of thought, and new models of action. I believe that such a transformation is starting to occur... To be well, we must set our sights on such a future (Alexander, 2003: pp. 568-569).

One has to quibble here: the critical importance of biological thinking applied to cities started in the early 20th century (Geddes). To have its advocacy propelled (unwittingly) into the 21 century is unassailable vindication for Geddes' committed urbanists.

The paper concluded by suggesting "Alexander"s contribution was less about making specific technical and quantitative contributions to an urban science, than in providing a broader theoretical and philosophical foundation for its future (and much-needed) advancements' (p.15). That may be but for this practitioner, it comes to the central question; how to apply the semilattice structure to towns and cities.

What remains is to offer a summary of the ideas reviewed, to the point of both understanding and application, ideally at the practitioner level.

5. Conclusion

GIS is the foundation for the comprehension and manipulation of urban information flows. However, GIS on its own is static in the sense that it does not present a dynamic "binding address" to the science of the city. For that, systems theory rescues matters. Therefore, the urban scientific platform is systems theory applied to GIS. Put another way, urban science is GIS-based and systems theory enriched.

Systems theory is the epistemology for understanding the data of the city. Data, however, concern the notion of scale and the patterns of supporting thinking. Are we seeking general principles from particular experiences; inductive thinking? Or are we seeking a meta- or global understanding of urbanism, which then percolates to the particular; deductive thinking? Batty, in his systems analysis, has conceded that the former "top-down" approach to systems thinking in relation to the urban phenomenon is now replaced by a "bottom-up" approach. The key to that is the concept and pursuit of urban resilience.

The most profound writer on urban resilience is, perhaps, Alexander. His advocacy for urban structure, as a multi-functional semilattice as opposed to a mono-dimensional tree, is clear to understand but difficult to put into practice. This is because of the strictures of land-use (or zoning) regulations, too often dominated by single functions. In turn, how does a town planner, faced with a one-hectare site, introduce a semilattice pattern to a housing layout. It raises the question of "at what level of granular thinking" can urban resilience be applied comfortably in town planning practice?

A city, as a system, has two practical features. First is its relationship to its environment; its city-region. The city-region rolls up to a global or big-data science. Research agendas for such are outlined above. Secondly, is a city's relationship with its governing institutions. The suggested starting point for that is local government. It is the ambition to see any city council as a dynamic local development agency and not simply as an offshoot of central government; simply a passive local administration.

Batty's systemic bottom-up conclusions seek to replicate the aspirations captured in biology; self-regulating renewal. It also captures Alexander's accumulation of experience and complexity over time, illustrated in the best examples of mixed-use urban environments. What is of practical import here is bringing matters down to a level that can be understood by both local government and town planning practitioners.

Is the science of cities useful? At the global level it is, though its nascent concepts have still to be defined rigorously. Globally, it is for researchers and academics to ponder the layers of information required to provide a consistent research discourse. Locally, the same applies in terms of the science *per se.* However, at this level, there are far more obstacles to securing an institutionally shared GIS platform, with organisations' planning and budgeting contributing to a common spatial perspective. Thus, at the practical town or city level: we strive for an openly accessible, inter-organisational GIS and a commonly agreed spatial strategy with supporting investment from "all the players in the city building process".

Perhaps the science of town planning rests on systemic analysis, GIS depiction and their combined contribution to RTPI's original "mediation of space". This is an economic and efficiency challenge: for example, relating land-use patterns to optimum transportation networks. In turn, the art of town planning can be the three-dimensional design of that urban space; RTPI's original "making of place". Making places work well and look good should be a conscious town planning action. If successful, it satisfies the psychological need to feel safe and happy in the urban realm. This should not be simply a Western luxury.

In the developing world, the urban system's ultimate performance can be tested through increased economic activity (to the point of full employment) and an eventual eradication of informal settlements (with careful upgrading and sensitive relocation). This is particularly pertinent in Africa, the globe's most rapidly urbanizing continent, where informal settlements make up at least half of the total urban housing stock[4]. In short, the urban crisis remains and the science of cities, both globally and locally, needs to be applied with intelligence and passion.

In closing, this has been research through reflective practice over many decades. It has sought to highlight some general principles that should govern not only town planning but also, a greater understanding of its conceptual underpinnings. Reverting to the February 2020 issue of *The Planner*, one also laments the demise of RTPI's mantra: "the mediation of space, the making of place" under its public logo. Mediating "space" as a two-dimensional challenge and making "place" as a three-dimensional one, captures the very essence of town planning.

If future research was possible, one would seek to explore the mediation of space as one that carries transformative complexity to an accepted level of practice. Alexander's semi-lattice structure is simply a starting point. The psychological aspects of how we feel about a place and how it is made so, whether consciously or not, demand much greater understanding, again, towards an accepted

[4]In 2001, 166.2 million people, or 72 per cent of Africa's urban residents, were living in slums. UN Habitat, *State of the World's Cities: Trends in Sub-Saharan Africa*, p.2, undated text. https://mirror.unhabitat.org/documents/media_centre/sowc/RegionalAfrica.pdf (accessed 28 May 2020).

level of practice. Sennet's work enriches this possibility.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Alexander, C. (1965). The City Is Not a Tree. *Architectural Forum, 122,* 58-62.

Alexander, C. (2003). *The Nature of Order: An Essay on the Art of Building and the Nature of the Universe.* Center for Environmental Structure.

Batty, M. (2008). *Cities as Complex Systems: Scaling, Interactions, Networks, Dynamics and Urban Morphologies.* Working Papers Series, Centre for Advanced Spatial Analysis, University College, London, Paper 131, 62 p.

Batty, M. (2011). *Building a Science of Cities.* Working Papers Series, Centre for Advanced Spatial Analysis, University College, London, Paper 170, 15 p.

Batty, M. (2013). *The New Science of Cities.* The MIT Press, 496 p. https://doi.org/10.7551/mitpress/9399.001.0001

Chadwick, G. F. (1971). *A Systems View of Planning: Towards a Theory of Urban and Regional Planning.* Pergamon Press, 396 p.

Cullen, G. (1961). *Townscape.* The Architectural Press, 315 p.

Cuthbert, M. (1974). *The Epistemology of Town Planning: The Contribution of Patrick Geddes*. Heriot-Wat University, Edinburgh.

DFID (2019). *Terms of Reference*. African Cities Research Programme, Department for International Development.

Edwards, P. (2015). *Videoconference Interview* (recorded by Townsend).

Friedmann, J. (1973). *Retracking America: A Theory of Transactive Planning.* Anchor Press, 289 p.

Friend, J. K., & Jessop, N. (1969). *Local Government and Strategic Choice: An Operational Research Approach to the Processes of Public Planning.* Tavistock Publications Ltd., 322 p. (Re-published by Pergamon Press, 1976)

Geddes, P. (1905). *Civics: As Applied Sociology.* (Republished by Good Press, 50 p).

Geddes, P. (1915), *Cities in Evolution: An Introduction to the Town Planning Movement and to the Study of Civics.* University of Michigan Library, 444pp.

Kozlowski, J., & Hughes, J. T. (1967). Urban Threshold Theory and Analysis. *Journal of the Town Planning Institute, 53,* 55-60.

McGill, R. (1996). *Institutional Development: A Third World City Management Perspective*. Palgrave Macmillan. https://doi.org/10.1007/978-1-349-25071-4

McGill, R. (1998). Urban Management in Developing Countries. *Cities, 15,* 463-471. https://www.sciencedirect.com/science/article/abs/pii/S0264275198000419 https://doi.org/10.1016/S0264-2751(98)00041-9

McGill, R. (2018). Making towns Work: Habitat III—What Relevance? *Planning Theory and Practice, 19,* 140-148. https://www.tandfonline.com/doi/abs/10.1080/14649357.2017.1369237 https://doi.org/10.1080/14649357.2017.1369237

McGill, R. (2020a). DFID's New Urban Discourse; A Critique. *Town Planning Review,* *91,* 461-474. https://www.liverpooluniversitypress.co.uk/journals/article/58156/ https://doi.org/10.3828/tpr.2020.26

McGill, R. (2020b). Urban Resilience—An Urban Management Perspective. *Journal of Urban Management, 9,* 372-381. https://www.sciencedirect.com/science/article/pii/S2226585619302316 https://doi.org/10.1016/j.jum.2020.04.004

McHarg, I. (1967). *Design with Nature*. Wiley, p.158. (Republished in 1992)

McLoughlin, J. B. (1969). *Urban and Regional Planning: A Systems Approach.* Faber and Faber.

McPhearson, T. et al. (2016). *Advancing Urban Ecology toward a Science of Cities. BioScience, 66,* 198-212. http://www.urban-landscape-ecology.com/english/wp-content/uploads/sites/2/2019/03/McPherson-et-al.-2016_-Advancing-Urban-Ecology-toward-a-Science-of-city.pdf

Mehaffy, M. W. (2019). Assessing Alexander's Later Contributions to a Science of Cities. *Urban Science, 3,* Article 59. https://doi.org/10.3390/urbansci3020059

Munshi, I. (2000). Patrick Geddes: Sociologist, Environmentalist and Town Planner. *Economic and Political Weekly, 35,* 485-491.

NRC (2014). *Convergence: Facilitating Transdisciplinary Integration of Life Sciences, Physical Sciences, Engineering, and Beyond*. National Research Council, The National Academies Press.

NSF (2018). *Sustainable Urban Systems: Articulating a Long-Term Convergence Research Agenda.* Advisory Committee on Environmental Research and Education, 31 p. https://www.nsf.gov/ere/ereweb/ac-ere/sustainable-urban-systems.pdf

Portugali, J. (2000). *Self-Organization and the City*. Springer, 352 p. https://doi.org/10.1007/978-3-662-04099-7

Sennet, R. (1970). *The Uses of Disorder: Personal Identity and City Life.* (Re-published by W. W. Norton & Company, 1992, 222 p)

Solecki, W. et al. (2013). It's Time for an Urbanization Science. *Environment: Science and Policy for Sustainable Development, 55,* 12-17. https://doi.org/10.1080/00139157.2013.748387

Sui, D. (2014). The New Science of Cities, by Michael Batty, Cambridge, MA, The MIT Press, 2013, 496 pp. *International Journal of Geographical Information Science, 29,* 345-347. https://doi.org/10.1080/13658816.2014.937717

The International Expert Panel on "Science and the Future of Cities" (2018). *Science and the Future of Cities.* Report of the International Expert Panel on Science and the Future of Cities, 60 p. https://www.researchgate.net/publication/329717388_Science_and_the_Future_of_Cities/link/5c17e0d192851c39ebf51b23/download

Townsend, A. M. (2015). *Making Sense of the New Urban Science.* New York University, Rudin Center for Transportation Policy & Management, 31 p. http://www.spatialcomplexity.info/files/2015/07/Making-Sense-of-the-New-Science-of-Cities-FINAL-2015.7.7.pdf

UK (2016). *Future of Cities: The Science of Cities and Future Research Priorities. A Report by the Project's Lead Expert Group.* Government Office for Science, 42 p. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/516407/gs-16-6-future-cities-science-of-cities.pdf

UN (2013). *Science, Technology and Innovation for Sustainable Cities and Peri-Urban Communities.* Economic and Social Council, 19 p.

https://unctad.org/meetings/en/SessionalDocuments/ecn162013d2_en.pdf

Williams, K. (2014). *Urban Form and Infrastructure: A Morphological Review.* Future of Cities: Working Paper, Foresight, Government Office for Science, 58 p. https://uwe-repository.worktribe.com/output/815766/urban-form-and-infrastructure-a-morphological-review