PEAK Urban

The Future of the Future City? The New Urban Sciences and a PEAK Urban Interdisciplinary Disposition

This brief is a summary of a published research article: The future of the future city? The new urban sciences and a PEAK Urban interdisciplinary disposition. (Keith et al., 2020)

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Exponential demographic growth driving global urbanization, particularly in China, India and Africa, generates commercial opportunities, ethical dilemmas and ecological challenges in equal measure. And while the importance of the city is recognised in the United Nations' explicitly urban Sustainable Development Goal (SDG 11), all the SDGs will succeed or fail in and through the future configuration of cities that will be the sites where most of the globe's future will dwell.

PEAK Urban international partnership

A growing academic subdiscipline claims to theorise, explain and predict the shape of the future city. We argue that situating cities as drivers of sustainable development is usefully captured by an augmented systems-based logic. With others we move from understanding the city as a system to a 'system of systems' that recognises cities as ***open* rather than *closed* systems**. An open system, or the parts of a whole, interacts with its environment by exchanging energy, materials, and information, changing the structure of the constitutive parts of the system itself. However, our interpretation of how urban science or systems thinking might be configured, presented here as 'PEAK Urban', elucidates both how forms of scientific knowledge 'know' the city but also reorganise the way the city is seen and organised – how science lands in cities and how scholarship might promote ethically sensitive and contextually nuanced urban transformations.

Key points:

1. **A PEAK Urban approach to urban studies both values and qualifies the power of (P)rediction in new urban sciences.**
2. **Paradoxically we know more about the short term but less about the long term future of open urban systems.**
3. **(E)mergence defines novelty entering the world through cities, disrupting urban systems and their normative settlement.**
4. **How science 'lands in place' and how technologies are (A)dopted drives diverse and path dependent urban futures.**
5. **The commensuration or inherent trade-offs in ascribing value and worth should be the focus of interdisciplinary and experimental (K)nowledge exchange.**

Prediction and the urban sciences paradox

PEAK Urban values but also qualifies the power of prediction in the new urban sciences. Recognising both that cities are open systems and the power of contemporary data analytics leads to two key starting points.

1. As systems that are open and complex rather than closed, simple or stable the constituent parts of urban systems themselves are subject to change. For example, the systemic relationship between homeplace and workplace in a city is disrupted by changes in: technologies of distance working; the cultures of gendered and sexed family structures and the modes of transportation between the two.

2. Data analytics speaks to trends that are calculable – big data that can be mapped and analysed in real time. It recognises the limitations of prediction in systems that are open and therefore unstable. So we foreground **the paradox of the new urban sciences**. We know more and more about the short term future of the city yet less about the long term future of open urban systems.

New sources of information about cities have proliferated and the host of new methodologies to analyse this data has pluralised. With the recent release of new high-resolution data and the advent of new tools, there are three key opportunities (Box 1) and illuminating examples (Box 2).

Box 1: Key opportunities of new data and tools

- **New datasets and novel tools to interrogate existing paradigms and theories concerning the functioning of cities.**
- **Potential to uncover new perspectives on the functioning of cities, and their constituent interacting systems.**
- **The imperative to integrate fresh insights into the existing know-how on urban processes.**

New sources of data include imagery via satellite and street photography, personal and environmental statistics captured by both mobile apps and fixed sensors, and social networks via online platforms. Beyond mapping the dynamics of urban life, this data can provide information on informal activities (e.g. housing, travel, business), a key component of developing cities not well-described by traditional data collection methods.

Alongside the emergence of urban 'big data', there has been a parallel push to develop methodological tools to cope with large data sets, identify patterns and relationships within this data, and build predictive models (Higham et al., 2017). This includes powerful advances in traditional econometrics via the realm of machine learning, capable of going beyond linear relationships, and ingesting large numbers of explanatory variables in order to maximise predictive power. There is much work to be done, however, to adapt these methods to policy needs. The difficulty lies largely in determining how much each variable contributes to explaining the overall change (Athey, 2017).

Nonetheless, in the modelling realm, network analysis provides a uniquely powerful tool to understand and quantify such complex systems whose aggregate dynamics depends not on individual agents or homogeneous populations but on an underlying heterogeneous interconnection structure. Most network models, however, are minimalist in the sense they aim to capture specific processes. Unfortunately, capturing a large number of heterogeneous interacting agents and systems becomes difficult. In this endeavour, agent-based modelling, which aims to simulate the decisions of large heterogeneous populations in space, might be better-suited to multi-agent multi-system urban analysis (Batty, 2013 and 2017).

The city assembled has properties that its parts do not have on their own. Recombinations of nature and culture, technology and science, built environment and social formations of organisation, rule and government reconstitute the urban system. The city is always unfinished, its mutations exemplify what in systems theory is described as emergence.

Box 2: Non-exhaustive survey of relevant works:

- **Using anonymized mobile telecoms data to shed light on the complex social structure of societies. Larger cities foster disproportionately more densely connected communication networks (Schlepfer et al., 2014; Eagle et al., 2010; Onnela et al., 2007);**
- **Connecting socioeconomic outcomes with physical form through mobility patterns. (Gonzalez et al., 2008; Lotero et al, 2016);**
- **Interrogating theories on what makes cities economically successful; in part through a revitalisation of the sub discipline of urban economics in the last two decades (Glaeser, 2011; Glaeser and Joshi-Ghani, 2015);**
- **Geographical literatures predicting emerging trends of urban economies (eg Storper et al., 2015; Nathan and Overman, 2013);**
- **Analysis of diversity and similarity of the economic base in structuring growth (Beaudry & Schiffauerova, 2009; Hidalgo et al, 2007, Frenken et al, 2007);**
- **Utilizing mobility data to quantify the spatial/temporal scale of knowledge and skill-pooling effects – as cities become larger, labour is allocated into increasingly complex industries as firms combine complementary capabilities derived form a more diverse pool of workers (O'Clery and Llora, 2016),**
- **Analysing patent data to look at the extensive margin of knowledge production and distribution (Balland et al., 2017);**
- **Examining the correlations between night-time lights and pixel density with income and productivity (Henderson et al., 2012);**
- **Econophysics theories and methods developed in the work of Geoffrey West and Luis Bettencourt on urban scaling (Bettencourt et al., 2007).**

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Valorising and qualifying new urban science powers of prediction

Neave O'Clery leads the Oxford Data Analytics team which focuses on studying cities as complex social, spatial and economic systems with themes including knowledge diffusion, skills and agglomeration economics and industrial complexity. They use tools of PREDICTION from network science to machine learning. In a recent publication they develop a network-based model analysing commuting times of up to 62 cities over a 6 year period. They show that industry productivity is maximized when Colombian cities can attract required skilled labour from a commuting radius of up to 75 minutes.

Jairo Gómez leads the EAFIT Past, Present and Future of Urban Footprint Growth in Latin America project. His team leverages worldwide data including night-time lights, GHSL, Landsat and OMS to generate PREDICTIONS via econometrics, data science and machine learning methods on the future of Latin American cities. In a recent publication he creates a framework for PREDICTING urban growth that lets decision makers understand future implications of policies, such as working directly with utilities providers to plan future provision.

Emergence: How novelty comes into the world through cities

The power of emergence is based on a conceptual framework used in both in scientific analyses of the urban and in approaches rooted in the humanities.

Michael Batty (2009, 5) a pathbreaking scholar of the new urban sciences highlights the logical power of fractals in space, the geographical opportunities for the city to evolve, to reconfigure and generate new urban form as the city grows. Contemporary humanities, anthropological and social theory subscribe to a similar logic which foregrounds the propensity of things -infrastructures and objects to combine, mutate and generate new urban forms and ways of life (Appadurai, 1985; Julien, 1995). Sennett and Urry assert that the recombination of built form and cultural practice manifest as emergence similar to non-linear systems where known and determinate beginnings can wind up producing unforeseen or unpredictable results, equivalent to 'chaos' in a complex system (Sennett, 2014; Urry, 2016). Cities are consequently systems rarely characterised by equilibrium, more often by autopoesis.

A sense of emerging urban transformation that invariably builds on something contrasts with both the notion of city making as entirely predetermined by its past or as a *tabula rasa*, where the city is ever created afresh from a blank canvas. This is known as 'path dependency' in systems theory but equates to a recognition of both the shared dynamics that structure urban change and the histories and geographies of the present that define unique city worlds.

Anthropology's contested 'ontological 'turn' more than a decade ago focused on how the status of material objects observed supposedly generated a technology of description which allowed anthropologists to make sense of their ethnographic material in new and experimental ways (Henare et al, 2007; Palacek, and Risjord, 2012, Pedersen, 2012). This focus was partially responsible for the growth of inquiry that considered how new combinations of culture and urban infrastructure characterises the dynamics of the 21st century metropolis and defines many of these forms of city emergence (Harvey and Knox, 2015; Larkin, 2014; Simone, 2018). Processes of bridging and combining are echoed in what is at times described as non-representational theory in urban studies (Amin and Thrift, 2016), itself in part building on Bruno Latour's influential actor network theory. These perspectives showcase how the city 'assemblages' associate humans and non-humans to form precarious wholes, changing the ways we see and understand cities as simultaneously material and cultural forms of life.

Even where a major new town or city is created—in Washington DC, Brasilia, Islamabad or in 21st century Xiong'An in China —it will always sit within an urban hierarchy that is relational and fluid. From the smallest unit to the grand plan, attempts to design the city necessarily invoke many different skills and many different values. Drawing liberally on the social theory of Peter Sloterdijk, Bruno Latour (2008) asserted that we need to understand five principles of such design that combine humility, attentiveness to detail, a recognition that the tabula rasa is a fiction in any urban context, and that design always invokes symbolic meanings and an ethical as well as a functional question. Latour and Sloterdijk echo the 2,000 year-old principles of

the Roman architect Vitruvius who suggested that every building can be assessed by three measures of 'value'; durability, utility and beauty. We may measure a building by its capacity to last (*firmitas*), a measure of whether it is functionally fit for purpose (*utilitas*) or how beautiful it is (*venustas*). But these are very different measures. **They are not always commensurable one with another, we may privilege one value over the other two depending on our choice (and our 'justifications' of that choice) and the basis for the evaluation may change over time as public preferences shift, catalysing demands for adjustment in the urban system**. And so of great significance for the new urban sciences, this dilemma of commensuration is central to a scholarship of future cities (Keith, 2019); how they are planned, how they shape themselves autonomously and how they might be shaped by others, deliberately or accidentally.

Autonomous mutation, strategic and tactical interventions and disruptive technologies are changes that share a propensity to generate emergent urbanisms and set up puzzles of metropolitan commensuration that are simultaneously analytical, instrumental and ethical. These changes demand an understanding of how technology disrupts urban life and the very reason the city has taken a particular form. They lead to an interrogation of how we make visible and try to make commensurable the DNA of urban transformations that are always simultaneously economic, fiscal, material, social and cultural.

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How novelty comes into the world

Gautam Bhan leads the IIHS Urban health in the Indian Metropolis project that works to locate and urbanise the question of the current state in the epidemiological transition in India. To uncover the role of work and workplaces in the delivery of effective and equitable health care for urban Indians, he interrogates the EMERGENCE of health outcomes and care seeking patterns by understanding the relationships between work status and the conditions of employment and between health outcomes and care-seeking patterns. In a recent publication he highlights the various structural conditions surrounding informal women workers and the impact on maternal and child health outcomes.

Jacob Doherty leads the Oxford Transport Studies Unit Everyday mobilities in African urban transport systems project which, among other results, uncovered how services provided by communal taxis in Abidjan, Cote d'Ivoire EMERGE from the combination of the extent and routinisation of violence in the transport sector and the infrastructural features of the city that shape conflicts over space. In a recent publication he demonstrates how the proliferation of digital mobility platforms in Kampala EMERGE locally with distinct additional benefits including to make evident moral practices, such as honesty, work-ethic and road acumen of drivers.

Adopting Innovation: How science lands in place

Use-based histories of technological change, in contrast to innovation-based histories, highlight the geographical variation in the uptake, value and capture of cities by specific technologies. Similarly, these use-based histories show alternative strategies residents devise to secure their livelihoods in the absence of technologies available elsewhere.

An understanding of **how new technologies land in place**, are adopted, governed, optimised or bypassed shapes city futures scholarship. In reality, technologies do not just appear they "also disappear and reappear and mix and match across the centuries" (Egerton, 2007, xii;). In contrast, the narrative tropes of innovation driven futurism are largely unchanging over time.

Exporting technologies such as specific transit systems from global north cities to the newly emerging metropolises of the global south has produced varied, uneven and unintended consequences. Settlements may succeed in leapfrogging the lock- ins of the mid 20th century planned metropolis. Old technologies may be reinvented in place to address both existing environmental challenges such as off-grid/on-grid translations to address energy poverty, new ecological challenges such as climate change (Pieterse and Simone, 2017; Sharan, 2014) or sanitation and gendered menstrual hygiene regimes (Mahon and Fernandes, 2010).

Hence the 'infrastructural turn' in urban studies that foregrounds how city infrastructures act on the metropolis but are reappropriated by its 'cityzens' might lead to an inquiry into how even the most ostensibly dysfunctional cities appear to work through a focus on their extemporised, creative and uniquely configured logistics (Keith and Santos, 2021).

Box 3: The impact of driverless cars will depend on global manufacturing capacity, technical facility, and complementary built environment technologies. But it will also depend on city-specific conditions. Conditions which include: the local socio-material drivers structured by the nature of market formation; the legitimacy of policy tools such as road pricing; culturally acceptable measures of calculable and legal risk; the informal as well as the formal modal transport shifts; and a qualitative understanding of the nudges that shape city behaviours in different locations. Consequently, driverless cars might produce more or less dense urban form, more or less dependency on mass transit, depending on different combinations of universal propensity and vernacular realities (Economist, 2018). *Thereby, local knowledge must inform analytical logic to make sense of emergent urban pattern.*

A focus on technologies used rather than innovations publicised reframes the balance between high profile technological novelty and vernacular and creolised technological practices and reality. The mobilities of the poor in cities of the global south may reflect extemporised forms of bus, taxi and vehicle sharing more than mass transit. For example, technologies of ride sharing in cities in the global south have been shaped by the path dependencies of politically controlled minibuses in 1990s Karachi, site specific motorcycle taxis in Kampala or Bangkok (Doherty, 2017; Sopranzetti; 2017). Analysis of urban futures consequently demands two key considerations, exemplified in Box 3. First, an understanding of the potential of new technologies as geographically universal and predictively behaviourist. Second, their use context as geographically variable, path dependent and culturally mediated.

Forms of scientific expertise also land in place. They are appropriated differently in different urban contexts. Epidemiology may play powerfully at time of pandemic, economics in the treasury, the architectural folly or *grand project* in the imagination of the city elites. Some forms of expertise travel and land better than others. For example, one school of scholarship argues that an academic discipline such as neoclassical economics becomes both a way of thinking about economy and society in the abstract, and by default a way of organising it in particular geographical contexts. The conventions, paradigms, analytical and policy prescriptions of a certain kind of economic theory performs as well as explains.

Analytically, economic theory has an ability to predict the manner in which utility maximizing individuals and institutions collectively generate specific patterns of behaviour with associated macro-economic consequences. But the deployment of economic reason also travels in a particular fashion. It lands in country and begins to organize and make visible the economy of the almost sovereign state and reconfigure its institutions to reflect this set of values as much as it makes comprehensible existing and historical patterns and processes of wealth creation. Utility serves as a measure of value; maximizing utility a logic that drives powers of prediction. As always, expertise operates in the name of the particular form of reasoning that is rooted in a specific calculus of value that is captured by (sometimes competing) definitions of utility. But, as Vitruvius described, utility may be one value amongst many; one logic but not the only logic through which the predictive lens makes visible the future.

Commensuration, in the economics of Amartya Sen (2009) and the philosophy of Martha Nussbaum (2003) becomes itself a subject of inquiry; the turn to a study of value and worth becomes a matter of major scholarly investigation (Beckert and Aspers; 2011; Stark; 2011). Likewise, in certain contexts discrete forms of academic expertise may serve as justifications of particular forms of action (Boltanski and Thevenot, 2006). For city scholars, how – for example - planners speak to architects about processes of economic development may be less about a distance of professional cultures than about how their different knowledge logics measure value and how we choose what is valued in the metropolis.

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How science lands in place: Value and values

Pengjun Zhao leads the team from PKU working on the Transitioning Cities: The complex interaction between behaviour, transport flows and urban society project. They use multi-source data, including from mobile phones to describe the temporal-spatial characteristics of urban land use, individual people's travel behaviour, socioeconomic features and traffic flows. In the Chinese context these tools and new data techniques are ADOPTED to examine how behaviour is influenced by social and cultural contexts, economic development, governance arrangements and the built environment.

Nick Simcik Arese leads Oxford COMPAS' Global land enclosures, urban-technology, and experimental property project. As part of the project his team develop an urban experiment in Moravia, a district of Medellín containing a large number of homes at risk of eviction. The experiment imagines how new technology, such as land property digital platforms, and new institutional, financial and legal mechanisms for property titling can be ADOPTED to achieve neighbourhood-scale circular economies and reduce incentives for quick sale of land at low prices.

Knowledge Exchange and the rise of experimental urbanism

Plural epistemologies and multiple regimes of value and worth make visible the mesh of trade-offs at the heart of new urban science.

Commensuration and its challenges surface the importance of reconciling alternative ways of knowing the city and the variety of optimal solutions to the dilemmas of city futures. Consequently, attempts to capture or describe these alternatives are generated through experimental urbanism (Karvonen and Raven, 2016), and a reconsideration of the relationship between urban science and its institutional setting.

Understanding the configuration and pathways of knowledge and power into and within the city authority is a prerequisite for understanding city futures. The contours of urban knowledge production and exchange are now weighted towards information system design and strategic planning platforms such as city development or national urban policies, exemplifying how different urban regimes may prioritise between economic growth, liveability or longer term ecosystem values (Mossberger and Stoker, 2001).

In many cities, elected officials and appointed professionals are no longer the dominant voices of urban arbitration between public goods and private interests as a wider template of stakeholders has emerged, either as the result of the hollowing out of the state or as participatory processes have brought civil society more directly into city decision-making. Some, such as the architect David Chipperfield (in Kretz, 2019), have characterised the 21st century as a time when the ethos of complete city planning has been displaced by the more architecturally oriented expertise of master planning smaller (and more fragmented) tracts of land than the 'whole city'.

Experimental urbanism

A PEAK Urban framework both acknowledges the evolving patterns of city governance globally and builds on the logic of open systems theory to suggest that making visible the commensuration and trade-offs of incommensurable knowledge systems has implications for how we seek to research urban futures and link academic practice to everyday urban life. A PEAK Urban disposition addresses the three concerns raised by Kitchin (2016) with the ethical dilemmas of new urban sciences. First, a conception of cities as complex systems that surface ethical dilemmas and qualify the powers of prediction. Second, a framing of the contingent and relational nature of urban systems, processes and science. Third, the adoption of ethical principles designed to realize benefits of smart cities and urban science while reducing pernicious effects. Conceptually, this involves recognising that scales of speed and time are as important as scales of space and geography in making sense of emergent urban life.

Plural temporalities of different systemic changes demand recognition of 'wicked problems' demanding 'clumsy' (or bespoke) solutions that rest on what anthropologist Mary Douglas long ago characterised as plural rationalities (Thompson and Beck, 2014). 'Clumsy' solutions may promote what is needed for the here and now over what might be ideal in an indefinitely postponed urban future.

The institutional setting of urban sciences

Existing institutional models of knowledge production in cities are recognising the implications of this logic and a burgeoning literature addresses the city as a site of micro and macro experimentation. In Europe a network of living labs (ENOLL, 2018) has built on social democratic traditions of state, market and civil society collaboration. Globally, the growth of new institutional forms of living laboratories and urban observatories is matched by claims made in the name of 'smart cities', and attempts to learn from models of innovation demonstrators that can be scaled up from initial intervention (FCC, 2018).

Such new institutions where the city is treated as a site of experimentation display diverse logics. Urban Labs in the private sector are very different to those based in the academy or are rooted in 'citizen led science' (Marvin and Silver, 2016, Keith and Headlam; 2017).

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How cities are domains of experiment and knowledge exchange

Susan Parnell and James Duminy lead ACC's National urban reform in South Africa project that aims to understand and capture how KNOWLEDGE was created and used in reform of urban governance policies and practices in Cape Town, with particular reference to health, fiscal and planning systems. The project has resulted in a book that captures the lessons emerging from the first seven years of the Supporting City Futures: The Cities Support Programme (CSP) and the Urban Challenge in South Africa.

Juan Pablo Orjuela leads the Oxford Transport Studies Unit's Communities, accessibility and healthy living in Itagüí project that studies the accessibility to healthy living among low-income women in Itagüí (Colombia). The study aims to understand the role existing transport options play by using a strongly collaborative framework that aims to EXCHANGE KNOWLEDGE and to co-create solutions to issues affecting local health with a group of 40 local women, people working in the three levels of government, and Colombian academics.

Conclusion

As the rapidly growing field of critical data studies demonstrates there are both multiple ethical dimensions of the new powers of real time data analytics of cities (Dalton et al, 2016; Iliadis and Russo, 2016; Ruppert et al, 2017) as well as longstanding suspicion of the utopian claims made on behalf of smart cities and big data more generally (Kitchin, 2014; Wiig and Wyly, 2016). In advocating a PEAK Urban disposition to studies of the future city we are suggesting both a careful consideration and cartography of the flows and circuits of knowledge and practice and a reconfiguration of the relationship between academic research and cities themselves through a complication of the traditionally hard boundaries between basic and applied research.

PEAK Urban consequently defines

1. **A disposition** that is experimental in the generation of knowledges of the future city structured by plural temporal rhythms and productions of space (Evans, 2011).

2. **A recognition** that the logics of commensuration, with registers of value and worth that are multiple and not singular, surfaces the trade-offs and ethical dilemmas shaping the future city.

3. **An assertion** that city futures scholarship reshapes the relationship between university research and applied knowledge through the growth of urban laboratories and observatories.

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About us

The PEAK Urban programme aims to aid decision-making on urban futures by:

1. Generating new research grounded in the logic of urban complexity;

2. Fostering the next generation of leaders that draw on different perspectives and backgrounds to address the greatest urban challenges of the 21st century;

3. Growing the capacity of cities to understand and plan their own futures;

In PEAK Urban, cities are recognized as complex, evolving systems that are characterised by their propensity for innovation and change. Big data and mathematical models will be combined with insights from the social sciences and humanities to analyze three key arenas of metropolitan intervention: city morphologies (built forms and infrastructures) & resilience; city flux (mobility and dynamics) and technological change; as well as health and wellbeing.

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Our framework

The PEAK Urban programme uses a framework with four inter-related components to guide its work.

First, the sciences of **Prediction** are employed to understand how cities evolve using data from often unconventional sources.

Second, **Emergence** captures the essence of the outcome from the confluence of dynamics, peoples, interests, and tools that characterize cities, which lead to change.

Third, **Adoption** signals to the choices made by states, citizens and companies, given the specificities of their places, its resources and the interplay of urban dynamics resulting in changing local power and influence dynamics.

Finally, the **Knowledge** component accounts for the way in which knowledge is exchanged or shared and how it shapes the future of the city.

PEAK Urban is managed by the Centre on Migration, Policy and Society (COMPAS)

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