

SYMPOSIUM

Urban Laboratories: Experiments in Reworking Cities

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Abstract

The notion of the 'urban laboratory' is increasingly striking a chord with actors involved in urban change. Is this term simply a metaphor for urban development or does it suggest urbanization by substantially different means? To answer this question, we review the work of science and technology studies (STS) scholars who have empirically investigated laboratories and practices of experimentation over the past three decades to understand the significance of these spaces of experimentation in urban contexts. Based on this overview of laboratory studies, we argue that urban laboratories and experimentation involve three key achievements — situatedness, change-orientation and contingency — that are useful for evaluating and critiquing those practices that claim to be urban laboratories. We conclude by considering some future directions of research on urban laboratories.

Introduction

On 3 August 2008, the Associated Press published a news article about China's Summer Olympic Games titled 'Pollution curbs turn Beijing into urban laboratory'. The article (Associated Press, 2008) summarized the massive efforts to clear up the perennially polluted skies of the city:

In what scientists are calling the single largest attempt ever made to improve air quality, scores of heavily polluting factories were shut down and some 2 million vehicles were pulled off roads across Beijing and a huge swath of northern China — an area roughly the size of Alaska. During the weekend, the hazy skies finally gave way to swirling blue. Beijing's massive experiment with controlling pollution is offering international researchers a one-of-a-kind chance to study the large-scale effort in a uniquely urban laboratory.

The articles in this symposium originated in a workshop entitled 'Urban Laboratories: Towards an STS of the Built Environment', held at Maastricht University in the Netherlands in November 2009. The event received financial support from the European Association for the Study of Science and Technology Studies (EASST) and the Netherlands Graduate Research School of Science, Technology and Modern Culture (WTMC). We extend our gratitude to our fellow workshop co-organizers Sally Wyatt, Simon Guy and Ralf Brand, as well as to workshop participants, for contributing to a constructive space for trialling new ideas and approaches to urban laboratories. A special thank you goes to Tom Gieryn for his guidance and inspiration for this symposium.

This experimental intervention to reduce air pollution in Beijing is a typical example of how the notion of 'urban laboratory' is emerging in multiple settings around the globe. From Toronto and Dallas to Glasgow and London, from Berlin and Hong Kong to Ethiopia and Curitiba, interpreting the city as a laboratory is increasingly striking a chord with actors involved in urban change. It holds forth the promise of experimental processes and innovative actions related to environmental protection, social cohesion, capitalist expansion, creative sector development, policy improvements, infrastructure provision, academic research, and so on. But is this use of the term 'urban laboratory' simply another metaphor for urban development or does it suggest urbanization by significantly different means?

The aim of this symposium is to explore the various ways in which urban laboratories are being conceived, constructed and practiced in contemporary cities, while also establishing a critical lens through which to assess these activities. In other words, the goal is to move from metaphor to analysis by unpacking the notion of 'laboratory' and understanding how it is helpful in framing and catalyzing urban change. To enable such an analytical approach, it is important to recognize that the notion of the urban laboratory is part of a wider discursive field that includes ideas of Mode 2 science, triple helix formations, engaged research, service learning, transdisciplinarity, living laboratories, applied innovation and the co-production of knowledge (Gibbons *et al.*, 1994; Nowotny *et al.*, 2001; Ramadier, 2004; Benneworth *et al.*, 2010; Evans and Karvonen, 2011). Bruno Latour, one of the most well-known proponents of this expansive understanding of laboratories and experimentation, notes: '[T]hat we are all engaged into a set of collective experiments that have spilled over the strict confines of the laboratories does not need more proof than the reading of the newspapers or the watching of the night TV news' (2001: 1). While we do not have the space to discuss the overlaps and conflicts between these various notions of innovation and knowledge production, there is an important link with interpretations of urban development as a collaborative, interdisciplinary process, as a knowledge-intensive research activity, and as constituting place-specific trial-and-error interventions.

On a more general level, this symposium is informed by the wider debate in STS on the normative aims of innovation. Urban laboratories centre on processes of change and the emergence of new practices and concepts, connecting future visions of cities to the 'politics and practices of hope' (Coutard and Guy, 2007) rather than to a Marxist political-economic discourse of socio-spatial inequalities, exploitation and instrumentalization (although Harvey (2000) convincingly argues that these styles of explanation are not mutually exclusive). Critics of STS in geography and urban studies have repeatedly argued that the shift towards a relational and flat ontology tends to ignore (or at the very least, downplay) power inequalities between differentially positioned actors (Kirsch and Mitchell, 2004; Routledge, 2008). We largely agree with this critique, and a common thread through this symposium involves the role of scalar structuration and pre-existing institutional elements in shaping urban laboratories in ways that can hardly be considered progressive. In this respect, there is clearly a need to conduct more symptomatic readings of urban laboratories that highlight their contribution to strategies of neoliberalization, urban marketing, branding schemes, and so on.

At the same time, one of the strengths of the STS literature is its situational focus and its insistence on analysing practices *in situ*. Whereas much of the political-economy literature too easily assumes the structuring of particular places by broader scales, territories and networks (e.g. Jessop *et al.*, 2008), STS urges us to make a closer, more detailed examination of what is actually happening on the ground. This by no means implies a celebration of heterogeneity and 'openness', but on the contrary an interest in the ordering capacity of emergent practices through the development and use of specific categories, standards, techniques and concepts (such as 'urban laboratory' and 'experimentation').

In this article, we begin with an overview of how natural-science laboratories have been examined in the past three decades by scholars in science and technology studies

(STS). Laboratory studies scholars reinterpreted these privileged sites of knowledge production by tracing how scientific insights travel back and forth between the laboratory and society. We then turn to experimentation, a key aspect of laboratory studies and the central activity of urban laboratories. Experimentation is helpful for opening up the evolution of cities to new conceptions and configurations, while nurturing innovation in a particular place — a laboratory — but it also introduces uncertainty and the potential for failure. We argue that the emphasis on experimentation leads to three achievements of urban laboratories: situatedness, change-orientation and contingency. Using these three achievements as normative benchmarks, we can then evaluate and critique those practices that claim to be urban laboratories. We introduce each contribution to the symposium by summarizing how these achievements are manifested in different ways. To conclude, we consider some future directions for research on urban laboratories and argue for a healthy combination of curiosity and scepticism regarding these test beds of situated innovation.

Unpacking the notion of laboratory

Laboratory studies scholarship began in earnest in the late 1970s, and today it serves as the foundation for the contemporary field of STS.¹ Laboratory studies researchers were inspired by the emerging notion of the social construction of scientific facts as well as various philosophies of scientific and technological knowledge production. Early laboratory studies served to deconstruct the objective claims of scientists by contextualizing scientific practice to emphasize the interests, techniques, materials and discourses involved in the stabilization of supposedly neutral scientific facts.² Scholars such as Latour, Steve Woolgar, Karin Knorr-Cetina, Michael Lynch and Andrew Pickering debunked the notion that scientific knowledge production was apolitical, asocial and universal by exposing the myth of laboratories as ‘special places from which pure knowledge emanated’ (Doing, 2008: 279). This opened up the laboratory practices of natural scientists to critical scrutiny by social scientists as well as by policymakers and the general public.

A key outcome of the contextualization of scientific ‘facts’ was that laboratories were understood as less special and more commonplace; the laboratory was no longer a privileged site of knowledge production but one site among many. This has had a number of consequences in the field of laboratory studies. First, historians of science in particular began to investigate the heterogeneity of laboratories. Whereas the twentieth-century modern laboratory was understood to be ‘set apart’ from the surrounding natural and social world (an idealistic representation deconstructed by laboratory studies), other laboratories often operated with less rigid distinctions and effectively combined scientific research with artisanal, commercial and other forms of non-laboratory practice (Galison and Thompson, 1999; Gooday, 2008; Klein, 2008). Secondly, STS scholars closer to the tradition of sociology increasingly interpreted the laboratory as a theoretical notion. Latour argues that the focus should be less on what happens inside particular laboratories and more on how laboratory practices are extended throughout society, in effect ‘transforming society into a vast laboratory’ (Latour, 1983: 166). He proposes three steps to achieve this transformation: first, scientists have to capture the interests of non-scientists outside of the laboratory (the field); secondly, they have to collect information on ‘real-world’ problems in the field and introduce this information into the controlled conditions of the laboratory to facilitate experimentation; and thirdly, scientists have to

1 For an overview of STS, see Hess (1997), Hackett *et al.* (2008) and Sismondo (2009).

2 Key laboratory studies include Latour and Woolgar (1979), Knorr-Cetina (1981), Pickering (1984), Collins (1985), Lynch (1985), Shapin and Schaffer (1985), Pinch (1986) and Traweek (1988). For an overview and critique of the laboratory-studies tradition, see Hess (1997), Sismondo (2009) and Doing (2008).

extend the laboratory to wider society by carefully re-introducing the experimental results back into the field. From Latour's perspective, the laboratory becomes a mechanism of control and distribution: it is through the strategic negotiation between inside and outside that the laboratory exerts its societal power. A similar conceptualization of this process of 'laboratorization' is offered by Knorr-Cetina (1995: 145), who argues that the laboratory is an 'enhanced' environment that "improves upon" the natural order as experienced in everyday life in relation to the social order'. This follows the laboratory studies emphasis on the natural sciences, but Knorr-Cetina also argues that laboratories 'upgrade' the social order and, as such, research should analyse 'processes of laboratorization' in a much wider variety of settings (1995: 146, 163).

The effects of opening the laboratory to the world has had mixed results. Arguably the most positive effect has been to critique the status of the scientific laboratory as a privileged site of knowledge production. In essence, the laboratory has been invaded by the outside world and conversely, the outside world has been invaded by the laboratory. However, the ethnomethodological and situational focus of most laboratory studies creates a type of research that prioritizes the *in situ* analysis of science in practice at the expense of *ex situ* institutional elements that shape the direction and substantial content of these practices (Sismondo, 2009). In the context of urban studies, laboratory studies are helpful for describing the contingent dynamics of particular sites, but less useful in analysing the broader organizational and institutional features that play a central explanatory role in the development of cities. It privileges laboratories as the locus of power, while overlooking other institutional and cultural sources of knowledge production.

Laboratory study scholars have also been helpful in blurring the distinction between the laboratory and the field. In his work on labscapes, Robert Kohler (2002a; 2002b) shows how laboratories played a strategic role in the discipline of biology. On the one hand, laboratories are seen as ideal placeless sites that 'enable biologists to study natural objects — organisms — on experimenters' terms, not nature's, free of all the messy complications of life as it is actually lived in a crowded and changeable world in which everything is related to everything else' (2002a: 473). It is this supposed placelessness of laboratories that gives the produced knowledge a universal quality. On the other hand, empirical research shows that this isolation from the outside world is an illusion, a social construction that allows for the regulation and control of flows of people, natural objects and instruments between inside and outside. In practice, laboratories are constantly re-embedded in and connected to their wider milieu and Kohler discusses various types of laboratories — marine biological stations, field stations, vivaria and biological farms — that have undergone processes of 'naturalization'.

A similar point is made by Christopher Henke in his research on agricultural field trials; he writes (2000: 490), '[f]ield trials combine the control of experimentation with the unique particularities of a given place. This combination gives them epistemic authority . . . but also makes field trials hard to control'. What is at stake is not the distinction between laboratory and field but the ways in which the laboratory vocabulary and associated practices enable a strategic ordering and regulation of uncontrollable field conditions. One way to bring the insights of laboratory studies to urban studies is to emphasize the importance of place and to examine the emergent tensions between control and lack of control, between uniqueness and generalization, between contingency and universality (Gieryn, 2006). Laboratories offer a tool to mediate these dichotomies (see Guy and Karvonen, 2011).

The promise of experimentation

An unfortunate consequence of unpacking the epistemology of laboratory practices has been the obscuring of the practice of experimentation. Early laboratory studies are partly to blame, because the focus on the actors, technologies, instruments and materials leads to a contextual focus that often overlooks the performative aspects of experimentation.

Subsequent applications of the laboratory vocabulary to non-laboratory contexts have led to a further neglect of the specific contribution of experimentation to knowledge production. This is particularly the case in urban studies, where a very loose usage of 'laboratory' and 'experiment' seems to be the norm rather than the exception. In a recent editorial, for example, Gail Davies (2010: 667) rightly identifies that once the 'laboratory overflows its traditional constitution', it changes 'the very idea of an experiment, and the question of how and where experiments end'. But her subsequent discussion does not help to answer this question, since almost everything now qualifies as an experiment, or at least all actions that 'engage with the transformation of spatial and temporal description, the framing of possible actions, and the preformatting of subject/object relations' (*ibid.*: 668). The discussion is so broad that it allows Davies to talk about experimental interventions, experimental sites, experimental experience, the body as experimental site, experimental geography, experimental aesthetic, alternative experimental knowledges and experimental landscapes without identifying the characteristics that differentiate experimentation from action or agency. Similar problems arise when social theorists such as Latour (2001; 2004) and Ulrich Beck (1995) characterize contemporary social change as 'collective experiments' or a 'global experiment'. These ideas are thought-provoking on a general level, but the terminology of experimentation is frequently evacuated of meaning and becomes frustratingly imprecise when applied to empirical research. Matthias Gross (2010: 66) rightly issues a cautionary warning on the increasing embrace of experimentation by social theorists, because 'the concept of experimentation comes to have the same meaning as development, complexity, interconnection, globalization and so comes to mean the same as virtually anything that is subject to change'.

Rather than conflating 'experimentation' with 'change' and claiming that everything is an experiment, we argue that there is a need to adopt a more precise understanding of the practice of experimentation. Returning to the laboratory studies scholarship, it is helpful to understand experimentation as (1) involving a specific set-up of instruments and people that (2) aims for the controlled inducement of changes and (3) the measurement of these changes. These aspects of experimentation are not essential characteristics; they are mutually constitutive of material and conceptual work. Moreover, failure in achieving these aspects is just as likely as success. An experimental set-up involves not only the identification of objects to be observed, but also the design, construction and use of instruments to manipulate these objects. The extent to which these instruments dictate the experimenter's actions and how the experimenter shapes the very configuration and use of particular instruments continues to be an open question (Gooding *et al.*, 1989), but the key point is that experimentation always involves a double move of observation and intervention. Many things can serve as instruments, and STS researchers have investigated everything from the telescope, the barometer and the common glass prism to brain-imaging scans and neutrino detectors. These instruments are commonly understood as neutral transmitters of the hidden truths of nature, but in reality, a great deal of work is done 'to establish the character of an object as an instrument' and 'to win the assent of a community to the object's reliability and transparency' (*ibid.*: 3). One important route for establishing this assent is through the creation of standards according to which these instruments are designed, constructed and used. Fixing the identity of particular instruments closes down discussion; the instruments are legitimized (people accept the instrument as a transmitter of observational data) and become replicable (in fixing standards, people can use these instruments elsewhere in similar ways).

Experimentation also involves the constant shuttling between local and non-local dimensions of concepts and theories. Experimental laboratory work is underpinned by various assumptions, ranging from research questions to background knowledge, systematic theories and topical hypotheses (Hacking, 1992). This constitutes the non-local aspect of experimentation, since most of these concepts and theories have emerged elsewhere and are being applied to a new situation. At the same time, experimentation has to be understood as profoundly localized — as taking place in and

through a certain locale — but in a seemingly paradoxical way. It is through situated experimentation that non-local concepts and theories emerge. This aspect of laboratorization is not recognized by authors such as Latour. In his early laboratory studies work with Woolgar, Latour defends a position of ‘strict localism’ by claiming that local laboratory conditions account for the identification and even existence of particular phenomena. Hans Radder (1996: 88) argues that this ‘makes it a complete mystery how and why scientists from different local contexts come to agree on issues of reproducibility, as they frequently do’.

Latour’s later work on actor-network theory (ANT) addresses this problem by arguing that reproducibility is achieved through processes of translation and extension — Latour’s three-step analysis discussed above fits this type of argument. However, this approach merely creates new problems, because the original context and the new context always differ in some respects. Most importantly, it ignores that the same experimental results can be achieved with different experimental processes, and that concepts are often applied to dissimilar observations (Radder, 2006). Indeed, as an example of the latter, what could be more dissimilar than trials in the natural sciences and urban development projects? Nevertheless, both processes are described with the vocabulary of experiments and laboratories because some actors feel this resonates with their experiences on the ground. This points to the need to move beyond the network-centric character of ANT to recognize the ways in which the ‘conceptual-theoretical dimension’ of scientific labour transcends ‘its technological dimension of material realization’ (*ibid.*: 148–49). In geography, this resonates with Trevor Barnes’s (2001: 549) argument that it is often the ‘ability to effect persuasive and novel redescriptions’ that produces new social interactions and different styles of analysis and explanation. The introduction of a conceptual vocabulary of laboratories and experimentation to an urban context, in which the use of these concepts is uncommon, constitutes such a persuasive redescription. In effect, such a move allows for a much stronger future-oriented and normative approach than ANT, since the application of new concepts and theories to particular situations can contribute not only to new meanings but also to new ways of doing things (i.e. to ontological emergence and novelty) (Radder, 2006; van Heur, 2010). This creates opportunities for politicizing the notion of urban laboratories in ways unintended and unforeseen by those keen on developing these sites along ‘neoliberal’ or ‘city marketing’ lines.

Furthermore, the use of concepts and theories plays an important role in communicating experimental results to other actors within and beyond the locality. This involves the communication of ‘objective’ research results, but it also opens up communication to rhetoric and the use of metaphors. Theories are underdetermined; actors have to be persuaded to accept and apply them to their own work (Cantor, 1989). We see the popularity of phrases such as ‘urban laboratories’ and ‘urban experiments’ as tapping into this rhetorical dimension of experimentation. This directs our attention to particular narrative strategies and language forms as well as to new practices of presentation. Experiments, as laboratory studies scholars have investigated in detail, are always public engagements: it is through demonstrating an experiment in public that particular audiences are persuaded (Shapin and Schaffer, 1985). In the current era of ‘post-Fordist science’ (Gieryn, 2008), persuasion is realized in the design of the built environment, with urban laboratory projects regularly accompanied by iconic architectural statements and persuasive branding strategies. This suggests that public experiments need to be explained with reference to economic as well as epistemic rewards. That said, it remains to be seen if the current popularity of urban laboratories leads to experimental results that can actually persuade the respective publics in the long term.

Three achievements of urban laboratories

In extending the concepts of ‘laboratory’ and ‘experiment’ from the natural sciences to the city, the key question should not be *if* one can understand cities as laboratories in

which experimentation takes place. Urban researchers have been appropriating this vocabulary for decades to describe urban development processes. Most famously, the Chicago School sociologists argued in the early twentieth century for the need to understand the city as a social laboratory and their main research site — Chicago — as an experiment in social research (Park, 1929). According to Robert E. Park, the emergence of cities created a ‘new social order’ that was ‘neither absolute nor sacred, but pragmatic and experimental’ (*ibid.*: 3) and this is what radically distinguished the city from the countryside. In his conceptualization, the city operated both as the site for experiments and as a cognitive frame of reference through which ‘observations of social conditions’ could be controlled (*ibid.*: 11). What made the city experimental was how these observations could be linked to policy intervention and reform: the assumption was that ‘more complete knowledge’ of people and urban areas could support social agencies in addressing and solving social problems (*ibid.*: 15). As Joseph Heathcott (2005) described in his study of the US planner Harland Bartholomew (who also interpreted the city as a laboratory), this emphasis on the need for complete and objective knowledge of the city through the systematic investigation of its parts was shared by most planners in the early to mid-twentieth century, but this ignored the extent to which moral visions, theoretical discourses, political struggles and positionalities of the researchers themselves shaped the knowledge being produced.

In emphasizing the ‘pragmatic and experimental’ nature of cities, the Chicago School sociologists were influenced by key pragmatist philosophers, notably John Dewey (Dewey, 1975 [1937]; Hickman, 2007; Jones, 2008; Gross, 2010). In that respect, this symposium contributes to the renewed engagement in geography with pragmatism (see Bridge, 2005; Atkins *et al.*, 2007; Moore, 2007; Cutchin, 2008; Wood and Smith, 2008; Karvonen, 2011; Karvonen and Yocom, 2011). The pragmatist concern with communities of inquiry and experimentation is important because it suggests not only that knowledge of the world is socially constructed within particular groups (reflecting the anti-foundationalist stance of pragmatism), but above all that we gain this knowledge through the development of concrete projects aimed at experimentally testing possible solutions to social problems. This experimental mindset derives from the pragmatist acknowledgement — perhaps even embrace — of radical contingency, i.e. the recognition that actors are constantly confronted by unexpected events, chance occurrences, and a general sense of uncertainty about how best to act in a precarious world.

In his analysis of the geographical implications of Dewey’s work, Malcolm Cutchin (2008) argues that this leads to a very particular ethical understanding of spatiality. Not only are specific places awarded analytical priority (as analysis and explanation from a pragmatist point of view must always be made against the case at hand), places are also seen as problematic. He writes, ‘[a]t irregular intervals of time, some quality of place is deemed problematic by someone or a group experiencing place. The problematic of place is seen not as an object to be repaired, but as a set of relations to be re-coordinated to enhance the experience of place for people that are part of it’ (2008: 1565). This understanding of place is very close to Knorr-Cetina’s STS understanding of laboratories as ‘upgrading’ the social order that we discussed in the previous section. Considering these previous usages, the question becomes *what* the vocabulary of laboratories and experimentation — the updated version as rephrased through the debates in STS — adds to our understanding of urban change. In using this new-old terminology, what can we see that we otherwise would not see? In our view, urban laboratories involve three key achievements: situatedness, change-orientation and contingency.

Situatedness

Urban laboratories are best understood as deliberately constructed sites of knowledge production. They are constructed because the very identification of a city or section of a

city as a laboratory necessitates substantial conceptual and material work. It creates a distinction between what is and what is not part of the space of the laboratory. In order to stabilize this distinction between the laboratory and the field, resources, data and actors need to be channelled and controlled in an orderly manner. As discussed above, this ordering can take place through the strategic use of particular instruments, techniques, standards, concepts and theories. Gieryn (2006) has shown how the Chicago School researchers construed the city as both laboratory and field site to capitalize on the scientific credibility of both terms. Most famously, they claimed to approach the city as a laboratory: a controlled environment open to scientific observation and manipulation to produce universally valid research results.

At the same time, the city was understood as a field site that was already situated and exhibiting its own locally specific dynamics. The urban laboratory, in other words, is then both a place and a non-place and much of the work that goes into constructing the laboratory revolves around mediating this tension. As Henke and Gieryn (2008: 359) argue, 'legitimate knowledge requires legitimizing places' and in the case of urban laboratories, this involves the production of knowledge that will be recognized as valid by local as well as non-local audiences. With respect to the current global emphasis on innovation and transformative urban strategies, the label of 'urban laboratory' legitimizes experimental practices within prescribed boundaries. The requisite 'placeness' of urban laboratories offers a material focus for certain actors to ascribe visions of alternative futures that are also globally recognized.

In the contributions to this symposium, the cognitive and material work that goes into the construction of urban laboratories as controlled environments is fundamental. Govind Gopakumar's (2014, this issue) analysis of the rollout of water-supply infrastructure in Bengaluru, India, recognizes how public-private partnerships dedicated to the marketization of water supply inscribe distinct spaces in the city. However, these laboratories are messy and constantly in flux owing to negotiations between formal and informal actors; the boundaries are fluid and contested. In their study of the low-carbon urban laboratory in Manchester, James Evans and Andrew Karvonen (2014, this issue) demonstrate how powerful urban actors can define a shared space of innovation based on their property ownership and influence in shaping the city. Here, it is clear that boundary setting is an essential precursor to experimental activities in the laboratory; the boundaries provide a legitimated space for innovation. Philipp Dorstewitz's (2014, this issue) study of Zollverein in Essen, Germany, demonstrates how an urban laboratory emerged from a former industrial site. This abandoned coal-mining facility catalyzed planning activities that brought together stakeholders with shared interest in cultural regeneration. And Ignaz Strebel and Jane Jacobs (2014, this issue) compare and contrast the interactions between building science and architectural design in two sites: experimental houses built inside scientific laboratories to study physical parameters, and the new high-rise housing typology in Glasgow that offered a field site for social-science research. In both cases, the laboratory actors struggled to maintain experimental conditions in which rigorous scientific research could be conducted.

The main difference, of course, between the production of novelty in the natural-science laboratory versus the urban laboratory is that in the latter the boundary conditions can only be controlled to a very limited extent. This is often taken to be a fundamental objection to applying the experimental method to society, but Gross and Wolfgang Krohn (2005) invert and radicalize this critique and argue that this actually suggests broadening the notion of experiment beyond the laboratory to encompass society as such: 'The experimental nature of society, understood in this way, changes from an evolutionary process . . . into an institutionalized strategy which includes all kinds of political, cultural, or aesthetic components' (*ibid.*: 77). Considering that experimentation has become a societal endeavour in which the researcher is simply one actor among others, Gross and Krohn conclude that the setting of boundary conditions for experiments should be collectively decided. Experimentation, in other words, should become a collective and recursive learning process.

Change-orientation

The emphasis on experimental learning leads to the second achievement of urban laboratories, change-orientation, or what Park (1929: 17) described as processes leading to a 'new rule of conduct' and a 'new definition of the situation'. While all places change over time, the urban laboratory is conceived for change that is intentionally radical — change that leads to ontological novelty — rather than incremental or entropic. Laboratory advocates express an explicit dissatisfaction with 'urban-development-as-usual' approaches. The bounded character of the laboratory allows for experimentation at an achievable scale and in a particular locale that has been selected because of its opportunities for success or because of the desperate need for different conditions. Thus there is a strong normative aim of urban laboratories to create more desirable futures. At the same time, the STS laboratory studies literature has taught us not to take these claims of radical change at face value, as the materialization of changes relies (to a lesser or greater extent) on existing tools, techniques, discourses, visions, people and organizations that by definition influence the substance and outcome of the experiment, although often in unpredictable ways.

In this symposium, Gopakumar's (2014) narrative of Bengaluru's water-supply reformation is driven by the formation of public-private partnerships that aim to modernize the city through socio-spatial and socio-technical control. The overarching aim of the partnerships is to standardize water-supply services through a complete reconfiguration of the water-supply network and the users. Evans and Karvonen's (2014) urban laboratory in Manchester uses the reduction of carbon as a driver to form an innovative partnership to collect data to inform urban development policy. However, the laboratory is configured to change the physical aspects of the urban metabolism while leaving the existing configuration of urban governance intact, further solidifying the power of the laboratory actors. Dorstewitz (2014) shows how the stakeholders at Zollverein ceded their dogmatic attitudes about desired futures and instead engaged in recursive planning activities to test the norms of society. The change-orientation here is focused on the nurturing of a community of inquiry rather than realizing idealized futures. Finally, Strebel and Jacobs's (2014) study unpacks how regulations are derived from laboratory tests as well as how users respond to the built environment. They show how the development of the modern built environment involves contradictory movements of standardization and lived reality, both of which influence urban change. In all of these cases, the laboratory is not simply about experimenting but about realizing new conditions and visions on the ground that are (or at least aim to be) markedly different from existing conditions.

Contingency

A third achievement of urban laboratories is the embrace of contingency and uncertainty. Based on the interpretation of urban laboratories as collective learning processes with contingent boundaries, the level of uncertainty and the possibility for failure increases. Experiments are thus understood to be contingent and open-ended, carrying substantial risks as well as rewards. Real-world experimentation is founded on the idea that one is compelled to act despite uncertainties and gaps in knowledge. The pragmatist heritage of urban laboratories gains renewed strength in the current era in which the belief in modernity, progress and development is in crisis. The increasing popularity of urban laboratories as tools in urban development seems to reflect this fundamental problematic, with the involved actors embracing the complexity and fluidity of urban change processes and recognizing that unanticipated outcomes are to be expected, while simultaneously aiming to reduce uncertainty by ordering the experiments through various strategies of laboratorization.

One of the key strategies of uncertainty reduction is the labelling of particular sites as urban laboratories. On the one hand, using the phrase 'urban laboratories' further increases semantic as well as ontological uncertainty (Lane and Maxfield, 2005: 10–11): semantic, because actors are often uncertain about what this term *means* and through

discussions find out that different interpretations of the term exist; ontological, because in a fast-changing world it is impossible to define what an urban laboratory should *do*, as the future context in which the laboratory will operate is simply not known. On the other hand, using the phrase ‘urban laboratories’ reduces uncertainty, as this offers a narrative in which local events can be embedded (*ibid.*: 11–12). The notion of the urban laboratory, in other words, offers an interpretive frame that can be utilized to make sense of what happens and to offer guidance for action. It is surprising that this problematic of modernity receives so little attention in urban studies and geography, with the exception of a few scholars in planning (Abbott, 2005; Healey, 2009; Madanipour, 2010) and environmental studies (Brown and Damery, 2009), whereas debating uncertainty has become almost obligatory in STS and social theory more widely (Pellizzoni, 1999; Nowotny *et al.*, 2001; Wehling, 2001; Wallerstein, 2004).

The contributors to this symposium grapple with the indeterminacy that is inherent in urban laboratories. Gopakumar (2014) notes how, in Bengaluru, the seemingly straightforward activity of modernizing the water supply is challenged by oppositional networks that engage in counterexperiments to define other socio-spatial and socio-technical configurations. The case reveals the deeply political aspects of laboratorization and the contested process of modernization. In Manchester’s low-carbon urban laboratory, contingency is restricted to monitoring activities and the translation of collected data into new urban policies. In contrast to the Bengaluru case study, there is no political challenge to the Manchester low-carbon laboratory; instead, the space serves to reinforce the existing mode of urban management and a singular vision for the future of the city. The iterative planning process in Zollverein is a recursive problem-solving endeavour that embraces contingency and recognizes it as an unavoidable component of the project. The laboratory actors fully embrace exploration and an open destiny for the project, suggesting that a consensual and constructive politics of place is possible. And in the building-science laboratories and Glasgow high-rises described by Strebel and Jacobs (2014), contingency emerges from the friction between the idealized laboratory and design studio versus the lived realities of residents in their houses.

The combination of situated, change-oriented and contingent achievements of urban laboratories make them distinct from other forms of urban development. They are intentional sites of urban innovation with both local and global implications. The emphasis on experimentation opens up urban development to new trajectories, storylines and consequences, but the outcomes of these endeavours are far from certain. Thus we argue that contemporary applications of the term ‘urban laboratory’ should be treated with a healthy combination of curiosity and scepticism, and like any form of urban development, they should be subjected to detailed analysis and critique.

Conclusions

The articles that comprise this symposium demonstrate the multiple ways in which urban laboratories are influencing the evolution of today’s cities, offering insights that cut across conventional notions of urban development and suggesting the need to embrace uncertainty and risk. Most importantly, laboratories recognize that cities are always ‘in the making’, on the move, and fluid (Guy, 2009); they are active rather than static, championing process over product. At the same time, urban laboratories are perhaps less special than advertised; they simply constitute one type of knowledge production among many others. They are worthy of study because of the ways in which they strategically negotiate the boundary between inside and outside through the channelling of actors, data and resources. Through experiments, relations are established between the local and the non-local, between the contingency of a particular laboratory site and the universality of concepts and theories. These ideas are investigated in more depth in the articles that follow, while raising several other issues that could be explored in future studies of urban laboratories.

First, the notion of scale is of central importance to urban laboratories. Considering our normative focus on urban laboratories as situated, we recognize the local scale as key because actors need to meet face to face, exchange tacit knowledge and undertake collective action. But is a laboratory confined to a particular neighbourhood or can it extend to a city or even a region and if so, what is lost with increasing complexity? Can we still experiment at 'scale one' as Latour (2001) writes when we attempt to embrace larger and larger geographic areas? Secondly, our review has emphasized the limited acknowledgement in the debate on urban laboratories of institutional elements that shape the very knowledge produced in and through laboratories in the first place. There is a need to conduct in-depth investigations of how urban laboratories address obduracy and the sedimentation of both social and physical infrastructures that resist radical change (Hommels, 2005). How do urban laboratories succeed or fail in effecting change? Thirdly, the argument that urban laboratories are local as well non-local and can be seen to mediate the tensions between contingency and universality echoes the renewed interest in urban studies and geography concerning the role of comparison (Nijman, 2007; Ward, 2008; McFarlane, 2010; Ward, 2010; Lees, 2012). Comparison relies on particular techniques of data collection, strategies of abstraction and use of concepts and theories quite similar to the activities occurring in urban laboratories. And finally, the loosening of urban development processes suggests that the ways in which knowledge about cities is debated and deployed needs to change radically. The Chicago School's understanding of urban laboratories connects most obviously to the tradition of American pragmatism, but ideas of collective and recursive learning also resonate with ideas of participatory, deliberative or radical democracy, and the right to the city.

Urban laboratories are at the frontline of new economic, cultural, political and societal configurations in cities. These spaces of innovation and change provide a designated space for experimentation where new ideas can be designed, implemented, measured and, if successful, scaled up and transferred to other locales. Some urban laboratories simply employ the notions of 'laboratory' and 'experiment' as a rhetorical strategy to further consolidate and reinforce existing patterns of urban development, while others make a genuine attempt to cultivate emancipatory forms of change that could have widespread implications on urban life in the twenty-first century and beyond. In all cases, these constructed spaces of innovation provide a fascinating lens through which to critique and reflect on the future of cities.

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