

19 STS in the City

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Introduction: STS and Urban Studies

In the last decade, science and technology studies (STS) is increasingly becoming a highly influential source of inspiration for other disciplinary and interdisciplinary fields. It is important to trace such intellectual trajectories because they function as test sites for our conceptual repertoires. In this chapter we explore the borrowings and travelings between STS and urban studies, two highly interdisciplinary and heterogeneous fields. We are interested in two types of displacement. On the one hand, the city provides us with a fascinating empirical site (or sites) to explore the workings of science and technology. On the other hand, STS conceptual repertoires are increasingly being used to explore urban phenomena beyond science and technology. In this way, the city and urban studies potentially also challenge STS to renew its own capacities, a point to which we return in the conclusion.

Bringing STS into the city remains urgent, we contend, considering how even in the last decades new technologies have been praised and introduced as a powerful force reshaping urban settings worldwide. Since the 1980s, new information and communication technologies (ICTs) have been seen as promising (or threatening) to overcome the need for physical proximity and thus dissolve what we know as cities. More recently, versions of citizen science and algorithmic regulation of infrastructures have become the new panacea for “smart urbanism” in order for cities to solve demographic, economic, and ecological challenges. Needless to say, such high-modernist hopes for technological fixes are nothing new to the city, as witnessed for instance by long-standing themes of development and mobility. In most of these discourses and actual policies and practices of city administrations all over the planet, we encounter the myth of a “technological essence” (Graham 1997)—the idea that technologies possess intrinsic logics or qualities, which they inevitably bring along in causing specific and necessary forms of urban change.

Within urban research, key traditions have generally tended to neglect the workings of science and technology and more broadly the type of sociomaterial processes underscored in STS. In a nutshell, urban studies has approached cities as spatial forms and ecological niches, as capitalist politico-economic actors, or as involving specific cultures of practice (see also Fariás 2009). First, the still influential innovation of the Chicago School of sociology of the 1920s was to conceive of cities as ecological niches within which human communities settle down in discernible sociospatial patterns resulting from competition for location, as well as invasion and succession processes. This perspective contributed crucial insights into the relationships, for instance, among neighborhoods, socioeconomic structure and segregation, the dynamics of real estate markets, and gentrification. Second, and at least since Max Weber, cities have been studied as key politico-economic formations shaped and shaping capitalist dynamics. The large influence exerted by French Marxist philosopher and sociologist Henri Lefebvre has been crucial to reimagining cities as “the major actors in the new global economy” (Sassen 1991, 14) and as key sites of political struggle. Third, following on Georg Simmel’s groundbreaking essay on the mental life of big city dwellers, cities have been studied as involving specific cultures of urban practice. Since the 1960s and 70s, the tradition of everyday urbanism associated with such authors as activist and planner Jane Jacobs or historian and philosopher Michel de Certeau has explored urbanity as involving spontaneous choreographies of multiple subtle orders of practice and contestation. Urban culture is recognized here in residual and transient spaces, seen as opposed to “the” city made of bounded places, fixed meanings, and big history.

Given this context, it is not surprising that when STS scholars approach the city, they tend to look for antecedents outside the field of urban studies. One key reference here has been the work of urban historian Lewis Mumford (1937, 1961), who is often cited as one of the few to have taken seriously how technological innovation, especially with regards to construction materials and techniques, influenced the built environments and cultures of cities (e.g., Aibar and Bijker 1997). The work of Mumford is, however, in many important respects antithetical to the STS project. In his view, the city is ultimately the technomaterial expression of superior and persistent symbolic functions, including military control, sovereignty, worship, and social integration. Despite his detailed analyses of how new technologies shaped towns, these remain in the end incidental. Mumford is thus far from constituting a direct precedent for an approach that takes seriously the mutually shaping roles of science and technology in cities.

In sum, the field of urban studies may thus be said to have been historically moving among three untenable positions: one in which urban technologies serve the eternal and essential social functions of the city; another in which urban technologies are

not problematized as constitutive of the definition of the city as a research object; and yet another in which urban technologies possess intrinsic qualities, which when implemented in cities necessarily change their functioning, thereby condemning or redeeming the city. It is against this general backdrop that we can begin to assess the fundamental intervention that STS can make, and indeed has increasingly been making, in urban studies.

Our review and exploration in the following revolves around an identification of three distinct avenues of STS in the city, each shaped by specific academic traditions, empirical sensibilities, and political concerns. The first section will review STS approaches that explicitly address the workings of science and technology in the city as a whole and unpack the technoscientific objects and practices overlooked by urban studies. The second section will be dedicated to STS work on the built environment, focusing on conceptual challenges associated with understanding what buildings do and how architects work on their realization. The third and final section will review what has been recently discussed as assemblage urbanism and which involves various attempts at studying cities and urban life via perspectives and concepts provided by actor-network theory (ANT) and related intellectual projects. We speak of avenues to highlight that each encounter enables two-way circulations of theories, concepts, and methods between STS and urban studies and to avoid a simple historical periodization. Indeed, each of these ways of bringing STS into the city maintains its actuality, within and across the increasingly heterogeneous fields of both STS and urban studies.

Science and Technology in the City

It probably all began with an “urban legend” (Woolgar and Cooper 1999), the one about the Long Island Parkway underpasses in New York, built under the direction of influential urban planner Robert Moses in pursuit of a subtle form of racial discrimination. Constructed with low heights, these two hundred or so underpasses impeded the circulation of public buses and thus the access of poor, black urban populations to the white, middle-class resort areas of Long Island. In his classic STS piece “Do Artifacts Have Politics?,” Langdon Winner (1980) tells this story to argue that urban and infrastructural artifacts should be seen as technical devices through which powerful individuals or social groups pursue their strategic interests and settle contested political issues.

The particular interest of this case for STS in cities is related to the various answers and debates triggered by Winner’s piece, which generally contested his intentionalist reading of urban artifacts. As Joerges (1999) in particular elaborates, a more detailed empirical analysis of Moses’s underpasses demonstrates that, rather than by individual

intentionality and strategy, these artifacts were shaped by the conjunction of various engineering, economic, and legal commitments of a wider planning culture. Woolgar and Cooper (1999), in turn, warned that Joerges's critique would imply that one could get to the heart of the matter, discover the true intentions of Moses, instead of tracing the effects of the bridge story, itself a shifting urban legend. What such positions on the bridge story share, however, is an understanding of the effects of sociotechnical artifacts in cities (as elsewhere) as contingent and subject to change, rather than (over-) determined by specific political strategies.

The City as a Technological Artifact

The contingency of urban change came first to be emphasized in studies using insights from the social construction of technology (SCOT) to study city-planning initiatives. Different from Winner, the analytical departure point here is that the city, understood as "a 'seamless web' of material and social elements" (Hommels 2005, 15), is a giant sociotechnical artifact whose change could be understood "with the same conceptual tools that are applied to other technologies such as bicycles, transport systems and refrigerators" (ibid., 21). The classical study by Aibar and Bijker (1997) on the urban controversy about the extension of Barcelona in the mid-nineteenth century inaugurates this approach. In line with general SCOT commitments, Aibar and Bijker adopt the methodological strategy of studying historical controversies in order to bring out the "interpretative flexibility" whereby different "relevant social groups" attribute different meanings to and valorize emerging technological artifacts differently. Accordingly, in the case of Barcelona's extension plans, Aibar and Bijker show how these resulted from negotiating different "technological frames" shaping the perspectives of architects, engineers, and industrial workers.

Whereas, in most SCOT controversy analyses, one technological frame becomes dominant and stabilizes the artifact (Pinch and Bijker 1984), the interest of the Barcelona planning case was that closure involved a compromise between the technological frames of architects and engineers at the expense of industrial workers' way of problematizing the plans. Subsequent work at the intersections of urban history, the history of technology, and SCOT-informed STS has added further empirical and conceptual sophistication to the study of how urban technologies, infrastructures, planning expertise, and democracy relate (e.g., Hård and Misa 2008). The study by Bijker and Bijsterveld (2000) provides a particularly striking case of the role of nonexperts in shaping urban technologies, by showing how citizen groups of Dutch women came to strategically influence the shaping of public housing and city planning in the years following World War II.

Aibar and Bijker (1997, 23) explicitly presented their analysis as an attempt to “draw the city into the limelight of social studies of technology.” At the same time, however, one problem with their SCOT-inspired perspective is that the specificity of the city as a difficult and messy object is conceptually backgrounded. The assumption that “the city as a kind of artifact” (ibid., 6) may legitimately be equated to other technological artifacts simultaneously facilitates *and* constrains dialogue between STS and urban studies. In this context, perhaps the most promising attempt at engaging with the specificity of the city from within the SCOT tradition is Hommels’s work (2005) on the obduracy of urban sociotechnical change. By looking at a highway, a commercial center, and a high-rise housing project in different Dutch cities—all of which persistently resist the broad social consensus about the need for their redesign and reconfiguration—Hommels depicts cities as key sites to understand how technological artifacts are made obdurate in specific sets of practices and discourses. Obduracy, in this sense, represents one way in which the city has challenged STS analysts to expand their conceptual repertoires.

Sociotechnical Systems and Splintering Urban Infrastructures

Even though the STS study of large technical systems (LTS) was never primarily concerned with *urban* technical systems, it has had an important influence for the current study of urban infrastructural transitions. Its particular usefulness for urban studies resides in the very change of focus it proposed, from singular technological artifacts to large technical systems, that is, spatially extended and functionally integrated socio-technical networks. Notably, the explicit systems perspective put forward by people such as historian of technology Thomas P. Hughes (1983) did not just involve linking technical artifacts to encompassing engineering systems but also the latter to organizational, economic, and political actors, institutions, and processes. The complexity of technical systems was thus seen from early on as involving various nontechnical contexts, and their very intermingling as giving shape to industrial modern life and, one should add, the modern industrial and networked city (cf. Coutard 1999).

Three types of systems in particular were seen by LTS analysts as crucial: “the modern transportation, communication and supply systems, which one might subsume under the heading infrastructural systems, since their primary function consists in enabling a multitude of specific activities to take place” (Mayntz and Hughes 1988, 233). Alongside Susan Leigh Star’s work on information infrastructures, LTS should be seen as a key antecedent for the subsequent development of relational sociotechnical understandings of urban infrastructures. The key insight is that infrastructures are not an ontologically fixed substrate but a relational arrangement that can simultaneously enable

specific types of activity and function as a technological barrier for other activities or social groups. Accordingly, the key question is not so much *what* an infrastructure is but *when* and *for whom* an urban sociotechnical arrangement becomes infrastructural in its effects (Star and Ruhleder 1996).

These insights have played a major role in the development of a prolific research tradition at the boundary between STS and urban studies, focusing specifically on late capitalist collapse of the modern networked city. The fundamental contribution to this debate is geographer Stephen Graham and urban planner Simon Marvin's (2001) *Splintering Urbanism*, a book that summarizes a highly ambitious project of describing contemporary trends of urban infrastructural change. Notably, the book starts by reconstructing the modern ideal of the networked city, said to have prevailed in Western cities from mid-nineteenth century until the 1960s and centered on the drive to integrate existing fragmentary pockets of urban infrastructure into centralized and standardized technical systems of sewage, electricity, transport, water, and so on. Two operations were key to this modern urban ideal. First, issues of social cohesion, order, and justice came to be seen as infrastructural problems, problems to be addressed by perfecting the operation of the city as a machine or an organism. Second, city space underwent a sharp bifurcation. The new underground city was seen as a purely technoscientific space, whereas the surfaces of boulevards, streets, and parks became realms where new purified forms of social life could emerge (Domínguez Rubio and Fogué 2013).

Relational concepts of infrastructure developed in STS emerged here as particularly well suited not just to unveil the hybridity of modern infrastructural arrangements but especially to elucidate the collapse of the modern integrated ideal since the 1960s. As Coutard (2008) summarizes, this collapse is generally connected with the global expansion of neoliberalism, withdrawal of the state, and various related phenomena, including notably the unbundling of urban infrastructures, that is, the process of "segmenting integrated infrastructure into different network elements and service packages" (Graham and Marvin 2001, 141). Vertical forms of unbundling, and what the authors call "bypass strategies," lead to the emergence of premium infrastructural spaces for "valued" or "powerful" users and places. A new urban landscape emerges in which interlinked premium spaces come to be disconnected from their immediate urban contexts. Infrastructural unbundling leads to a wider process of splintering urbanism, where new conflicts and struggles over infrastructural privatization and democratization begin to take place across both "developed" and "developing" cities in North and South America, Asia, Europe, and beyond.

Graham and Marvin's global narrative has generated fruitful critical debates among STS scholars (Coutard and Guy 2007), who see here yet another story of universal

alarmism, so common in (post-Marxian) urban studies, yet based this time not on economic but rather on a soft form of technological-cum-infrastructureal determinism. In the view of Coutard and Guy (2007, 713), an STS perspective on these matters is helpful exactly to “move beyond this ‘universal alarmism’ by emphasizing the ambivalence inherent to all technologies.” Two elements of this response are indeed critical. First, whereas Graham and Marvin claim to study the city as a sociotechnical process, Coutard and Guy note that their empirical analysis of splintering urbanism ends up contradicting processual, contingent, and relational approaches. Second, Coutard and Guy suggest that STS scholars should adopt an explicit ethical and political commitment to producing more hopeful accounts of urban change, in the understanding that such accounts will have performative effects and are thus always-already part of political projects. Here again, we see how more general debates, this time on reflexivity and positionality in STS analysis, are played out and diffracted through the city as a challenging test site.

Metabolisms and the Urban Politics of Nature(s)

STS scholarship has also played a role in rethinking the entanglement of natural and urban processes. Hence, whereas the human ecology of the Chicago School aimed at understanding how humans adapt to their environment, the city as such was always conceived as a purified social phenomenon. Louis Wirth (1938, 1–2), for example, would write that “nowhere has mankind been farther removed from organic nature than under the conditions of life characteristic of great cities.” It is only in the 1960s that industrial ecologists begin to develop models to think through the intermingling of natural and urban processes. Yet, these models propose a cybernetic separation between city systems and natural environments: imagining the city as a machine converting natural resources into waste, nature remains a realm outside the city and urban operations.

While noteworthy exceptions may be cited—such as environmental historian William Cronon’s (1991) famous study into the natural causation of Chicago’s development path—urban studies has thus tended to uphold, rather than to challenge, the society-nature binary. This is the backdrop against which the work of STS authors such as Donna Haraway (1991) and Bruno Latour (1993) has become widely influential in the more recent development of so-called urban political ecology (UPE)—by now a widely influential urban research tradition that proposes to think of cities and their development as processes of “cyborg urbanization” (Swyngedouw 1996). What distinguishes the city as a complex infrastructural and sociotechnical apparatus, according to the UPE approach, is that all of its components, human and nonhuman, are constantly

in flux, interacting with each other, and exchanging their properties. The city involves thus “a perpetual passing through deterritorialized materials” (Kaika 2005, 27), a socio-natural-technical process to be grasped by means of an old Marxian concept: metabolism. Indeed, as geographer Erik Swyngedouw (1996) stresses, the notion of metabolism understood as involving the human transformation of nature through labor was the building stone of Marx’s early version of historical materialism. Labor, as a hybrid but asymmetrical process, is thus the key to understanding how social relations and regulations channel the process of environmental production in cities.

On these grounds, UPE scholars put forward their own distinct theoretical articulation between post-Marxian traditions of critical urban studies and STS insights to study how social histories, power structures, and capital accumulation dynamics shape urban socionatural environments, often in ways that reproduce ruling class privilege (Swyngedouw and Heynen 2003). Accordingly, UPE’s political challenge involves the struggle for environmental justice, that is, the work of unveiling, resisting, and ultimately changing the differentiated environmental impacts of capitalist or neoliberal urbanization on urban populations worldwide such as, for instance, the unequal exposure to toxic waste of the urban poor.

As the latter point suggests, UPE’s attention to natural entities and processes amounts largely to a methodological enhancement of Marxian-Lefebvrian urbanization theory rather than to any decentering of human (or other) agencies, let alone the economy. This arguably makes the approach sit awkwardly vis-à-vis widely held STS commitments. As Holifield has noted (2009, 646), “the significance of nonhuman agents here lies in their ‘social mobilization.’” Even in empirical studies that more strongly acknowledge the capacity of nonhuman entities to, for example, resist commodification and thus change capitalist accumulation patterns, there is a tendency to imagine the economy “as an already constituted structural unity *that only consequently comes into contact with a recalcitrant non-human nature*” (Braun 2008, 669, emphasis in original). It becomes apparent that the Marxian definition of metabolism is still anchored in a purified understanding of nature as that which has not (yet) been transformed by labor.

There are, however, some key contributions to urban political ecology that adopt a more symmetrical look at the capacities of human and nonhuman actors, while also breaking with the idea of imagining the city as one single, overarching metabolic process. One important example here is Paul Robbins and Julie Sharp’s (2006) analysis of the capacities of urban lawns to interpellate homeowners as subjects, thus contributing to the reproduction of these ubiquitous urban mono-cultures. Another key contribution is the work of geographers Sarah Whatmore (2002) and Steve Hinchliffe et al.

(2005) on what they dub, following Isabelle Stengers, the “politics of conviviality” at play in civic practices of caring for biodiversity within urban brownfields and otherwise wild spaces of Birmingham. Conversely, anthropologists Ann Kelly and Javier Lezaun (2014) have studied municipal programs of mosquito surveillance and larval elimination in Dar es Salaam as processes of multispecies disentanglement, thus raising the vexed question of the role of separation practices in a politics of nature. Here, STS commitments to civic practices of knowledge-making and world-making come to articulate with emerging concerns for specific and hybrid urban natures.

Similarly, related STS sensibilities toward the co-production (Jasanoff 2004) of science, politics, and urban nature(s) has been brought to bear on more historically oriented studies into urban change. Sociologist Jens Lachmund (2013), for instance, tells the fascinating history of the birth of urban ecology as a scientific discipline in divided West Berlin after World War II and traces the radical reshaping of the city’s greenery effectuated since the 1970s via its articulation into new planning regimes of biotope protection. In a similar vein, geographer Andrew Karvonen (2011) explores the various technonatural paradigms through which cities in North America and Europe have traditionally dealt with the problem of urban water flows—including the rise in recent years of more ecological and relational approaches to landscape architecture. What becomes clear in these studies is the strong sense in which the politics of urban nature(s), including in the realm of urban climate mitigation and adaptation, is always also a politics of shifting and competing expert knowledge regimes and practices (Blok 2013). Here again, urban studies is made to resonate with long-standing STS preoccupations, including questions as to how expert worlds of city planning may be further democratized through new forms of civic engagement in urban knowledge-making.

The Discovery of the Built Environment (in the City)

For a long time, STS did not really take into account the shaping capacities of buildings in the production of science and technology. This is particularly apparent in laboratory studies, where a whole subfield of research is defined by reference to a building typology, the laboratory. And yet, the architectural mediation of laboratory science has hardly been discussed, except perhaps for the fact that the lab enacts a carefully policed epistemic space vis-à-vis “society.” This is, for example, the point made by Karin Knorr Cetina (1989, 129): “if the laboratory has come of age as a continuous and bounded unit that encapsulates internal environments, it has also become a link between internal and external environments, a border in a wider traffic of objects and observations.”

However, apart from such general observations, one finds little research into how the actual design of laboratories shapes knowledge production.

An instructive case is Latour and Woolgar's (1986) purposely naïve description of the activities occurring in two main areas of a biological laboratory: the bench, where technological equipment is located and technicians, in particular, pursue activities such as cutting, mixing, shaking, and marking; and the office, where scientists, in particular, engage in activities such as reading, writing, and typing. According to the authors, this spatial division offers a suitable entry point to understanding knowledge production as a process of circulating inscriptions. Such analysis, however, assumes the built environment of the laboratory to be an unproblematic expression of the activities "contained" within it, implying that the architectural layout of the laboratory fully corresponds with certain sets of functions and practices, thereby tracing no distinction between the design of the building and its practical appropriation.

Over the past fifteen years, however, STS scholars have come to actively address architecture, buildings, and the built environment from different perspectives and across divergent empirical sites, although almost always within urban settings. There are many ways of bringing together these inventive STS accounts; yet, one fruitful route is precisely in terms of the problem of the "gap" between the design and use of buildings. This gap is well known in urban studies, where it was made famous not least by Stewart Brand's (1994) classic (proto-STs) work on *How Buildings Learn* after they are built. Here, we deploy the gap rather as a device for distinguishing different strands of STS work.

Laboratories of Architectural Design

In two papers written in the mid-1990s, ANT theorist Michel Callon proposes a radical redescription of the processes of architectural conception (Callon 1996, 1997). Whereas this native term usually denotes an individual mental process, Callon reads it as a collective process involving not just different voices (Cuff 1992), but mediated by various material supports such as plans and models. Paying attention to such material mediators, Callon demonstrates that each of them settles in specific ways the epistemic and evaluative differences among the multiple actors involved in the design process. In fact, he goes even further to argue—in ways reminiscent of Antoine Hennion's (2015) study of music—that the entire architectural design process cannot be understood as incrementally advancing toward the realization of an object but rather toward the creation of a multiplicity of mediators. "There exists no equivalence between what it [the building] is on paper, what it is in the scale model, and the final construction that finds its place in a social space which gives it its measure" (Callon 1996, 29; our translation).

Architectural design thus would be a classic example of what John Law (1987) calls heterogeneous engineering, but with one difference: what holds together such multiplicity is not just its black-boxing toward the end of the process but the maintenance of a certain *style* throughout the process.

Whereas the distributed production and maintenance of an architectural style has remained an unexplored hypothesis, Callon's work has been influential in the growing field of STS-inspired studies into architectural design. Much work, by now, has focused on design as an epistemic practice shaped by the problem of producing knowledge about a not-yet existing object. In a key contribution, ANT scholar Albena Yaneva (2005) has shown how architects gain knowledge of their emerging buildings through processes of scaling their physical Styrofoam models up and down, thereby enabling jumps between otherwise irreconcilable visual perspectives. In a similar vein, but invoking historian of science Hans-Jörg Rheinberger (1997), organization studies scholars Boris Ewenstein and Jennifer Whyte (2009) propose to understand architectural plans as epistemic objects, that is, as well-defined but abstract and incomplete objects calling for completion and thus inspiring architects to contribute to its realization. They also show how plans function as boundary objects (Star and Griesemer 1998) facilitating collaboration among different professional disciplines without the need for strong coordination. In related fashion, Ignacio Farías (2015) has described the organized occurrence of epistemic dissonance in architectural design processes, paying particular attention to how the work with visual mediators, such as photorealistic renderings and video animations, enable the production of uncertainty.

Apart from such epistemic problems, key contributions by Yaneva and anthropologist Sophie Houdart have highlighted the nonlinear, multiple, and oftentimes controversial character of architectural design processes. In documenting the nonrealization of a highly contested extension of the Whitney Museum of American Art in New York, Yaneva (2009) lays the foundation for a more general approach to understanding architectural design via the public controversies it generates (Yaneva 2011). In detailed ethnographic accounts of a well-known Tokyo-based architectural firm, Houdart and Chihiro (2009) show that what matters in architecture is not the specific sequence of the versions of a building (as in scientific inscriptions), but rather how their simultaneous presence defines a space of architectural conception and alternatives.

While analytically generative, however, the fact that laboratory studies has been taken as a role model for these new "studio studies" has also posed problems (cf. Farías and Wilkie 2015). In other words, and in spite of programmatic statements (e.g., Latour and Yaneva 2008), taking the equivalents to the lab (the office) and the experiment (building project) as key research objects has, for example, happened at the expense

of a more precise understanding of architecture as a complex and power-laden expert-client assemblage (Cuff 1992). Be that as it may, part of what these studies demonstrate is the sheer extent to which buildings are imagined, within processes of architectural design, mostly as technological artifacts unproblematically enabling a certain type of social uses. As such, it has taken different kinds of STS approaches to detect the possible gap between the design and use of buildings.

What Do Buildings Actually Do?

The critical importance of the question of what buildings actually do, addressed by sociologist Thomas Gieryn in the STS field in the early 2000s, becomes particularly evident when noting the ubiquity of certain modernist understandings of buildings as technologies tailored for highly specific human activities. In the famous words of Le Corbusier, homes would be “machines for living in.” Gieryn’s (2002) discovery of buildings as somehow “difficult” technologies opened a whole set of reflections on such modernist conceptualizations.

As his starting point, Gieryn points out that popular social theories of the time (the late 1990s), such as those of Bourdieu and Giddens, dilute the question of what buildings do in the old problem of structure and agency. As such, they miss the varying capacities of buildings as unfolding material objects. In a move similar to that of SCOT readings of cities, Gieryn (2002, 41) proposes to understand buildings as technological artifacts: “Buildings, as any other machine or tool, are simultaneously the consequence and structural cause of social practice.” Accordingly, his study of how a new building for biotechnology research comes into being at Cornell University mobilizes three concepts originally coined for grasping technological artifacts: heterogeneous design, blackboxing, and interpretative flexibility. With their help, Gieryn shows how design of the building’s material form is tied into processes of enrolling and articulating multiple human and nonhuman actors and how in this process it reaches a point where it attains stability and gets built. This blackboxing, however, remains open to interpretation and practical reuse and retrofitting; in Gieryn’s apt terms (2002, 35; emphasis in original) “buildings stabilize social life [...] yet, buildings stabilize *imperfectly*.”

This understanding of buildings as always contestable technological black boxes has gained some traction in STS-inspired urban geography and been deployed to, for example, understand the modernist mass high-rise building, such as the Red Road development in Glasgow, which within only forty years went from enthusing inauguration to being earmarked for demolition (Jacobs, Cairns, and Strebel 2007). As any other technological artifact, buildings attain the uncontroversial status of a black box only

provisionally. Not just their past is plagued by controversy; so too is their future, leading to interpretative contestation (as shown by Gieryn) or, in other cases, to downright demolition. Indeed, as with any other technology, the key to a building's continued existence is maintenance and repair (Strebel 2011)—a point that has also been made forcefully about cities as such (Graham and Thrift 2007). There is now a growing STS-informed literature on the myriad roles of repair and maintenance work in the city, showing, for instance, how constant work is needed to maintain the dwelling ecology of high-rise housing in Singapore (Cairns and Jacobs 2011). Here, maintenance and repair not only keeps in check the recalcitrant agencies of water, mold, and mosquitoes but also serves to manage the agency of residents through forms of cyclical checking and surveillance.

So far, what buildings do and how they fit into their urban surroundings resemble other material objects; interpretive flexibility, as noted, is how SCOT describes any technological artifact, not something specific to a building. Other STS scholars, however, have taken the opportunity to deploy the specificity of buildings as a challenge to such uniform ideas of (socio)materiality. Michael Guggenheim (2009), in particular, has pointed to three characteristics of buildings as objects that make them stand apart from such objects as artworks, technological artifacts, and scientific inscriptions. Buildings, he argues, occupy a stable location; they are singulars with distinct biographies; and they are used by different people at the same time for different purposes. This implies that buildings are defined by their environment in stronger ways than other objects. Hence, Guggenheim inverts the classic ANT analysis of technological artifacts as immutable mobiles: buildings, he argues (2009), are mutable immobles and, as such, only qualify as quasi-technologies. The mutability of buildings may pertain either to their material configuration or to the usages to which they are put, and changes often generate controversies mediated by building codes and zoning laws that regulate possible sociomaterial covariations: at what point are members of the Muslim minority in a Swiss city, as new users of a former factory, allowed to erect a minaret onto the building? (Guggenheim 2010). Here, the law—another expert practice—becomes a key site of building conversion, and hence of negotiating the stability and mutability of the urban built environment.

Among other things, Guggenheim's work clearly pinpoints the gap between the design and use of buildings; a gap centrally mediated, in his reading, by legal means. Yet, this reading arguably still falls short of fully engaging the question of how built environments are used and experienced as material settings for everyday urban life, sometimes in ways that diverge from any encoding by design.

The Sociomaterial Mediation of Urban Built Environments

The built environment of cities, as involving more than the sum of single buildings, is a long-standing topic of urban studies. At least since American urban planner Kevin Lynch's (1960) inaugural work on *The Image of the City*, the urban built environment has been cast as a text that is written and read by different urban actors in different ways. Lynch studied how the built environment is mentally read and mapped by different types of city users. Other analyses of the built environment focus rather on the processes of writing and, especially, on the production of urban symbolic landscapes of power by certain institutions and social groups. Such processes may serve variously to naturalize the privileged positions of elites (Zukin 1996) or the politics of national identity (Jones 2006), as well as to attract corporate investments by sending star-architectural messages regarding the position of the city in the global system of capital circulation. In this context, STS approaches to the built environment are making significant contributions that take seriously the material capacities of urban environments to mediate such social practices and processes (e.g., Göebel 2015).

Building on Bruno Latour's description of how human bodies are formatted, for instance, cultural sociologists Degen, Rose, and Basdas (2010, 62) have pointed to the urgent need of understanding "how the design of the material environment and people's embodiment co-constitute the experience of [...] places" in cities. Their study of shopping practices in two English commercial streets is an important contribution, as it shows the extent to which the different formatting offers made by the various elements of the urban environment are variably effective in affecting urban dwellers. In paying close attention to the various bodily practices in which people engage, whether task-oriented shopping, waiting, caring for others, hanging out, and so forth, they observe how the affordances of the built environment gain or lose their capacity to actually accommodate bodies. The built environment, they conclude, is "not only multiple in the sense of many, but multiple in the sense of ambivalent" (ibid., 73).

A perhaps extreme example of a similar approach is geographers Ralf Brand and Sarah Fregonese's (2013) study of the role played by the built environment in the political polarization and radicalization of urban conflicts in Belfast, Beirut, Berlin, and Amsterdam. Apart from pointing to features of the urban environment that act as mirrors of preexisting conflicts, such as fences, peace lines, and graffiti, they are interested in subtler mediations of polarization and conflict. This analysis entails showing, for instance, how a new footbridge to cross the Westlink carriageway in Belfast played a crucial role in the escalation of violence in 2007, as it provided access "to a launching spot for missile attacks," while giving "youths an easy escape route" (2013, 16).

Analyses such as these valuably demonstrate how the built environment is a constitutive mediator of urban practices, in the sense of opening up both foreseen and unforeseen spaces for activities. Moreover, by engaging both forms of embodiment and the capacities of materials, such as brick stones (Edensor 2013), to enable sensual and imaginative experiences, this line of work serves to open up new exchanges between STS and urban studies on the question of how to retheorize the specific “affective atmospheres” (Latham and McCormack 2009) of city settings in nonreductive and materially sensitive ways. This may, in turn, invite analysts to ask questions about those affective energies of specific urban milieus, such as the Biopolis research center of Singapore (Ong 2013), where sciences are made to thrive. So far, however, while studies of the built environment are almost invariably placed in the city, the STS approaches reviewed here cannot be said to have conclusively shown how buildings contribute to the making, remaking, and unmaking of entire cities. On this point as well, there is potential for further cross-fertilization of STS and urban studies.

Reassembling the City

Yet a third type of STS accounts of cities has relied on the conceptual repertoires of ANT and related intellectual projects. In this third avenue, which has come to be known as assemblage urbanism (e.g., Farías and Bender 2009; McFarlane 2011a), the city is cast not primarily as a novel site in which to study science and technology or as confronting STS scholars with new difficult artifacts, such as buildings. Rather, what is at stake is the extent to which it is necessary to recast and reassemble the very object of urban studies: the city.

Making the Invisible City Visible

Whereas strongly relational and postrepresentational approaches to the city began to emerge in the fields of urban studies and urban geography in the mid-1990s, probably the first dedicated work by an STS scholar to address the city on such terms was the book-website *Paris: Ville Invisible* by Bruno Latour and photographer Emilie Hermant (1998). This work focuses on different urban sites of material practice, embodied circulation, and infrastructural maintenance and coordination. While the deployment of the medium of the web mimics the dystopian imagination of the death of physical urban space with the rise of ICT, nothing could be further from this work’s main tenets. The book-website serves rather to demonstrate that visual and textual representations of cities are always locally assembled and that the urban experience involves a constant passage through a proliferating array of interconnected locales.

One key focus of the book is the control rooms, in which urban technical systems and urban natures are made visible, coordinated, and organized. Within these confined sites, visual, textual, and numeric inscriptions of urban processes are accumulated, aligned, and used to inform practices of knowledge-making and intervention in urban realities. In Latour's ANT vocabulary, these sites are urban oligoptica, that is, places in which very little can be seen at any one time but in which everything that enters appears with great precision. The oligopticon stands in contrast to Foucault's panopticon; indeed, the notion aims to counteract the fantasy of totalizing overviews associated with the latter. At the same time, it shifts attention toward those crisscrossing networks of urban actors, practices, and material devices that are needed for any inscriptions to enter these often hidden places. In this sense, oligoptica not just interpret the city according to the different functions they address; rather, they involve different and overlapping ways of visualizing, constructing, and practicing a city.

Building on Latour's early work on visualization and cognition in scientific laboratory work, Swiss geographer Ola Söderström (1996) studied the role played by different visualization techniques in the history of urban planning, paying special attention to their varying capacities to make a complex object such as the city visible. Retracing the invention of the geometrical plan of the city, Söderström shows how the historical transition from an oblique to a zenithal, bird's eye gaze led to a naturalization of the city as a measurable object that could be classified in zones according to indicators such as socioeconomic profiles, criminality rate, and life quality. More recently, and along similar lines, STS-informed scholars have explored the current decentering of city visualizations resulting from the proliferation of digital interfaces articulating new relationships between citizens and urban infrastructures. Anthropologist Jennifer Gabrys (2014), for instance, has shown how smart city infrastructures perform the city as data sets to be managed and how they redefine citizenship as segmented practices of producing, managing, and monitoring data.

These developments support in different ways Latour's key claim that there is not one Paris, but multiple Parises; that is, that the city needs to be understood as a multiplicity that is simply impossible to totalize or to fix. Anticipating what later becomes his generalized social ontology, Latour (2005) extends this point to every urban agency: persons, institutions, social movements, tourists, political parties, and so on. In urban spaces one does not encounter stable subjects but rather flexible and fluid agencies being co-defined by different regimes of materiality, affectivity, and intelligence. "In front of the bank automat I had to act as a generic individual endowed only with an individual pin code; pressed against the barrier on the pavement I was a mechanical force weighing against another mechanical force; in front of the traffic light I became

a reader of signs, capable of understanding a prohibition; by swearing at a reckless driver I am transformed into an indignant moral citizen [...]" (Latour and Hermant 1998, plan 33).

The greatest challenge posed by the city to the conceptual repertoires of ANT, arguably, is precisely how to think of this multiplicity. Whereas it might be evident that different urban technical systems, institutions, and actors build up different networks, the city entails a complex multiplicity, "folded perhaps, and folded again like an origami, but flat everywhere" (ibid., plan 31). Such "flat" multiplicity remains however invisible; it is a virtual plane of potential associations. The city appears thus as a *terra incognita*, a plasma waiting to take shape (Latour 2005). In this sense, *Paris: Ville Invisible* is certainly the most overtly Deleuzian book ever written by Latour. And as such, it contains many of the key propositions that have gone into current discussions of urban assemblages and assemblage urbanism, while perhaps not yet being quite recognized for it.

Reimagining the Urban as Assemblage

While hard to pin down conceptually, the notion of assemblage has gradually come to reshape urban studies in terms of ANT-consonant principles of symmetry, flatness, and multiplicity. This reshaping, arguably, was crucially facilitated via the book *Reimagining the Urban* by geographers Ash Amin and Nigel Thrift (2002). Urban everyday life, urban politics, urban economies, urban technical systems are all recast in this book as sets of constantly evolving assemblages that collectively form what these authors (echoing Deleuze) call a *mechanosphere*, a virtual plane of abstract machines informing the constitution and operation of cities. Relying on theoretical inputs from ANT and technoscience studies, this is perhaps the first book to propose a radical decentering of urban actors and spaces. Tools, machines, and technical systems are to be refigured as integral parts of human actors, just as bacteria, plants, animals, and humans enter relationships of co-production in the same urban symbiotic sphere. The city appears thus as a site of intensive encounters of humans, technology, and nature. These encounters, which escape the dynamics of metabolic organization, are grasped better with the language of chemistry in terms of compositions, reactions, emergences, and intensities (cf. Stengers 2005).

In one sense, what the concept of urban assemblages does is to make explicit the key theoretical displacements in the understanding of cities put forward in such contributions: the human-nonhuman hybridity of urban associations (e.g., Hinchliffe et al. 2005); the flattening of scalar and nested models of urban space (e.g., Latham and McCormack 2009); and the redefinition of the city as a multiplicity of intensities

and ordering practices. This redefinition is indeed how ANT might be said to change urban studies (Farías and Bender 2009). Yet, at the same time, urban assemblages has also come to denote a more complicated set of two-way exchanges with urban studies, challenging ANT in particular to move in novel directions (cf. Blok 2012, 2013; Blok and Farías 2016).

Perhaps one of the more far-reaching routes opened up by assemblage thinking is the radical redefinition of urban economies and politics. Paying attention to the more-than-human passions, attachments, and entanglements occurring in urban spaces, for instance, Amin and Thrift (2002) suggest reconsidering the economic role of cities, away from the traditional macroeconomic focus on regional clusters and other urban geographies as assets for production. Instead, they underline the way cities shape the economy in terms of how urban intensive encounters are capable of constantly generating new affects and passions (e.g., Tironi 2009), thereby eventually constituting new types of demands for goods and services, demands which are however not strictly economic (e.g., Färber 2014). As such, they invite new reflections at the intersection of urban studies and ANT insights into economization processes (Callon 2007).

The city as an intensive, affective, and passionate site also defines and recasts the urban political. In one language, rediscovered recently by ANT theorists (e.g., Latour 2007; Marres 2007), it reconstitutes urban politics by way of what American pragmatist John Dewey (1927) described as publics of variable geometry and duration, constituted around emerging issues of shared concern. Following this Latourian (and Stengerian) recasting of political philosophy, urban politics becomes a version of cosmopolitics, the politics of searching for and building the shared common cosmos, an urban common world (Blok and Farías 2016; Farías 2011; Tironi and Sánchez Criado 2015). More than anything, this is a politics of urban knowledge-making, one committed to new forms of collective experimentation and learning in the city by way of constituting and strengthening urban democratic publics (McFarlane 2011a).

The Assemblage Urbanism Debate

Since 2011, lively exchanges have unfolded, primarily in the pages of the journal *City*, fueled by theoretical critiques of assemblage urbanism coming from critical urban scholars. This debate is interesting because it gives us clues to how ANT, and also more general STS insights and analytical tensions, are currently traveling across academic fields of inquiry, being taken into account, transformed, and contested.

A major critique has focused on the empirical commitments of ANT analyses of the city, and often more generally STS approaches to technoscience, as involving a form of naïve realism. Accordingly, post-Marxian critical scholars have attempted to adjudicate

different ways of using the notion of urban assemblages and to argue for “a narrower, primarily methodological application” (Brenner, Madden, and Wachsmuth 2011, 230) that could serve as add-on to more substantial forms of theoretical and critical engagement. Such a position is perhaps unsurprising when considering that the ethical and political consequences of thinking with assemblage seek to debunk, or at least seriously deflate, the very premises upon which classical critiques of ideology rest.

The first of such premises is that urban politics results from struggles among well-defined classes of humans over the appropriation of urban space (Brenner, Madden, and Wachsmuth 2011, 236). In this context, the city is conceived as a “point of collision” between the mobilizations of the deprived, the discontented, and the dispossessed on the one side and, on the other, ruling class strategies to instrumentalize, control, and colonize social and natural resources” (Brenner, Marcuse, and Mayer 2010, 182). ANT complicates this picture, not least by pointing to the importance of objects and sociomaterial devices for equipping humans with agency in the first place. At the same time, ANT also entails a shift from a conflict-based model of politics, rooted in structural (capitalist) contradictions, toward a controversy-based model of urban politics based on the eruption of uncertainty and critique (Fariás 2011).

The second main challenge involves the task of the critical scholar, which in critical urban studies is usually described as deciphering the hidden structural contradictions and injustices, unveiling the ideologies of the ruling class, and enlightening people about the structural forces lurking behind their apparent matters of concern. ANT’s empirical stance, and arguably also that of much other STS work, is fully incompatible with this position, as it implies modest, careful, and analytically respectful engagements with the various actors involved in urban politics—including financial capitalists and neoliberal technocrats—in order to “not impose ‘ready-made explanations’ upon the cartographies of actors and networks” (Puig de la Bellacasa 2011, 88).

This ANT position, however, is not without tensions of its own. Indeed, one important route for strengthening the urban assemblages approach will be to cross-fertilize it with the long feminist STS tradition and its strong focus on questions of asymmetry, invisibilization, and exclusion. This might involve following philosopher Maria Puig de la Bellacasa (2011) when she proposes to treat sociotechnical assemblages as “matters of care” rather than through the Latourian language of “matters of concern.” A focus on caring entails posing the question of who actually does the devalued doings necessary to sustain urban assemblages, including sustainable or “smart” infrastructures. Thereby, the point is not just to make urban caring practices visible, but to actively generate care by way of maintaining a commitment to the possible and alternative becomings of things. Indeed, the key ethical and political question resulting from treating

urban assemblages as matters of care is perhaps not *whose* assemblage or *for whom* to care but rather *how* to care, *how* to carefully (re)assemble urban life.

Concluding Remarks: New STS Avenues, New Cities?

In this chapter we have pointed to three important avenues by which STS concepts and approaches have engaged in studies of the city and urban life, thereby entering into dialogues with the similarly heterogeneous field of urban studies. In the first avenue, well-established STS frameworks were mobilized to rethink the city as a technological artifact. In the second avenue, STS scholars discovered the urban built environment as a challenging new technical object of study. In the third avenue, ANT and Deleuzian intersections seek to reconstitute the ontology and politics of cities. While we have narrated these various encounters mainly from the point of view of important and innovative STS scholars, we have stressed throughout that intellectual borrowings and travelings are indeed two-way streets, with urban phenomena and analysts at times calling on STS scholars to tinker with and rework their conceptual tools.

Indeed, arguably the most fascinating feature of the city for STS is that it confronts us with ethicopolitical questions associated with the articulation and composition of common worlds of sociotechnical cohabitation. Multiplicity in cities is not just an analytical insight from a sophisticated STS-cum-ethnographic reflexivity but a fundamental urban experience not the least channeled into political mobilizations and controversies. Thus, whether we study urban technologies, infrastructures, socio-natures or buildings, questions concerning the local articulation of multiple, often incommensurable ways of enacting the city keep emerging and challenging our concepts and methods. Notably, after decades of conceptual work to explore network and fluid topologies of technoscience assemblages (cf. Law and Mol 2001), the city arguably challenges STS to once again rethink notions of place, of regional topology, of localized heterogeneities. In terms of methods, it invites us to not just follow the objects throughout translocal networks but also learn to stay put and study how urban sites are made and unmade through their multiple sociotechnical enactments, exploring the urban politics of coexistence and copresence. The city, in short, emerges as a crucial site in which to explore all the key political problematiques of a hybrid, technoscientific world (Blok and Fariás 2016).

By way of concluding this tour of the urban test site, we want to briefly point to some of the routes less traveled so far—as an invitation also for future STS engagements in the city. One striking white spot in this respect is the relative lack of engagement from STS scholars with long-standing questions of global urban hierarchies and,

more generally, the problem of urban difference. No two cities are quite the same. This simple fact has long been reckoned with in urban studies, mainly through vocabularies of Northern and Southern urbanisms (Roy 2011), global versus ordinary cities (Robinson 2006; Sassen 1991), and various postcolonial urban legacies outside of the West (Yeoh 2005). Yet, STS scholars have had little to say on these issues, in part reflecting the—perhaps paradoxical—fact that many have preferred to stay at home, in a Euro-American metropolis, turning this into their truth spot (Gieryn 2006). With attention to other-than-Western contexts of science and technology picking up across STS these years, this picture may be expected to change—thus opening up new challenges of how to adapt and decenter STS concepts into those globally traveling knowledges through which cities are shaped and reshaped (McCann and Ward 2011; McFarlane 2011b).

A second and related lacuna concerns what might be called the performativity of STS vis-à-vis the formation of urban knowledges, including those more long-standing urban professions of architecture, design, and planning. While these worlds of urban knowledge and practice are by now the object of STS inquiry, as noted, it remains to be seen what might emerge once STS concepts and approaches start leaving their mark more strongly on the very socialization of urban professionals and, more generally, the formation of urban policy-related claims. In this respect, one hopeful projection is to imagine the formation of an engaged program (Sismondo 2007) of urban STS—one willing and capable of posing critical questions and providing constructive input at the moving boundaries of science, technology, and democratic politics in the city. Here, addressing the prospects and limitations for democratizing urban expertise, and for inventing new forms of technical democracy in the city, constitutes one important route ahead for STS in its situated search for the future of cities.

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