Of Sensors and Sensitivities

Towards a *Cosmopolitics* of "Smart Cities"?

Martin Tironi
Pontificia Universidad Católica de Chile

Tomás Sánchez Criado
Open University of Catalonia

Abstract This essay reviews diverse strands of empirical and theoretical work in different urban studies areas (urban planning, urban ethnography, urban geography, and STS) reflecting on the manifold ways in which the *smart city* project is being "opened up" for scrutiny through experimental projects developing digitally-mediated sensing practices of either a specific or broad kind: i.e., producing both devices formally devised for sensing specific parameters, and sensing devices –emerging from less specific digital technology arrangements– used to share experiences, show solutions or politicize different urban issues. In doing this, we seek to understand, from an STS standpoint, the different ways in which a broad range of works are analysing the development, intervention, maintenance, and opposition of these ideas. In the first section we focus on understanding the definitions, features and clashes that several of these corporate projects (mostly municipal in nature) have come across, deploying smart devices, such as sensors to produce an "algorithmic city". In the second section we expand the meanings of "smartness," focusing on grassroots appropriations of broader digital arrangements and politicizations of open source infrastructures to display other forms of urban sensitivities, contributing to the *cosmopoliticization* of the "smart city" project.

Keywords: Smart city; cosmopolitics; sensors; experiment; sensitivities.

Corresponding author: Martin Tironi, Pontificia Universidad Católica de Chile, School of Design. Los Navegantes 1919, Providencia. Santiago de Chile – E-mail: martin.tironi@uc.cl.

1. Introduction: Opening up "smart cities"

The "smart city" has recently become a fashionable yet broad concept in urban design (Picon 2014). It designates those cities that are governed through the pervasive use of manifold digital devices, and most notably sensors, with the aim of providing more accurate data intelligence for better decision-making.

This paper reviews and discusses, from an STS standpoint, diverse strands of empirical and theoretical work in different urban studies areas (urban planning, urban ethnography, urban geography, and STS) that reflect on some of the ways in which the smart city is being "opened up" for scrutiny through manifold experimental projects, developing digitally-mediated sensing practices of either a specific or broad kind (i.e. both devices formally devised for sensing specific parameters, and sensing devices emerging from less specific digital technology arrangements to share experiences, show solutions or politicize different urban issues). In doing this, we seek to understand the different ways in which a broad range of recent works are analysing the development, intervention, maintenance, and opposition of these ideas; but also countering the disembodied versions of *smart city* projects through the deployment of the manifold ontological politics of its "urban assemblages" (Farías 2011).

In line with these prospects, the first section discusses literature analysing the experimental deployment of so-called *smart city* devices (Marres 2012; Karvonen and van Heuer 2014; Tironi and Laurent 2015), mainly developed by municipal and corporate consortiums around the world. Indeed, these arrangements require of manifold experts and citizens to either become avid interpreters of sensors' data or to engage in different forms of urban automated sensing (Gabrys 2007) on a huge variety of issues, ranging from air quality and urban hygiene to traffic lights and roads maintenance, mobility and public transportation, urban accessibility or remote care for older and disabled people. Thus, many of these initiatives might be contributing to the articulation of different forms of *cyborg citizens* (Gandy 2005) or *citizens as sensors* (Goodchild 2007).

The second section explores the "cosmopoliticization" of smartness, addressing a number of experiments in slowing down the *smart city* project. On one hand are top-down institutional and industry-led projects, seeking to govern entire urban ecosystems with the participation of the public – be it as providers of data or taking part in their interpretation and classification. On the other hand, individuals and communities are also crafting and using digital technologies, from very sophisticated sensors to over-the-counter smartphones and social media. These individuals and communities are increasingly organizing into different forms of *do-it-yourself* grassroots collectives, seeking to "open up" the city through different forms of urban sensing devices, hence forging different breeds of *expert amateurs* (Kuznetsov and Paulos 2010). For some of these diverse and not always coordinated collectives of amateurs, this "opening" means having the chance to share ideas and knowledge on how to build and experiment with sensing technologies with a more or less fixed institutional framework. For other activists or advocacy-led projects, permeated by a more radical *hacker ethos,* opening sensing devices means making available other sorts of experiences and urban sensitivities, as well as explicitly countering top-down versions of the smart city through the articulation of open-source infrastructures that redistribute *smartness*.

2. Experimenting with the urban: The practices and discourses of smart cities

There has been growing consensus in recent years that the advances in Information and Communication Technologies (ICT) are transforming the urban experience, redefining many of the usual presuppositions in the analysis and management of cities. The analysis of the role that different technologies have played in the design and government of the city is far from new in STS[1]. What seems to be contemporary relevant to analyse is the usher dynamism and the great investment in a gigantic and transnational "market of experimentations", leading to the craft of all sorts of digital technologies for the management, organization or regulation of urban space.

Many of these transformations and its associated discourses and hopes are usually captured by the term *smart city*. Indeed, the *smart city* concept has materialized into specific urban technology projects, having an undeniable impact: transforming many urban spaces into vast and privileged scenarios to experiment with multiple computational interventions and strategies. In fact, it has become a catchy category that has managed to jump into many urban discourses and practices, an aspirational benchmark for cities all around the world (Campbell 2012; Greenfield 2013; Picon 2014; Sheltona et al. 2015). Thus, in line with this trend, several capital cities are nowadays in a feverish process of developing *smart* solutions, attempting to make the principles of the techno-smart or digital city tangible and operative (Greenfield 2013; Picon 2014).

Beneath the surface of the different experiences in smart urbanism through an extensive application of new ICT, cities are allegedly able to transform themselves into "more intelligent and efficient" places, "improving the quality of life" for their inhabitants (Campbell 2012). This techno-intelligent paradigm is gaining particular momentum in light of the exponential growth of urban zones in the planet (UN 2008), with its concomitant effects: an increasing public demand for services and growing difficulties faced by local governments in responding appropriately to this surge in demand (Harrison and Donnelly 2011; Yesner 2013). In fact, this context is tightly associated to the creation of a new technology market boosted by industries and companies (e.g. AT&T, IBM, CISCO, Huawei, Telefonica, Siemens, etc.) that see in the expansion of this discourse possibilities for the development of new and specific services for municipalities in a moment of great economic contraction.

[1] Classic STS references include the works of Callon (1980) on the controversies surrounding the electric vehicle project; Hughes (1983) on the electrification of urban zones; and Winner (1985) on the political effects of infrastructures, together with the seminal work by Latour and Hermant (1998) on Paris' infrastructures.

Building on more recent research in STS, combining aspects of urban planning and Actor-Network Theory, that has explored the sociomaterial aspects of urban infrastructures (Aibar and Bijker 1997; Coutard et al. 2005) in this paper we would like to analyse how those "smart" infrastructures might be enacting an ontologically multiple space of "urban assemblages" (Farias and Bender 2009; Farías 2011). To our mind, the "urban assemblage" perspective is especially of interest to address these contemporary ICT-driven transformations affecting the urban fabric – such as those digital technologies seeking to build augmented environments and connected atmospheres–, and how they enact manifold articulations of the urban as well as diverse definitions of its users, going beyond socio-constructionist and critical discourses of the contemporary forms of the urban that address these transformations as the mere materialization or transposition of ideas, discourses or ideologies into the built environment[2].

What sorts of recompositions and redefinitions are being introduced by this "intelligent city" paradigm? And consequently, what are the empirical and theoretical challenges that this scenario poses to urban-minded STS? Building from this, in this section, we will outline some of the issues which, in our opinion, are presented by the practices and discourses of smart cities, associated with a profoundly experimental understanding of the city and the urban experience.

2.1. Normative variations around a concept

The high level of visibility that the *smart city* concept has garnered (in international fairs, rankings, corporate white papers, public administrations' grey literature, etc.) has been accompanied by a prolific and varied output of academic papers, books and TED-like talks on the subject. In general, such literature can be classified into two broad categories:

(1) Works that focus on the great transformations and urban reconfigurations that come to be associated with this concept, be it in terms of how it entails economic advantages for the city, pushing for the social innovation of smart infrastructures, or stressing the increasing importance of users' experiences and their new role as "sensors" and codifiers of information (Mitchell 1995; Florida 2003; Campbell 2012; Harrison and Donnelly 2011; Caragliu et al. 2011; Yesner 2013). These perspectives, glorifying smart artefacts, not only highlight the features of auto-programmable infrastructure networks (roads, bus stops, maps, waste disposal, heating, tourism, banks, restrooms, signage, shops, energy, street lighting, cycle lanes, etc.) but also the role of the "creative class" (Florida 2003) in producing flows of information. One of the key con-

[2] For example, Graham and Marvin postulate that modern urban infrastructures are more and more closely linked with "neoliberal" political criteria relating to the way the city is governed and managed (Graham and Marvin 2001, 96).

cepts is that of "sentient cities" or "senseable cities" (Shepard 2011). This concept refers to the capacity of cities to record and digitally-encode their "sensations" and states (e.g. weather, air pollution, traffic, energy consumption, etc.) thanks to thousands of smartphone users – smart sensors distributed among people and infrastructures able to manage large data sets and flows of information about both human and non-human life in the city.

(2) Works that criticize this triumphalist version of the smart city. These works are usually sceptical about the extent of the alleged claims that ubiquitous and intelligent city projects might be fostering greater "urbanity", "democratization" and "inclusion" (Gabrys 2014; March and Ribera-Fumaz 2014; Powell 2014). Many of them analyse the asymmetries (of information, control, transformation, etc.) generated between users and large telecommunication companies (Greenfield 2013; Viitanen and Kingston 2013; Kitchin 2014), the omnipresence of these companies in fabricating and managing the city (Galdón-Clavell 2013; Vanolo 2013; Sennett 2012), the role of the narrative strategies used by multinationals to become an "obligatory passage point" (Söderström et al. 2014). One of the most acerbic and well-known critics of the *smart city* idea, Evgeny Morozov (2014), even maintains that the promises of smart urbanism are based on "technological reductionism" and "neoliberal short-termism", in which all of the city's ills appear to be resolved privately (via smartphone apps) which, so he states, lead to processes of disconnection and de-politicization.

2.2. Design and experimentation with "intelligent" futures

One aspect seldom discussed in both strands of literature is the "experimental" or, rather, speculative nature of the socio-technical assemblages that constitute the *smart city* constellation of projects. The relationships between the entities that feed this paradigm –their layout and devices, concepts and designs, services and actors, markets and cities– are far from being a finished product. In this respect, adopting a Foucauldian approach, Gabrys suggests that "[…] smart-city plans and designs, as proposed and *uncertainly* realized, articulate distinct materialities and spatialities as well as formations of power and governance" (Gabrys 2014, 3). Therefore, although the concept is presented as an "organic model" of urban management, its *modus operandi* is way more related to forms of urban prototyping and speculative design.

It is no coincidence that the principal development strategy of *smart city* projects consists of pilot studies, allowing large companies to test technological and service prototypes, carrying out different forms of "urban laboratories" to test and demonstrate the durability and "social" integration of their products and services (Tironi and Laurent 2015). Be-

yond what usually happens in Living Labs[3], it could be said that in many of these *smart city* projects the city itself is used as a testing ground, crafting other forms of urban experimentation. That is, *in vivo* interventions expanding the frontiers of the urban laboratory towards the city itself, multiplying the uncertainty and the possible overflows, in order to determine the life or death of smart innovations.

Smart city projects, hence, are part of very specific corporate-led "speculative design" investments (in the sense developed by Dunne and Raby 2013), creating grand scenarios outweighing the need of being actually carried out and implemented in full. Those grand speculative scenarios acting out potential urban futures – most of them grounded in the idea that an extensive management of technological intelligence will solve the cities' problems – are rather developed to experiment with different technological solutions. Indeed, very often the actual ability of the developed artefacts to calculate and capture different urban activities (from a person's caloric consumption to the levels of carbon dioxide present in the streets) is not very accurate, opening up multiple spaces for further experimentation on such devices[4]. Therefore, in *smart city* projects, the future becomes an experimental category used to mobilize resources and interventions, to manage uncertainties and expectations (Bublex and During 2014)

This means that, despite the heavy corporate investment in promoting the concept, *smart city* business models and applications usually reveal far more uncertainties than certainties, its technological devices being more *speculative* and *exploratory* than decisive or definitive in character. In other words, in many of these projects *intelligent cities* exist on a virtual level of "emergences" (Thrift 2014) or "latencies" (Latour 2005), meaning they have not yet achieved a well-defined level of solidification and stabilization as a closed sociotechnical system. The durability of smart action plans depends, to a large extent, on the results of tests carried out on "laboratory" cities or neighbourhoods, citizens and environments, policies and infrastructures (Karvonen and Heur 2014; Tironi and Laurent 2015).

[3] *Living Lab* approaches to innovation design were developed in the beginning of the 2000s (originally attributed to W. Mitchell, from MIT's Medialab). They could be summarized as user-driven forms of co-creation of corporate services and products. Their methods usually entail the modelling of real-life environments in a closed space of experimentation (e.g. the home), deploying manifold interactive technologies to record different parameters (Mulder 2012). These approaches have been crucial for the development of contemporary "ambient assisted living" (AAL) care solutions or sustainable home environments.

[4] For instance, the ontological disputes over the accuracy and the meanings and possible interpretations of algorithmic data on one's health have been haunting the development of sensor-based personal and ambient-assisted living care technologies (see Soler and Trompette 2010 for an interesting ethnographic study on the disputes between health professionals, engineers and users in a sensor-based "epilepsy crisis detection" pilot project).

The speculative mode of smart city experimental strategies can then appear as a way of granting *degrees of reality* to white papers and narratives, protocols and socio-technical artefacts, individuals and collective actors. Drawing on Latour's latest work, we can say that smart urbanism has a "mode of existence" based on testing in situations of ontological uncertainties (Latour 2012)[5]. It is precisely this "experimental mode of existence" of the *smart city* concept that we aim to problematize in this paper.

2.3. Designing algorithmic cities

One of the main presuppositions of *intelligent* urbanism is that every event or actor (human or non-human) has the potential to generate some type of perceptible pattern, metric or information. Thus, Benjamin's "flâneur" city, together with its oblivious and creative experiences, might vanish in the face of an ongoing process in which "cities are [treated as] becoming 24 hours operations", where everything is available, predictable and prone to manipulation (Thrift 2014). Different sorts of algorithms, processing the ongoing data generated by a wide gamut of specific sensors, are the tools enabling this availability/calculability operation within urban spaces, transforming cities into mass producers of "big data", allegedly allowing for the calculation of patterns and forecasts in real time: data on consumers' spending preferences and waiting times, on the availability of parking and electrical distribution, on traffic congestion and weather conditions, etc.

While the capacity of "algorithmic urbanism" to predict and anticipate has a clearly speculative dimension, there is no certainty as to the type of "intelligence" that can be attributed to this sea of information in terms of how and who might process it. As indicated by Gillespie (2014), the relevance of algorithms (the content, form and hierarchy of information) is never neutral. On the contrary, the urban experiences out of which these algorithms operate are codified and assembled by framing them through a particular range of political notions, nomenclatures and visualization metrics. The invisibility with which these technologies operate (their design, patterns, negotiations, and maintenance) may give its users the sensation of navigating and interacting with these interfaces in a transparent manner, determined only by criteria of "algorithmic objectivity". As Gillespie indicates, "algorithms are a powerful invitation to understand ourselves through the independent lens they promise to provide" (2014, 186-187).

We might talk about an interest in producing the smart city as a form of "algorithmic urbanism", because in many of these projects data-

[5] As various works in STS have shown (Pinch 1993; Shapin and Schaffer 1985; Marres 2012; Tironi and Laurent 2015) experimentation not only acts as a means of testing, it also manufactures and fabricates realities. Prior to such experimental testing, the cognitive and material entities that make up the world are unknown.

processing technologies are increasingly required to become the omnipresent strategies to engage with the city. However, this scenario raises questions regarding (a) the types of experiences taken into account by these intelligent algorithms translating the city into digital interfaces; and (b) the degrees of intervention available to users to feel, practice and participate in the construction of the city. It is therefore necessary to question the "interface politics" of these algorithms, examining their form and content and the ways in which information about the city is modelled, simulated and made visible. If we consider the interfaces as *oligoptica* (cf. Latour and Hermant 1998), i.e. as situated devices-emplacements where information about the world is framed, interpreted, condensed and miniaturized, we might also question the way in which the urban experience is encapsulated and standardized (Mattern 2014) in these accounts.

2.4. Configuring more affective cities?

With the expansion of smart sensors and algorithms, the capacity of contemporary cities to *feel* has also become the focus of analysis (Thrift 2014). In the smart cities project, the emotional dimension is no longer considered an exclusive attribute of human beings; it is an element that has become integrated into the distributed computational nomenclatures (Sadin 2013). Through a heterogeneous collection of sensing technologies, the city might become for these authors an animated and organic agent, "able" – like humans – to emit, monitor and manage its different states. Within smart urbanism, or so it is argued, the responsibility for feeling or being affected is not a human property, and sensoriality becomes a distributed action, equipped and measured by multiple sensors and interfaces.

Indeed, Thrift (2014) states that the most innovative feature of the so called sentient and smart city is not so much the permanent processing and sending of information, but its unusual ability to propagate sentient beings by developing forms of awareness of the urban ecology. It is this capacity to be aware of the things, events and situations that occur, that enables Thrift to make a link between the sentient city and Latour's "parliament of things', in terms of the capacity of non-human entities to exercise forms of agency, to feel and be affected.

In addition to showing how many of these projects incorporate and mobilize more plural, and sometimes unknown, non-human agents through responsive and algorithmic strategies, we should be careful in using such a parliamentary metaphor, and address the particular materializations of politics in *smart city* projects. In fact, analysing the role attributed to citizens' participation in such projects, Gabrys (2014) shows how individuals in these projects might be considered as *sensing* citizens, sensitive nodes who through their interconnections with computational environments are constantly being fed data back, but:

> The actions of citizens have less to do with individuals exercising rights and responsibilities, and more to do with operationalizing the cybernetic functions of the smart city. Participation involves computational responsiveness and is coextensive with actions of monitoring and managing one's relations to environments, rather than advancing democratic engagement through dialogue and debate. (Gabrys 2014, 9).

Gabrys (2014) uses the notion of "biopolitics 2.0" to refer to the capacity of intelligent cities not only to determine intimate aspects of people's daily lives, but also to redesign and reprogram environments and citizens' behaviours from calculated patterns of data captured through these sensor technologies. Another interesting term for this might be "soft biopolitics", as employed by Cheney-Lippold (2011) in his studies of algorithmic identity construction by social media retailers such as Amazon. Schüll's (2012) ethnographic study on the algorithmic design of Las Vegas casino environments, and her most recent work on the Quantified Self community, using commoditized sensor-based devices or "wearables" to track different aspects of their everyday life and "prod oneself to take action" (Singer 2015) being interesting epitomes of these "soft" or 2.0 forms of biopolitics to reflect on.

Building from here, many critics point out that such corporate-driven arrangements might be forging a "post-political" urban design scenario, and hence urge "[…] to repoliticise the Smart City debate" (March and Ribera-Fumaz 2014, 12).

3. Cosmopoliticizing *smartness*, or experiments in slowing down the smart city?

To address that purpose, in this second section, we further analyse the *smart city* idea by focusing on other works that might help us expand the meanings of what sensing and urban *smartness* might mean. Here, we would like to review literature addressing digitally-mediated sensing practices developed in grassroots projects that have emerged alongside, but also intersecting and opposing, *smart city* projects. These initiatives have as their main goals the democratization of the cities' infrastructures – both digital and non-digital – and the politicization of several aspects of urban matter (Barry, 2013).

Indeed, in the past decades our urban arenas have seen the emergence of many online and digital collaborative platforms (Aurigi and De Cindio 2008; Fish et al. 2011; Juris 2005; Turner 2006) whereby people devote to jointly creating, maintaining and sharing all kinds of data allowing them to constitute into communities of sorts, producing many types of urban events, and taking part in manifold urban sensing activities such as, for instance, "collaborative mapping" (Furtado et al. 2012) of certain areas to

generate relevant visualizations for political action (see, for instance, Denis and Pontille (2013) on the efforts by OpenStreetMap activists to create and maintain maps where cycling ways are explicitly shown).

What if these grassroots appropriations and politicizations of digital infrastructures might be helping us to display other forms of sensing urban sensitivities? What if these so-called alternative projects might be contributing to the *cosmopoliticization*, to use Isabelle Stengers' (2005) terms, of the "smart city" project? Indeed, "alternative" projects may provide concerned parties with instruments to slow down, avoid the pitfalls of either praise or criticism, and learn how to build more interesting relations to what the ongoing digitalization of the urban might bring (DiSalvo 2012; Ratto et al. 2014). They could also help, in the process, to account for the manifold actors and entities that could have something interesting to say about such intricate urban digital assemblages.

3.1. Crafting alternative digital arrangements to sense neglected urban sensitivities?

"In what ways do distributed sensor technologies contribute to new sensory processes by shifting the relations, entities, occasions, and interpretive registers of sensing?", asks Gabrys (2012). We believe that, beyond the highly formatted and algorithmic-centric sensing experiences deployed by the *smart city* projects analysed in the previous section, other forms of ICT-based assemblages might have also formed in recent times, prolonging richer and more intricate forms of sensing urban experiences (cf. Ingold and Vergunst 2008; Pink 2008), with a long tradition in the social sciences[6].

The current intensive use of digital devices – from over the counter devices, such as personal blogs, social networks, mapping apps; to other more elaborate yet cheap DIY sensors (Newitz 2015) – by many activists and advocates is in many cases signalling a true "media rebellion" (Chateauraynaud 2013). The *Indignados* and Occupy movements are a recent epitome of this trend, as explored by Corsín and Estalella (2013), Lenzner (2014), and Postill (2013). This allows for the more collaborative and sometimes non-structured identification, reflection and vindication of neglected urban issues (Chateauraynaud and Debaz 2013). Thus, they bring into existence more complicated forms of digital urban "sensing", expanding the register of experiences beyond what appears in many municipal and corporate-led smart city projects.

Chateauraynaud and Debaz (2013), for instance, examine different examples of environmental health activists using digital sensors to make perceptible what might be affecting people sensitive to different things.

[6] See Highmore (2002) and Wark (2011) for interesting accounts on the surrealist and Situationist movements, as well as on the work of "everyday life" theorists, such as Lefebvre or De Certeau.

For example, atmospheric toxic chemicals in the city (Calvillo 2014) or ever-expanding electromagnetic radiation camps such as the ones produced by ICTs – the very same ICTs the smart city project deems interesting to build more efficient and inclusive cities (Chateauraynaud and Debaz 2010). Hence, through the use of such digitally-mediated sensing practices, their otherwise unruly and uncertain bodily sensations are "remediated" (cf. Bolter and Grusin 2000) creating space for the "articulation of the bodily differences" (Latour 2004). This is not only to systematically share all sorts of data on one's experiences and produce new information about a particular condition, but also to produce and share relevant knowledge on how to tackle those situations (Akrich 2010; Brown et al. 2004; Goodings and Tucker 2013; Tucker and Goodings 2014).

By creating different forms of sensors, these collectives "[…] would not allow to be defined by the metrological space held together by exterior instances and take charge of the laboratory in the open" (Chateauraynaud and Debaz 2013; our translation), producing a relevant intervention in the "regimes of perceptibility" that is, in the "[…] sedimented contours of perception and imperception produced within a disciplinary or epistemological tradition" (Murphy 2006, 24) emplaced in our urban arenas. Those regimes of perceptibility "[…] populate our world with some objects and not others, and they allow certain actions to be performed on those objects" (Murphy 2006, 24). In fact, many of such practices might be thought of as digital vernacular forms of "street science" or other analogous activist interventions in knowledge, techno-economic and legal expertise, *reclaiming the production of knowledge about the city and its inhabitants* (Brown 1992; Corburn 2005; Parthasarathy 2010; Rabeharisoa, Moreira and Akrich 2014). That is, such practices are about producing forms of "sensible politics" (cf. McLagan and McKee 2012) crafting digitally-mediated platforms, allowing them to create and redistribute not only sensing repertoires but also the relevant expertise needed to produce and inhabit such urban spaces.

For instance, in analysing the experience of Multiple Chemical Sensitivity (MCS) online communities, as sites of environmental health activism on urban matters, Murphy stated:

> […] In cyberspace MCSers found support groups, homepages, and "do-it-yourself" popular culture; people shared information on how to make their own personal ecologies, where to find a "safe" home, do-it-yourself treatments, and therapies that worked for them and might work for others. They offered each other advice and warnings about navigating the workers' compensation machine and other institutional apparatuses, as well as prayers for sustaining the spirit. The Internet [online fora and chats] was a vital site where MCSers communicated how to grapple with the everyday, a space facilitated by an ethic of information exchange (Murphy 2006, 168).

In a way, we could say that such experience-based forms of remediat-

ed sensing practices bring to the fore neglected sensitivities, making space for alternative experiments to the *smart city* projects delineated above, opening up and expanding the register of urban *smartness* to "more sensitive" contours.

3.2. Experimenting with DIY infrastructures, or the redistribution of *smartness*?

On a different register and to conclude, the *smart city* project might also be juxtaposed to a very particular set of works engaging in the description and politicization of urban infrastructure (Graham and Marvin 2001; Graham and McFarlane 2015; Mongili and Pellegrino 2014). This interest for infrastructure, developed mostly in STS and drawing from the work of Susan L. Star, seeks to foreground "[…] the truly back-stage elements of work practice, the boring embedded things, and, of course, infrastructure" by recurring to narrative strategies producing "infrastructural inversions" (Lampland and Star 2009, 17). Indeed, the most part of citizens living in urban environments affected by smart developments,

> […] relate to infrastructural processes as unproblematic "matters of fact'. That is, for them, infrastructures like energy or water supplies exist ordinarily as take-for-granted resources that can be easily called upon by the simple flip of a switch or by opening a tap. The complex networks of technologies, experts and political actors lying behind those mundane actions are rarely spared a thought. They exist as part of largely invisible "subpolitical" worlds organized and managed by different forms of expert knowledge operating largely outside public debate and accountability" (Domínguez Rubio and Fogué 2013, 1045).

For Domínguez Rubio and Fogué, "[…] the transformation of the subpolitical worlds of infrastructures and nature into fully public and political worlds not only offers a new understanding of urban space but also the possibility of new forms of civic participation and engagement" (2013, 1039). In recent times, an interesting source of politicizations and infrastructural inversions of the urban infrastructures has been the development and great expansion of DIY and experimental urban projects forged by different breeds of what might be called *expert amateurs* (Kuznetsov and Paulos 2010): for instance, engaged communities importing FLOSS[7] concepts –such as the use of free forms of licencing and patenting or the construction of collaborative peer-to-peer (p2p) horizontal governance networks (Musiani 2013) – and a *hacker ethos* (Coleman and Golub 2008) for the purposes of technological (Powell 2012) and urban intervention (Corsín 2014a; 2014b). Many of these collectives and communities –working in new digital workshops, such as FabLabs and other

[7] Free Libre and Open Source Software.

forms of shared machine shops (Dickel et al. 2014; Walter-Herrmann and Büching 2013)–, are engaged in intricate practices of documenting and freely sharing their urban prototypes for collective scrutiny and betterment (Corsín, 2014b; Corsín et al. 2014), constituting forms of "epistemic ecologies in beta" as Corsín calls them[8]. That is, forms of "experimental collaboration" (Estalella and Sánchez Criado 2015) in the production and open-sourcing of urban space.

Open-sourcing could here be taken as an experimental opening of the very matter of urban design for scrutiny and intervention. Indeed, this emerging constellation of projects *in beta*[9] might be entailing an expansion of experimental cultures to urban arenas beyond "the lab" (Gross and Krohn 2005) or "in vivo" forms of controlled experimentation (Callon et al. 2001), so dear to *smart city* initiatives. Thus, such projects *in beta* would be: (a) redistributing who can speculate and open up new questions on how urban spaces should be designed (cf. DiSalvo 2012; Dickel et al. 2014; Michael 2012); and (b) prolonging the political and epistemic reflections on the *right to the city* (Mitchell 2003) in urban studies to other, more experimental, re-thinking of how to democratize the urban. As a result, they might be collectively crafting what Corsín terms a "right to infrastructure," i.e., a right to openly engage in the production and transformation of such infrastructural aspects of the city, which:

> […] gathers materials, devices, appliances, media systems, interfaces, and social relations in a dance of graphematic concatenations. It is a right incarnated in and deployed through very specific (open source) sociotechnical designs, interventions, and affordances. These various capacities make their appearance in an urban ecology as prototypes, whose work tends to destabilize epistemic formations because of their sourcing and enabling of new compossibilities. As I suggested earlier, we may think of the prototype as a sort of "infrastructural being": a fluctuating betagram of persons and things whose holding processes "in suspension" lends political, administrative, and legal ritual different rhythms and capacities" (Corsín 2014b, 358).

In sum, many collaborative forms of DIY experimentation through the articulation of open-source infrastructures might very well be expanding or opening up what we might mean by *smartness*: not only allowing for the generation of other forms of data but also collaboratively redistributing "intelligence" amongst usually neglected agencies, allowing more people to engage in processes of urban *infrastructuring*.

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[8] See http://www.prototyping.es/uncategorized/epistemic-ecologies-in-beta-anthropolog-beyond-open-access

[9] See for instance Wylie et al. (2013) on DIY environmental hazard sensors or Sánchez Criado et al. (in press) on open technical aids produced by independent-living advocates to sense and protest the inaccessible city.

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