Title

Double binds of the informal smart city: Community informatics and vernacular mapping in Mirpur, Dhaka

Abstract

Community mapping, FLOSS (Free/Libre Open Source Software) and participatory design belong to a wider group of methods and platforms that address limitations and critiques of ICT4D. They contribute to the imagining of smart cities that are not beholden solely to the interests of dominant class, multinational corporations or a technical elite. In South Asian megacities, such concerns about the neocolonial incursions of technology companies into local markets contend with enthusiasm for the prospect of low-cost Internet, particularly for people living in fast-expanding informal and impoverished settlements, where lack of access to essential services is both a logistical and political constraint on daily life. Alternatives appear possible through open source systems and their communities. Social and technological counter or “vernacular mappings", produced by peers adding and editing data to participatory GIS platforms such as *OpenStreetMap*, revive potentials for producing these informatic rights to the city, addressing service discovery and navigation through custom maps, databases and social media.

Funded and administered by the international NGO Save the Children, the *Kolorob* project is an example of participatory GIS and open source development carried out in Dhaka, Bangladesh. Working with young volunteers, NGO staff, developers and researchers, communities have mapped services in *OpenStreetMap*, and co-created an open source mobile Android application to help navigate them. Through focus group discussions and participant observation, we show the project to be an illuminating case of peers producing technological artefacts and social change, and one which also faces financial and political limits that threaten the durability of these accomplishments. Acknowledging these tensions, inherent in a wider smart city dialectic of control and freedom, involves a necessary recognition of the sometimes partial, temporary or intangible benefits of urban peer production activities. We further examine the utopic designs of mid-twentieth communist urbanism and cybernetic economies for clues about how programs for smart informal cities might wrestle with these dilemmas, under conditions of vastly amplified information production and availability.

Keywords

Vernacular mapping, OpenStreetMap, informal settlements, smart city, wireless feedback

Full Paper

Introduction

Theories of the smart city have often sought to integrate seemingly conflicting impulses between the logistical governance of populations and the creative activity of a liberated citizenry. Plato's *The Republic* argued for rule by philosopher-kings who nonetheless would regulate a city of an enlightened *demos*. Straddling ideological lines, mid-twentieth planning narratives understood city design and management as scientific programmes that would also not eradicate the glorious spontaneity of urban life. Socialist and communist experiments – the *CyberSyn* project of Allende's Santiago, or the *New Unit of Settlement* proposed for Soviet cities – were as much guided by liberational aspirations as neoliberal responses to modernist planning that sought an emergent "smartness" in market forces. Conversely, the neoliberal city has been no less preoccupied with techniques and technologies for the control, regulation and securitisation of financial and human capital.

The recent injection of digital technologies into urban development both reinforces and reexamines this integration. Sensors, video cameras, digital dashboards, automated transport ticketing systems and Big Data analytics are conspicuous examples of how cities can be "smartened": made more convenient for commuters, more efficient for rate payers, more governable by authorities and more attractive to investors. The smartphone materialises digital urbanism dramatically. The device par excellence of citizen science and individual autonomy, it facilitates everything from public transport notifications to "off-the-grid" communication networks. Yet it transmits data across networks maintained by large business, and through software offered by the current oligopoly of Silicon Valley corporations: Apple, Google, Amazon, Microsoft and Facebook, which as of mid-2017 represent approximately 3% of the world's GDP [Derived from market capitalisations of the five companies according to Google Finance, compared with figures stated by the World Bank in 2015]. Such concentration appears to realise and refine the aspirations of earlier urban planners for command-and-control structures of governance.

This convergence of software supply reinforces the standardization and replication of sameness in the smart city (Easterling 2014; Verebes 2016). For Verebes (2016), this poses a "Dilemma of Similitude", and requires a willful counter-tendency to preserve and accentuate the complex tones of urbanisation: "Questions remain as to what makes the

specificities of cities, both in history and in a future which is definitively an urban future […] how, at the start of the twenty-first century, do we heighten the materialization of unique spaces and systems?" Others have pointed to the diversity that exists despite the desire for uniformity. Kitchin (2015) discusses "how different initiatives, led by a plethora of stakeholders, work together or compete to produce a certain kind of smart city", one which is moreover inevitably marked by "the messy realities and politics of implementation and contestation" (p. 134). The smart city both self-replicates and mutates.

In South Asian megacities, where massive standardization coexists with massive areas of informality, critique of the erasure of difference in the instantiation of the smart city overlaps with the ongoing attention to colonial and post-independence urban development (Datta 2015; Nair 2015; Mundoli, Unnikrishnan & Nagendra 2017; Varghese 2017). Concerns about neocolonial incursions of multinational technology companies and the fast-paced, non-deliberative productions of "entrepreneurial urbanism" (Datta 2015) contend with enthusiasm for the efficiency and democratic dividends technologies deliver to those living in informal and often impoverished settlements, where lack of access to essential services is both a logistical and political constraint on daily life (McQuillan 2014; Bunnell 2015). McQuillan (2014) further notes in relation to NGO-led initiatives to improve informal settlements with smartphones, sensors and networks, "smart slums could still repeat the problematic cycle of first generation ICT4D if the technologies are dropped into communities without an effort to build the capacity of poorer citizens to use them". As we discuss below, and as noted in scholarship of 'postcolonial computing' (Irani *et al*. 2014) and participatory or reflexive ICT4D and HCI4D approaches (Ahmed, Mim & Jackson 2015; Wyche 2015), even such capacity-building efforts are not without supplementary dilemmas of their own.

Situated at one of conceptual intersections between smart cities, postcolonial computing and participatory design, open source community GIS systems such as *OpenStreetMap* constitutes emerging media platforms for undertaking what Gerlach (2012) has referred to as "vernacular mappings" that enact a political "multiplication of difference". We describe a project based in the Mirpur area of Dhaka that extended *OpenStreetMap* with a Bangla-language smartphone app to address service discovery and navigation through custom maps, databases, direction routing and social media feedback. Developed by an NGO with an explicit aim of promoting local community political agency and representation, the project's tight feedback loop between software development, mapping, testing and use offers a practical case of the informal smart city at work. Equally, its ideological, logistical and technological overlays indicate a structure of double-binding that is both specific to the contemporary smart city formulation, and echo important historical antecedents in the cybernetic or communicative city. We draw upon the maps themselves, focus group discussions with project community mappers, youth facilitators and software developers,

and our own experiences and observations as project participants to discuss the tensions, complications and affordances of mapping informal space. We then widen our discussion to reflections upon this double-binding structure in the context of articulations of cybernetic cities that, on account of their historical character and different ideological arrangements, reflect forward onto nascent efforts to peer-produce today's participatory smart city.

Urban Clamour

In her sensory ethnography study in the slums of Govindpuri and neighbouring middle-class suburbs of New Delhi, Chandola (2012) argues noise acts as a sensory identifier of community and industry. Music amplified loudly by cheap equipment and "sonic performances of everyday activities" signals the liveliness of slum settlements, and annoys more affluent neighbours. The hum of factory machines once regulated daily routines of illegal camps; the closure of those factories and the resulting silence meant lost jobs and loneliness. According to one respondent, the silence was "deafening" and they felt "lost" (Chandola 2012). Without noise, the city became unnavigable.

It is appropriate that a community mapping project, developed with an explicit aim to boost political representation of residents of two informal settlements in Dhaka, was named *Kolorob*: 'noise' or 'clamour' in Bangla. Administered by Save the Children Bangladesh, the project ran from July 2015 until January 2017, and mapped local legal, health, education, government and other services into the *OpenStreetMap* database. A customised Bangla-language open source smartphone app provides a way for these services to be discovered and navigated to. The project commenced in July 2015, with funding provided by *Save the Children Australia*, in response to a successful Bangladesh application to a competition run across the federation of international Save offices. From its inception, the project was developed as a collaboration between local communities, mappers, software developers, young volunteers, staff at Bangladesh and Australia offices, with additional support provided by a network of small Bangladeshi firms and Australian academics.

At its completion, significant areas of Mirpur, a district in Dhaka's north, had been mapped. Over 2,500 locations had been entered into the *OpenStreetMap* database, and the *Kolorob* app had been downloaded more than 10,000 times from *Google PlayStore*. The source code for the software has been made published under a permissive open source license on *GitHub*, a widely-used repository.

The project's ostensible social and technical successes have not translated into the kinds of sustainable revenue its initial plan anticipated. An attempt to integrate advertising into the

app was unsuccessful in generating any meaningful revenue, as well as unpopular with users and the technical team. Another plan for mappers to recruit businesses to list their businesses in the database was never trialed systematically, and efforts to recruit large Dhaka companies were also unsuccessful. It continues to be developed by several of its developers on a volunteer basis, and is looking to crowdsource funds locally and internationally. Parts of the project are also being integrated into other mapping projects run by *Save Bangladesh*.

As researchers we were involved in the project since its inception, invited by Save's Australian office to advise on agile software development, interface design and evaluation methods. Our technical input included providing feedback on database structures, researching path finding approaches and data collection techniques for use with *OpenStreetMap*, adapting algorithms to respond to user input on irregular cartographic geometries, and suggesting ways to manage sprint cycles, versions, code refactoring and feature back logs. We visited Dhaka twice, in February and November 2016, and communicated often with the technology team via Skype, email and Slack (an instant message communications tool). During our visits, we conducted focus group discussions with mappers, volunteers, users, other community members and the software team. These discussions covered detailed feedback on the *Kolorob* app, use of mobile phones and technology, and dilemmas associated with locating services and moving around Dhaka.

Mapping Mirpur

From the outset, the project planned to crowd source a database of services, building upon the knowledge of local communities. Late in 2015, it engaged groups of volunteers to begin registering services in Baunia Badh and Paris Road areas of Mirpur. These two areas were selected based on Save staff's familiarity with local communities and leaders, established in prior projects. After an initial training session run by a small cohort of *OpenStreetMap* trainers recruited for the purpose, volunteers began walking blocks of the two districts and recording health, legal, educational, administrative and commercial services. Simultaneously, *Save* hired a small technical team to build the custom Android app for searching and browsing services, utilities for importing locations into the *OpenStreetMap* database, and an supplementary database that would record information about services that could not be easily integrated into *OpenStreetMap*.

The direct recruitment of mappers and developers is unusual in the NGO context, and had not been done before by Save's Bangladesh office. The local IT manager had prior experience with software development in an international firm, and together with the project manager, were keen to recruit rather than outsource development to a Bangladeshi

or overseas company. Attempts to integrate external providers for parts of the development, such as the user interface design, were not successful and, aside from occasional specialist technical advice, the subsequent software development was done by Save staff. This kept project costs low, and allowed for continued community feedback to shape development and adjust the mapping process. On the other hand, as discussed by the developer team, the inexperience of a mainly young team led to occasional delays during software implementation.

Despite Dhaka being a large and rapidly developing city, and the areas of Mirpur being reasonably well established, many of the services had not been mapped before. With the exception of some schools, religious centres and NGO offices, *Google Maps* shows the areas as largely vacant, while previously *OpenStreetMap* had few if any buildings or streets marked. The improvement in quantity and quality of data led to unanticipated uses: for example, local leaders and community groups had begun to use the augmented maps to plan disaster management strategies.

Figure 1 – Main interface of the *Kolorob* application, version 2.04 (released November 28, 2016).

Mirpur was first established as a residential area in Dhaka's north in the 1960s to accommodate "the lower and lower middle income groups and Muslim refugees from India" (Nilufar & Khan 2016, p. 81), and expanded rapidly after independence in 1971 in both area and population density. Despite being overseen by the Housing and Settlement Directorate, it lacks the "high space and service standards and physical designs" of nearby planned residential distracts, Gulshan, Dhanmondi and Banani, that were developed to accommodate "high and high middle income families" and "expressed an aura of Western suburbia, modernity, and status" (Nilufar & Khan 2016, p. 81). The two mapped areas of Mirpur, Baunia Badh (Ward 11) and Paris Road (Ward 10), are distinctive relative to each other and to their surrounding areas. Spatially, Baunia Badh is bordered by two main roads on its north, west and south sides, and small lakes to the east and north. As *Figure 2* shows, it is internally well ordered, laid out according to a grid spatial arrangement that runs north-south and east-west, and is divided into approximate squares. It contrasts with the surround areas, which feature long, thin and often irregular rectangular blocks, a distinctiveness which stems from its origins as a UN Habitat-planned resettlement in the early 1990s. Despite the top-down appearance of order, at a street level it exhibits a mix of formal and informal characteristics, organised often with different land tenure arrangements. Street markets and shops on the periphery of the area are busy day and night, populated by bustling rickshaws, bird sales and mobile phone outlets. What appear topographically as streets on the interior are narrow lanes full of playing children, mothers standing on their doorsteps, and construction workers ferrying liquid concrete to construction sites. These sites are often vertical extensions elevating what were originally

one and two storey buildings to three or four levels, to generate further rents from what has become a constant stream of incoming migrants arriving from the countryside in search of work. Significantly, the lane ways that connect these buildings are far too narrow for emergency service vehicles or Google vans to penetrate; Street View stops at the periphery, and residents reported that Google Maps neither identifies many of the services and shops, nor the optimal routes of its interior.

Figure 2 – Baunia Badh area, Mirpur, Dhaka.

Paris Road is a less clearly demarcated zone. Large apartment buildings – some still in construction, and conspicuously marketed to Dhaka's growing middle classes – straddle a streetscape of retail outlets that is just as busy as Baunia Badh. The wide street that gave the area its name has a growing array of fashion stores which point to the presence of the nearby garment industry. Yet in its interstices live a number of small, crowded and highly precarious slums, constantly under threat of seasonal flooding, waterlogging, earthquakes and eviction. Such threats readily materialise: in 2016 one of the slums was completely demolished to make way for more multi-storeyed development. Like other residents in Mirpur, people living in these slums contend with poor roads and open drains that overflow during times of heavy rain. Additionally, they struggle with problems of unemployment, unattended medical needs, high education costs, threats of sexual harassment and the experience of frequent conflicts between police and drug dealers.

Figure 3 – Paris Road area, Mirpur, Dhaka.

Selection of the two sites was motivated by these internal differences, as well as their shared standing as comparatively long-standing and coherent communities for the trial of mobile technologies and apps. Early work in 2015 developed the core materials of the project: survey forms for the community mapping activities; a review of existing open source directory service systems; and two briefs for Dhaka-based consultancies to develop, respectively, an experimental physical kiosk and a mock-up user experience and interface. Soon after, work commenced on an initial database design and app prototype, and project staff ran a series of community workshops, to introduce the project, encourage discussion and feedback, and encourage participation in the mapping process and use of the application. These proved invaluable in communicating the broad intended benefits of the project, and in generating interest and anticipation in the app specifically.

Simultaneously, mapping volunteers were recruited to begin mapping Baunia Badh and Paris Road services, walking street-to-street, using their phones to obtain GPS locations

which were then recorded alongside the details of each service. These included basic information – the name, address, type and hours of operation of the service – as well as details particular to the service type. In the case of schools, for example, these details include their fees, year levels, facilities, average class size and number of bathrooms.

Initially this information was recorded on paper sheets, which meant a tedious and error-prone process of transcription into a database. In May 2016, the paper-based process was replaced by forms developed in *OpenDataKit* and *OpenMapKit,* digital tools designed to help community mappers record integrate locations into *OpenStreetMap*. Developed initially by Red Cross, *OpenDataKit* has since been widely employed by other humanitarian organisations to simplify and expedite crowd mapping. The efficiency and ease of the tool has also made it popular among research and government organisations (Esraz-Ul-Zannat & Haque, 2014). In response to further feedback, the technical team redesigned and simplified the structure and layout of forms several times. Each time required time-consuming modifications to the database and *Kolorob* app. By the end of the project, the time for entering a single service had decreased from thirty to ten minutes, and the use of geo-located tablets and highly structured forms improved the quality of records considerably.

The improved approach meant mappers could enter information about services directly through forms on their phones, and automatically register their GPS coordinates against each new record. This information was uploaded as a batch at the end of each day to a hosted service; after being validated at a later point, the same information was added automatically to the database. Service locations – though not the full set of data collected for each service – were also contributed back to the *OpenStreetMap* database. *Figure 4* shows a section of the Baunia Badh district in *OpenStreetMap* as of November 2016, where specific health, education, religious and commercial services are clearly visible. Only a small number of these are marked on the corresponding *Google Maps* view in *Figure 5*, which also omits important lanes that could be used to provide electronic routing and navigation services. The massive increase in detail illustrates the significant contributions of *OpenStreetMap* to participatory GIS initiatives, and in turn, the importance of those initiatives to the creation of global open data repositories.

Participants also welcomed the opportunity to gain expertise and contribute to this mapping process, with one of the organisers stating they found learning how to map “quite interesting, definitely a new thing… to access the Internet through a map”, and another seeing further applications of participatory GIS in “DRR (Disaster Risk Reduction) for coastal people in Bangladesh”. Unsurprisingly for a project that employed largely young staff out of school and college, many also talked about the personal benefits of working for an international organization, developing public speaking skills, being part of a supportive team, and collaborating with communities on data collection, using *OpenDataKit* and

setting up WiFi access points. Yet the excitement of developing such expertise intermingled with a feeling of unease, as expressed by one participant: "For the last 2 years and they have learnt a lot about map use and technology using and they have many training – and they are now skilled […] If the platform created does not progress – will there be other projects to continue developing their skills on that project?"

Figure 4 – Close-up view of Baunia Badh, OpenStreetMap, November 2016.

Figure 5 – Close-up view of Baunia Badh, Google Maps, November 2016.

A Case of Vernacular Mapping?

The process of mapping is often seen as an enactment *for* (to claim) or *against* (to contest) a piece of territory. Introduced by Peloso (1995), "counter-mapping" references mapping undertaken to undermine the dominant and hegemonic power structures that have historically mapped territories as means for asserting control over them. Over the two past decades, the term has resonated with indigenous, postcolonial and conservationist struggles to reassert claims or rights over disputed territory (Hodgson, D. L., & Schroeder 2002; Harris & Hazen 2005; Wainwright, J., & Bryan 2009). The open source qualities and accessibility of *OpenStreetMap* has seen it emerge as a kind of Wikipedia for cartography, a "massively distributed commons-based peer" produced platform for undertaking counter-mapping at scale and delivering "where expertise and justice are not in the exclusive service of dominants, but democratically available to all" (O'Neil 2011). However, as Gerlach (2012) notes, practices of *OpenStreetMap* mapping complicate the implied binary between dominant and non-dominant forces implied in the term "counter-mapping". Instead, he argues its use is better described as "vernacular mapping", a form of informatics layering that "look to always add to our abstractions of the world, to generate maps that attend to the everyday, to reorientate and disorientate bodies and things in the spaces of day-to-day life" (2012). Mapping, from this vernacular stance, is viewed as a more complex process – an enactment *within* a piece of territory. This process of producing individualised difference was suggested by a member of the developer team:

> "*Kolorob* is making people able to make their own decisions which is better for them. The information I might get other people more easily I can see all information

> by myself and make my decision and I am not depending on another person and also increasing capacity for decision-making".

While such affirmation may sometimes oppose existing power, the self-articulation that accompanies "seeing" and "decision-making" alongside the mapping process itself produces a vernacular mapping, an array of tonalities or perspectives.

Humanitarian use of *OpenStreetMap* complicates these accounts still further. Critics of ICT4D have argued the promotion of ICT, including open source platforms like *OpenStreetMap*, by international NGOs frequently betrays a "modernist" bias that equates the technological equipping of communities with social advancement or economic development. More often, this bias coerces communities into compliance with existing neoliberal and neocolonial interests, producing subjects ready to be coopted into wider circuits of global labour, production and consumption (Andrade & Urquhart 2012

As others have noted (e.g. Wyche 2015), such critiques are difficult to apply uniformly to the huge diversity of ICT4D projects, which run from websites developed by grassroots volunteer and activist community-based organisations through to multinational corporate platforms such as Facebook's *FreeBasics* programme. Critiques of older ICT4D practice are being addressed by incorporating local and largely autonomous management structures, participatory design and indigenous approaches to software development, transition funding from overseas to local sources, and deliberative development (e.g. Irani *et al.* 2010; Hagen 2011; Donovan 2012). ICT4D projects also often run into more mundane difficulties. Against the enthusiastic rhetoric often espoused by agencies seeking donor funds to develop web and mobile applications, technical deliverables can be inappropriate for their intended audience, underwhelming in functionality, or discarded and unsupported once agency funding runs out. As noted by Poggiali (2016) in a community mapping study in a Nairobi informal settlement, these openings of social and technological exchanges produce complications, "as both potential vectors of sociopolitical recognition and as battlegrounds on which the urban poor's claims to transparency are affirmed or ignored, heeded or disregarded" (Poggiali 2016).

Funded by Australian and US offices, and with an explicit mandate to self-fund by generating sustainable revenue, *Kolorob* is far from immune to criticisms of neoliberalism or neocolonialist smuggled in through technology platforms. Yet in important ways, it sought from the outset to work against "top-down" directives, whether from overseas advisors, Bangladesh government or internal management. The project was largely

conceived, developed and managed by Save Bangladesh staff, with support from local partners and communities. One of the developers emphasized the local dimension of its technical outputs: "what Google is doing on an international level *Kolorob* is doing at a localised level". Young facilitators, mappers and developers, many recruited from Baunia Badh and Paris Road areas, also had considerable input into the social and technical programming. Against financial and logistical constraints, local communities were consulted often about the application design and the accuracy and relevance of mapped sites. The project proceeded even without evidence of sustainable funding, and even at its completion the digital assets, including contributions to *OpenStreetMap* and the *Kolorob* app on *Google PlayStore*, remain freely accessible to use and further development.

The conceptual difficulty of either endorsing *Kolorob* as a case of counter-mapping or, conversely, criticizing it as yet another example of INGO meddling in local political economies is further complicated by the hybridised and intersectional face of intensive sociotechnical collaborations. In our conversations with local office staff, some felt the organization was unhelpfully competing against start-up companies that needed to establish brand awareness and business models around advertising services. Others thought the absence of a history of YellowPages-type directories in informal settlement areas instead signaled the need for large humanitarian agencies with funding to show government and corporate organisations what was possible. As one of the project's field officers noted:

> "we can work as a bridge so we can connect them with a better service or a service that they actually need and that is the advantage for *Kolorob*. That we are making this bridge so they can have access and so they need any type of information or anything they can just go for it - that is the main advantage that we are making that bridge for them".

One of the explicit aims of the project had been to encourage social media ratings, reviews and dialogue about local services, and while this feature had only been partially implemented, our discussions with community members indicated the service directory helped gain access to government services and encouraged debate about how these

services might be improved. Another of the field officers discussed how *Kolorob* was seen as valuable because people "have the information in their hands", and therefore could utilise services more effectively. Whether or not this minimal citizenship might widen into other forms of participation, information access constitutes one of necessary conditions for greater representation for those living in Dhaka's large informal settlements.

Despite it being a possible tool for critique, the Bangladeshi government appears to have welcomed *Kolorob's* development, awarding it "Champion" in the "Inclusion and Empowerment" category of the Bangladesh National Mobile Application Awards in April 2017. An initiative of Digital Bangladesh [ENDNOTE: http://a2i.pmo.gov.bd/digital-bangladesh/], a whole-of-government initiative designed to bring "public services to citizens' doorsteps and increasingly within the palms of their hand", this endorsement points to the accommodation of "unofficial" mapping within Bangladesh government discourse. Indeed, it is likely that nationalist concerns around exerting digital property rights to maps are very much subordinate to the current enthusiasm for promoting digital capacity building and economic development. In such contexts, fostering entrepreneurial software cultures and boosting mobile phone adoption appears to outweigh the state's relinquishing of control over urban cartography. At any rate, if *OpenStreetMap* constitutes a form of vernacular mapping, one of its affordances as an open platform is that its data can always be reintegrated into proprietary company or state data systems.

Rather than a form of mapping that directly counters a hegemonic power, here the use of *OpenStreetMap* makes for a micropolitics that embroils actors in situations structured by contrasting and contradictory aims. These contradictions were not merely the product of bringing together NGOs, communities and companies, nor of conflicts generated by the confluence of local and Western ex-patriate and overseas-based staff. Indeed, from our own point of view as participant advisors and contributors, the working relationships across time zones and spatial divides were productive and complementary. Rather, as Redfield (2012) has analysed in his study of ex-patriate workers at Médecins Sans Frontières, contemporary NGO practice frequently involves various forms of a *double bind*: "contradictory injunctions posed by a valued interlocutor, neither of which could be satisfied without failing the other". In the *Kolorob* context, such injuctions multiply in the form of demands for economic sustainability, appropriate technology, institutional fit, international and inter-organisational collaboration, and localised political empowerment and participation.

Cybernetic Cities and Double-binds

These complications are not limited to the peculiar circumstances that might attend ICT4D mapping projects. In the *Preface* to *The Urban Apparatus*, Reinhold Martin has recently expanded upon the functions of the double bind that attend contemporary urbanization:

> Urbanization is built on massive cracks. A widening gulf between wealth and poverty divides populations on multiple scales, both on the ground and in the social and cultural imagination. Differentials of race, class, and gender crisscross this divide, cutting new crevices and occasionally building bridges. These differentials, and the fissures and bridges they entail, are without exception enacted by material bodies, infrastructures, things. In general, the *mediators* and their political-economic entanglements observe the laws of the double bind. That is, they enable one set of possibilities while disabling another, equally plausible one, by delineating the horizons within which thought and action take place. In doing so, they reproduce the no-win scenarios of the double bind by appearing to reconcile mutually exclusive possibilities in a manner that is far more intractable than any ordinary contradiction (2016, p. 6).

Not named explicitly as such, maps and software clearly constitute examples of Martin means by "mediators": "infrastructural, technical, and social systems that condition experience, delimit the field of action, and partition knowledge" (2016, p. 4). Martin's reflections on infrastructural mediators include, along with the conventional materials of architecture and urban planning, the new "hardware" of sensors, WiFi and Bluetooth networks, data centres, satellites and mobile phone: the very stuff that make up smart city infrastructure.

In Martin's argument, cybernetics is rarely mentioned explicitly, but notions of feedback, the quintessential demarcation of the self-regulating and self-adjusting machine, feature heavily in his description of infrastructural mediators and the production of a "mediapolitics". In an earlier essay, Martin recounts the cybernetic city envisioned by Norbert Wiener in a *Life* article published in 1950, "How U.S. Cities can Prepare for Atomic

War". Set amid advertisements for cigarette lighters and other articles about Nebraskan goose hunts, Wiener and his co-authors make the case for the "decentralization of our cities" and the installation of "lifebelts" – communications and transport networks that girdle urban centres. Analogous to Mumford's "polynucleated city", Weiner's cybernetic urbanism foregrounds the defensive militaristic characteristics that include, in addition to decentralisation, "redundancy, information management, feedback" (Martin 1998) which were to later mark the network topology of the Internet, and which today have returned to urbanist currency in both boosterist and critical discourses of the smart city.

The respective languages of mid-twentieth century cybernetics and new millennial smart cities have been analysed in terms of their close intellectual, ideological and operational affinities (Gershenson, Santi & Ratti 2016) and, occasionally, differences (Goodspeed 2015). In some cases, distinctly cybernetic antecedents have motivated baroque and convoluted prescriptions for smart cities, as in the triple-helix model presented by Lleydesdorff and Deakin (2011) that draws explicitly from the systems theory adaptions of cybernetics by Talscott Parsons and Niklas Luhmann. Our own revisiting of earlier examples is motivated less by the specificity or refinement of models, and more by their historical recognition of "mutually exclusive possibilities" that smart cities, as megascale "mediators" in Martin's sense, necessarily oscillate between.

Of the many mutations of the cybernetic city to emerge in the post-WWII period, the *New Unit of Settlement* proposed for Soviet cities in the late 1950s and the *CyberSyn* project of Allende's Santiago in the early 1970s are distinctive in their marrying of futuristic urbanism to a language of collective emancipation and liberation that has re-emerged in the – often, but not uniformly – in the quite different individualised and consumerist discursive articulations of the smart city. The *New Unit of Settlement* was proposed by a group of Soviet architects led by Alexei Gutnov at the University of Moscow in *The Ideal Communist City* (Gutsov *et al.* 1968[1957]), authored at a time of heightened optimism about the prospects of socialism (Myers 2008). While it reinterprets prior prescriptions for urban planning from Ebenezer Howard and the Garden City movement, it also integrates the biomechanical language of cybernetics into its diagnosis of the ills of the city of "monopoly capitalism" (p. 21). Unplanned growth leads to the "megalopolis" (p. 23), a place that exhibits "functional disintegration" (p. 28), and produces "conditions of health and sanitation, traffic frustrations, a great waste of time, and the isolation of individuals in extremely confined spaces" (p. 8). By contrast, the communist city, strengthened by state-of-the-art scientific principles that include those of cybernetics but also "information theory, human engineering and the esthetics of technology" (p. 17), will set free the creative impulses of the urban citizen. In what seems a prescient premonition of contemporary techno-optimism, "automation opens up unlimited possibilities for machine specialization and for the consequent liberation of labor". Acknowledging cybernetic

feedback, planning also intervenes in the chaotic tendencies of unplanned growth: "the problem is not to limit growth as such, but to interrupt its linear continuity, to impose a systematic pattern and plan on its territorial expansion".

Among other conditions, such detailed planning would require "a single comprehensive system of information storage and exchange" (Gutsov *et al.* 1968[1957]) that remained will beyond 1950s – or indeed later – Soviet computational capacities. Planning in major Soviet cities eventually proceeded down lines that bore little resemblance to Gutnov's ambitious urban designs. The *CyberSyn* project of Allende's Santiago has received considerable recent critical attention, partly as it came at a time – only fifteen years after the Soviet city publication – when state-of-the-art computerization would make comprehensive and real-time state planning and monitoring conceptually if not quite practically feasible (Espejo 2014). The confluence of a socialist government keen to develop a "people's oriented economy" and with the arrival of Stafford Beer, a leading cybernetician and management consultant, led to a short-lived utopic social experiment that sought to direct incipient network and information processing technologies towards the creation of a utopic "liberty machine" (Espejo 2014) – an anticipatory form of what Medina has termed "sociotechnical engineering" (2011) and "algorithmic governance" (2015). Though directed toward the nation rather than the city, the project's Operations Room in Santiago further anticipates control rooms that feature in famed smart city projects such as Rio's Operations Center (Goodspeed 2015), and their virtualization through urban digital dashboards (Mattern 2015). While the smart city movement has been tied more directly to the rise of entrepreneurial urbanism, smart growth and new urbanism in the 1980s and 90s (Kitchin 2015), central tenets of the cybernetic city as imagined and planned in *CyberSyn* – interlinked networks, data flows translated into managerial information forms, scalar and granular organizational units that traverse governed centres and peripheries, and even the participation of citizens in monitoring and decision-marking – remain integral to many articulations of the smart city today.

The double-bind structure might be considered part of this legacy too. Its cybernetic underpinnings sought to avoid the deterministic logics that beguile technocratic states into delusory control, instead championing epistemological uncertainty and performativity (Pickering 2004). Yet even sympathetic accounts of *CyberSyn* still point to a radical overestimation of rational process, and an under-acknowledgement of the ideological tensions that tore at the dual pursuit of economic rationalization and political emancipation (Pickering 2004; Espejo 2014; Medina 2011; Medina 2015). The exteriorization of memory, cognition and information processing into mediator technologies of the screen, storage tape, telex machines and operations rooms constitute a point at which these new objects begin to make obsolete the old tools of bureaucratic statecraft. As Easterling (2014) has observed, they directly and essentially introduce

"extrastate" actors in the scenes of governance: hardware and software vendors, IT standards committees and, more remotely, the firms that mine, manufacture and dispose of the material and logistic infrastructures essential to the continuous hum of the smart city.

They point also towards the contemporary urban situation of what Martin (2016) diagnoses as the "mediapolitical" double-bind: the injunctions that become impossible partly through the very agency of specific types of technical media. These bring into being a city that is neither "mechanistic" nor "vitalistic" but, with echoes of Stafford Beer's cybernetic ontology, performative, rooted in "active, willed action", which at the same time as they put into play the contradictory circumstances of modernist urbanism also engage means for their overcoming. Martin (2016, p. 6) cites Deleuze's interpretation of Nietzsche's "antidialectic" as an example of what might be thought a counter-logic, where "[N]egation is *opposed* to affirmation but affirmation *differs* from negation". Following this dense formulation, such a counter-logic would belong to the family of paraconsistent logics that ignore axioms of non-contradiction, symmetry, transitivity or associativity. Like counter-mapping, or its elaboration into a vernacular mapping, this counter-logic would itself be opposed to as well as differ from the logics that operate within and through technological media itself: quintessentially the dominant, computational relational, description and probabilistic logics that govern today's smart city databases, networks, algorithms and machine learning systems.

Drawing upon Ashby's (1965) "Law of Requisite Variety', Salingaros (2015) has argued the simplification and dehumanisation of the industrial model triggers cognitive dissonance: "cultural norms demand a monotonous mechanical world, whereas human biology craves variety and ordered complexity" (p. 50). Within this particular conceptual unfolding, the double-bind constitute more than such cognitive dissonance experienced by an observer who stands on the periphery of the cybernetic or smart city. It is equally an affective dimension for those who, as observers, necessarily also participate and perform. Structurally, it develops not only from the abstractions codified as socialist, neoliberal or neocolonial ideology, but also through the agency of informatic infrastructures that function according to locally logically consistent processes – archetypically computational – and yet produce total situations full of impossible injunctions. The "liberty machine", as imagined in Beer's theorization of *CyberSyn*, applied the principle of "structural recursion" to management: differentiated in scale in factory, industry, networks and the wider political economy, but logically congruent across as well as within each of these systems. The structural conditions of the double-bind suggest instead the operationalisation of alternative and incommensurable logics. The resonance of the contemporary urban ICT4D project, rooted in human subjectivity and also awash in mediatic infrastructure, appears to exemplify the adjustments of this more-than-cybernetic condition.

Megaphonic Amplifications, Wireless Feedback

In today's city, every smart phone is an Operations Room. Android devices can be purchased in Dhaka for less than $30USD. From *Uber* to localised digital dashboards, apps compress the noise of the city into curated graphical displays. Data pools and collects in centres that operate at scales scarcely imaginable to visionaries of Soviet cities and cybernetic economies. Electronic circuitry, wireless information waves and data registered on the silica of solid state drives agglomerates alongside human populations, concrete, asphalt, steel, glass and dust. This digital adumbration of the megacity allows us to think these telecommunication networks as a collective "megaphone", complete with its amplifying effects. In contrast to information theory, here the signal is precisely its noise, a rising sound of static that constitutes an indeterminate political force through its very emergence (Hagen 2011; Chandola 2012).

Ebullient smart city discourses almost will themselves to be written in response, and arguably, the ambivalent tenor of critical geography and STS soon follows of necessity. Reaching back to the alternative socialist and cybernetic theorisations of the city need neither be contemptuous, nostalgic, nor reductive of the specificity of the contemporary urbanist moment. These earlier periods, couched within radically reduced technological conditions, instead anticipate a computational uncertainty that only appears naïve in the face of the deluge of information, the accelerationist tendencies of machine learning, and the emergence of cognitive capitalism. The imagined Soviet city desired informational capacity commensurate with the collective needs and desires of its urban population. In Beer's acknowledgement of cybernetics as the science of the unknown, and in his premonitions of a post-computational world (Pickering 2004) lies a distinct awareness of the limits of the logic that governs digital processing. Communist and cybernetic cities are readily critiqued as examples of modernist overstepping. Equally, their imagining forecast a collective appeal therapeutic to the privatization of space, and an epistemological cautioning that the surfeit of smart city data – an entire population of public transport transactional data, for example, rather than samples with bias and margins of error – can otherwise blind us to.

The structure of double-bind might arguably here be incorrectly generalized and ontologised from its identification within the specificity of a given ICT4D project or sociotechnical assemblage. Other projects, other problems and other arrangements might find ways to reconfigure those binds if, as Martin (2016) suggests, "knots can be cut and binds unwound, albeit with difficulty". Alternatively, it might be feasible to consider this structure as, in the vernacular of software development, a "feature rather than a bug" of ICT4D and related humanitarian-technological work – not a feature in the sense of a quality for promotion, but rather as something semi-geographical, to be wrestled with in the landscape of the wider political economy. For the foreseeable future, types of platform and

cognitive capitalism appear set to predominate. Within that horizon, neither willful ascent to the smart city's commanding heights nor quietist descent into its labyrinths appear viable responses.

Dependent upon technological mediators, each case lies exposed to double binds that constrict realization of the complex utopia always implies in the qualified noun of "political economy". The case of *Kolorob,* an ambitious and progressive engagement with urban informality, is no less subject to the "impossible injunctions" that attend humanitarian contributions to and adaptations of the smart city: to be inclusive, collaborative and participatory; to be agile and "fail fast" in software development; to deliver measurable social impact; to be cost-effective and develop sustainable business models; to align informality to the stricture of formal systems and logic; and to build technology appropriate to the diverse capacities that compose the informal settlements of megacities.

Our focus here has not been to seek to resolve these contradictions. Rather we have sought to amplify how *Kolorob* fuses open platforms, social collaboration and software innovation to produce another instance of Gerlach's (2012) notion of "vernacular mapping", creating possibilities for "a cartographic ethics that encourages the generation of maps that tell open-ended and inconclusive stories, of spaces constantly on the move and coming into being, an ethics that takes care of what might come next" (p. 167). Traceable via the reverberations of mobile mediators and their wireless feedback, this open-endedness continues one of the legacies of the cybernetic city: listening to the unheard, and listening out for the unknown.

Kolorob has contributed to the "massively distributed commons-based peer production project" (O'Neil 2011) of *OpenStreetMap*, and adds to the community empowerment arguments provided by *Map Kibera* (Hagen 2011) and other slum mapping projects. Its immediate future lies with Save the Children Bangladesh and the citizens of Dhaka's informal settlements. Future possibilities for smart informal cities can be sketched. Smartphone apps could be extended with statistics and machine learning to help rural citizens evaluate job and housing prospects. Community co-designed dashboards might provide real-time information and warnings about floods and slum evictions. The possibility of building upon "mobility mash-ups" (Ching *et al.* 2012, p. 5) to improve public services and transport infrastructure. Informal technology training and mentoring could open extend awareness of technology beyond the dominant platforms of information consumption, and prepare itinerant and casual workforces for transitions in the employment market. Principles of platform cooperativism might be applied to the exploration of new models of legal land tenure. Electronic voting and feedback could be applied to issues of local development and governance. These and other possibilities open channels for an active listening to the collective and uncertain noise produced by the

"requisite complexity" (Salingaros, 2015) of informal cities, and a further amplifying of the expertise of their citizens.

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