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SMLXL: Scaling the smart city, from metropolis to individual

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ABSTRACT

The 'smart city' is an oft-cited techno-urban imaginary promoted by businesses and governments alike. It thinks big, and is chiefly imagined in terms of large-scale information communications systems that hinge on the collection of real-time and so-called 'big data'. Less talked about are the human-scale implications and user-experience of the smart city. Much of the current academic scholarship on smart cities offers synoptic and technical perspectives, leaving the users of smart systems curiously unaccounted for. While they purport to empower citizens, smart cities initiatives are rarely focused at the citizen-scale, nor do they necessarily attend to the ways initiatives can be user-led or co-designed.

Drawing on the outcomes of a university studio, this article rethinks the smart city as a series of urban scales—metropolis, community, individual, and personal—and proposes an analytical model for classifying smart city initiatives in terms of engagement. Informed by the theory of proxemics, the model proposed analyses smart city initiatives in terms of the scope of their features and audience size; the actors accountable for their deployment and maintenance; their spatial reach; and the ability of design solutions to re-shape and adapt to different urban scenarios and precincts. We argue that the significance of this model lies in its potential to facilitate modes of thinking across and between scales in ways that can gauge the levels of involvement in the design of digitally mediated urban environments, and productively re-situate citizens as central to the design of smart city initiatives.

1. Background

The 'smart city' is an oft-cited techno-urban imaginary that has been promoted by businesses and governments alike, locally and internationally. Smartening up our cities, so the rhetoric goes, promises to deliver 'sustainable', 'efficient', 'secure', 'livable', and 'equitable' outcomes. The smart city joins a long history of techno-urban imaginaries, including—from an architecture and design perspective—the modernist visions of Le Corbusier's machine city and Archigram's Plug-In City and Computor City, to the more recent and largely corporate and technically-driven visions of electronic, digital, cyber, virtual, wired, sentient, and ubiquitous cities. Yet, what sets the smart city apart from its predecessors, is the significance placed on data over infrastructure and the ways to collect it, collate it, and significantly, how to translate it into 'useful' information. In this way, the smart city is often seen as synonymous with the concept of so-called 'big data' that typically refers to massive-scale data sets that can only be processed and analysed through the use of computational tools, and that offer new ways to understand and manage city-scale operations.

In addition to its common associations with big data, the smart city is also understood as the application of 'intelligent' digital technologies and computational processes to form smart systems that operate to improve ways of living in twenty-first century cities. Kitchin (2015) has summarised the smart city narrative as following two key paths including, the application of information communication technologies (ICTs) to stimulate economic development, and, the embedding of software-enabled technologies into the urban fabric to augment urban management (p.131). Similarly, Goodspeed (2015) argues that there are two key, yet diverging perspectives, including on the one hand the knowledge economy and urban development, and on the other governments' use of technology. Above all, the smart city thinks big, and a key focus has been the implementation of large-scale ICT systems for data collection to enable real-time and predictive analytics. Given this, and not unsurprisingly, the bulk of smart city discourse is also focused at the big-picture scale; it is visionary, numbers focused, and gives emphasis to the ways big data can inform city-scale optimisation strategies, including infrastructure management such as road traffic, public transport, and waste services. Yet it is people's use of digital devices and the network connectivity they enact that now figures centrally to the amassing of big data, and also increasingly, to the very delivery of

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smart city services. Despite this, what the smart city rhetoric typically overlooks are the human-scale implications of its proposed technological systems, that is, its users and the user-experience.

The smart cities initiatives that are reported in the mainstream media and scholarly publications alike, are largely those that are government-led and enabled through corporate investment, and while they purport to empower citizens, they are rarely focused at the citizen-scale, nor do they necessarily attend to the ways smart initiatives can be 'citizen-led'. Instead, smart city thinking is grounded in big numbers, such as key demographic trends including urbanization, the growing population in cities, and the ageing population (Rose, 2015). Furthermore, while the smart city rhetoric directs significant focus back to "cities as engines of growth" (Glasmeier & Christopherson, 2015, p. 5) this often thinly veils a drive by many tech-companies to market their products as the best way to 'fix' urban problems and enable cities to compete in the twenty-first century global knowledge economy. While the 'user', 'citizen' or 'publics' are certainly not absent in smart city accounts, reference to these terms is typically made in the context of generalised notions of participation, and in ways that embody a kind of abstract and empty quality (Rose, 2015). This represents a significant oversight, Rose (2015) argues, as the "genealogy of the 'user'" is in reality far more diverse. Along similar lines, Moritz (2016) notes that while big data offers new ways to see the world, "large and easily available data-sets may not show us the world we live in".

A growing body of critical literature has responded to the smart city's relentless focus on technicity, IT infrastructure and big data (Allwinkle & Cruickshank, 2011; Foth, 2016; Greenfield, 2006, 2013; Hollands, 2008; Kitchin, 2015; Luque-Ayala & Marvin, 2015; Moritz, 2016; Rose, 2015; de Lange & de Waal, 2013). Much of this discourse is framed in terms of 'the right to the smart city', and advances alternate models of smartness that are bottom-up or citizen-led (Foth, 2016; Foth, Forlano, Satchell, & Gibbs, 2011; Greenfield, 2013; Townsend, 2013; Vanolo, 2014). Such approaches lend emphasis to the small-scale or finer grain workings of the city and to ways of utilizing technologies to shift 'control' into the hands of citizens. While these approaches are valuable, they skip directly to the other end of the scale and by-pass alternate strategies that might lie somewhere in-between, and where designers, architects and third sector organisations might become more innovatively and productively engaged (Rose, 2015). The approach outlined herein draws into focus how large-scale smart city thinking can translate to the human or citizen scale through smart design initiatives that take into account local-scale specificities.

2. Scales of thinking smart city design

Undoubtedly, big or large-scale data sets in the magnitude of terabytes and petabytes can offer unprecedented and new ways to analyse places, people, and times, and significantly, their interrelationships. That big business and private enterprise are necessary to the technical and organisational complexities of collecting, managing, and transforming big data to address city-scale conditions cannot be underestimated. Aside from collecting data, private-sector organisations are often those that 'clean' data to make it more useful, and also anonymous. Yet, as Schwartz and Hochman (2014) note, these approaches rarely examine the "particularity of specific places within the city, favoring an aggregated image of the entire city or of confined regions within the city" (p.53). In this way, the smart city's large-scale focus can mean the sociocultural aspects of specific places and times can remain unaccounted for.

With the issue of how the smart city can better account for locational specificities in mind, this article takes up a question of scale by considering an approach to designing between and across scales. The notion of scale carries numerous interpretations across disciplinary contexts, yet for our purposes, scale is understood here in terms of its analytical definition, and as that which describes a spatial and temporal range at which a given phenomenon (such as interaction), or a system,

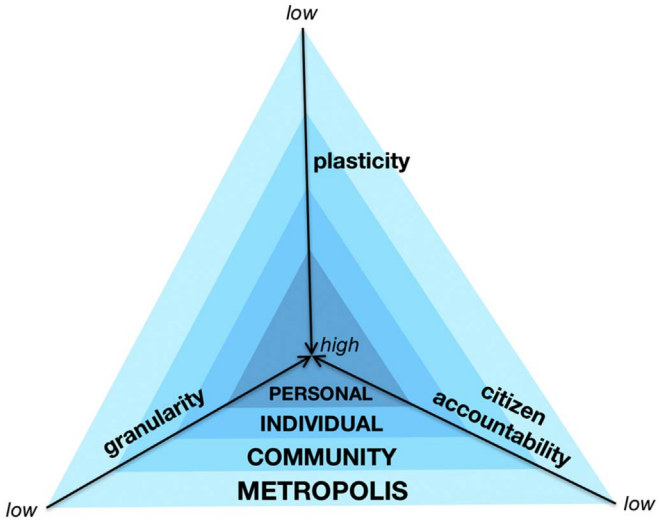

Fig. 1. Model for user-centered design of smart city initiatives.

operates and can be observed. Problematising scale provides a significant way to lever open the smart city debate, as ways of conceptualising scale fundamentally shape how social interaction and its attendant spatiality can be understood (Herod & Wright, 2002). From this perspective, and informed by the theory of proxemics (Hall, 1968), we define the levels of design analysis and intervention in terms of a series of urban scales [Fig. 1].

Translating the focus of smart city thinking from city-scale technocentric policy to local-scale interactions, events, actions, and situations, reflects broader shifts in urban theory, planning and design approaches. In the mid-twentieth century, urban theory, design, and planning focused on radical and massive–scale morphological change including zoning, infrastructure, and large-scale residential schemes with little concern directed towards the smaller-scale and the 'local'. While attention to cities as centres of economic growth has more generally gained traction since the new millennium, more recently, the possibility to track, collect, and analyse a diverse range of networked data, has meant the functional and economic value of the city could be better understood in terms of how smaller spaces and local movements sustain it (Batty, 2012). As Batty (2008) points out, cities are complex systems that mainly grow from the bottom up, that is, from the level of the individual to that of the metropolis. Some of the internal processes driving the interactions between citizens, and namely those related to the use of space, follow well-defined scaling laws that work in similar ways regardless of the city size, since they reflect nothing more than the accumulation of discrete, individual interactions. In other words, while the city is always created at a citizen level, depending on the scale of analysis, urban interactions can reflect different levels of intensity, such as more intense at the level of the individual citizen, yet smoother at the level of the metropolis.

In the subsequent sections, cross-scalar smart thinking is discussed in the context of a university design studio. Following this we propose an alternate, human-centered model of smart city thinking that designers, architects and so-called third sector organisations can operate within to address the often less attended questions of what sort of urban life the smart city can offer, and for whom? This classifies smart urban initiatives with consideration of their level of citizen-engagement, to provide ways to address the genealogy of users at community and individual levels, but also with attention to various degrees of personalisation.

3. The design studio

Putting the user-experience at the centre of the smart city is a key approach advanced in the first year design studio "Ubiquitous Cities"

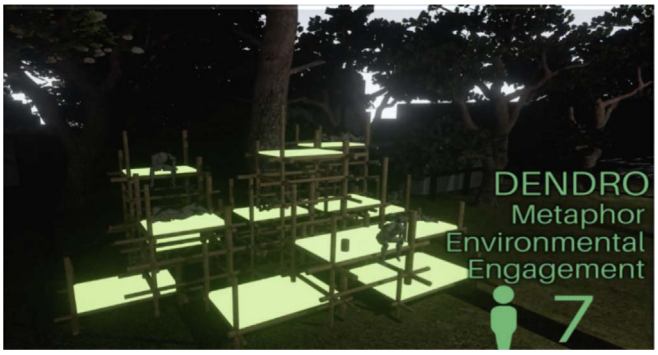

Fig. 2. *Quadendro* by Emily Leung and Simon Giang.

within the Bachelor of Computational Design at the University of New South Wales, Sydney, Australia. The following section outlines the structure and outcomes of the Ubiquitous Cities design studio and subsequently informs the analytical model proposed here.

The Ubiquitous Cities design studio forms part of the practice-orientated teaching trajectory 'contextualising' in the Bachelor of Computational Design. This course draws its name from the concept of ubiquitous computing, an idea initially developed in the computer science field, and one that has now come to represent a particular expression of computing's pervasive presence in our day-to-day lives. The course blends conceptual and methodological approaches from the research communities of architecture, urban design, human-computer interaction (HCI) and interaction design to advance a key shift in the thinking on cities, from a focus on how hard networked infrastructures shape the city, to consideration of how 'softer' infrastructures— including ICT systems and devices—might also shape the city. The various ways cities are being (re)networked, through digital systems and digital data, and how these can be productively taken account of as well as deployed in the design of the urban and built environment has been investigated and tested through a series of speculative design projects for local government areas (LGA) in Sydney, Australia.

The course is structured to shift through three key scales of design thinking. This begins with the scale of the city and involves case study research into broader planning and governance strategies linked to ICT's, and namely, digital and smart city initiatives. Comparing the smart city case studies provides a way to address the often-unattended questions of cultural specificity and the differentiated politics of 'smartness'. The second scale of thinking is focused at an urban precinct scale, and more specifically in 2015 pertained to seven public realm sites in the Willoughby LGA as identified by the Willoughby city council. This part of the course involves combining a diverse range of data from traditional empirical, observational urban analysis and mapping techniques, and statistical and demographic data, through to digital open data sources such as openstreetmap.org[1] and social media sites to build a rich picture of the allocated site. Particularly, this introduces students to the analytical value of user-generated social media data that includes date and time stamps, geospatial information, as well as sentiment. Based on this local analysis, and then drawing on 'global' smart city thinking and objectives, the objective here is to formulate a 'problem definition framework' as a set of constraints and opportunities to be addressed in the final assignment. The third scale of thinking concerns the scale of interaction, the human, citizen, or user-scale. The interaction scale relates to the final assignment for the course which builds from the contextual picture and problem definition established at the urban precinct scale to propose an urban interaction design project.

A key skills component of the Ubiquitous Cities course is the introduction to, and development of skills in, Arduino programming. To this end, students are required to develop an urban interaction design proposal for their allocated site that incorporates Arduino programming in some way. Above all, the final project is required to address the urban analysis and problem definition framework established during assignment 2, and which corresponds to the second scale of thinking as described above. Resultantly, the outcomes of the design studio are a diverse range of projects that demonstrate how Arduino programming skills can be applicable to built and urban environment design proposals. Broadly speaking, the projects from 2015 addressed issues of placemaking, including community (re)engagement, spatial optimisation, social orchestration, and safety and security. As this article cannot feature all of the outcomes a select number of examples are discussed here.

Quadendro proposed a large-scale interactive revitalisation strategy for Currey Park, Willoughby. This comprised a series of interactive installations constructed from bamboo to support park trees, and to accommodate Arduino-powered seating platforms that, depending on levels of detected engagement, would glow with green light [Fig. 2]. Significantly, the project extended beyond the boundaries of the park itself to address the main user-journey to and from the park. This proposed an illuminated path fringed by sensor-equipped light poles to improve general lighting conditions for safety and security, and demand-driven lighting to address energy conservation. The project's interactive lighting solution sought to catalyze wider community engagement and awareness of Currey Park through an element of playfulness, a characteristic of urban space that is often overlooked in big-scale smart city initiatives.

While smart cities strategies often cite 'sustainable' aims, this typically refers to large-scale emissions reductions targets linked to traffic optimisation or waste management initiatives. The *Ripples of Sustainability* project adopted a sustainable objective at a finer-grain level by proposing a series of land-marks in the form of interactive recycling bins, to promote responsible waste disposal in the grassed area adjacent to the historically significant Incinerator art and café complex, and sports grounds in Willoughby. Aptly, the focus of this project was highlighting refuse disposal through interactive recycling bins embedded with movement sensors connected to Arduino boards and clad in responsive LED lighting, as well as a connected field of responsive LED poles. The interactive strategy describes how placing recyclable items in a bin will trigger a pulse across the LED light field, producing a ripple effect as a 'visual reward' [Fig. 3]. Not only does this design approach seek to raise awareness of recycling, it also extends the useable hours of the site by enhancing safety and security.

The Visions project responded to issues identified during the urban analysis of a popular thoroughfare laneway in Chatswood that connects a shopping centre, pedestrian mall, and the Chatswood train station. The two main issues observed were a lack of public lighting at night time, causing the laneway to be perceived as dangerous, and pedestrian safety in relation to delivery vehicles and loading docks along the laneway. The concept proposed to re-skin one side of the lane with a proximity sensor enabled media façade as well as ground plane LEDs to illuminate the lane when in use by pedestrians. Equally, proximity sensors were proposed to identify incoming trucks and trigger a sound alarm to warn pedestrians [Fig. 4].

Also addressing the Post Office laneway site, the project *Shape Shifting* responded to four key issues including odour, safety, aesthetics/amenity, and vehicle-pedestrian conflicts. The project's interactive approach features a media façade comprised from a series of Arduino-powered low-resolution light panels in conjunction with planting [Fig. 5]. The project proposed infrared camera and motion sensing of pedestrian movement and the subsequent projection of 'inverse shadows' on the northern laneway elevation [Fig. 6]. Each of the Post Office lane projects addressed a key theme of smart cities discourse, traffic intelligence and optimisation. And while arguably the sensing technology proposed could feed back into larger traffic data, the key aim of these proposals sought to operate at a more immediate and sensorial level. Rather than targeting 'efficiency' outcomes, they instead

[1] http://www.openstreetmap.org/.

Fig. 3. *Ripples of Sustainability* by Michael Broderick and Montanna Green. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

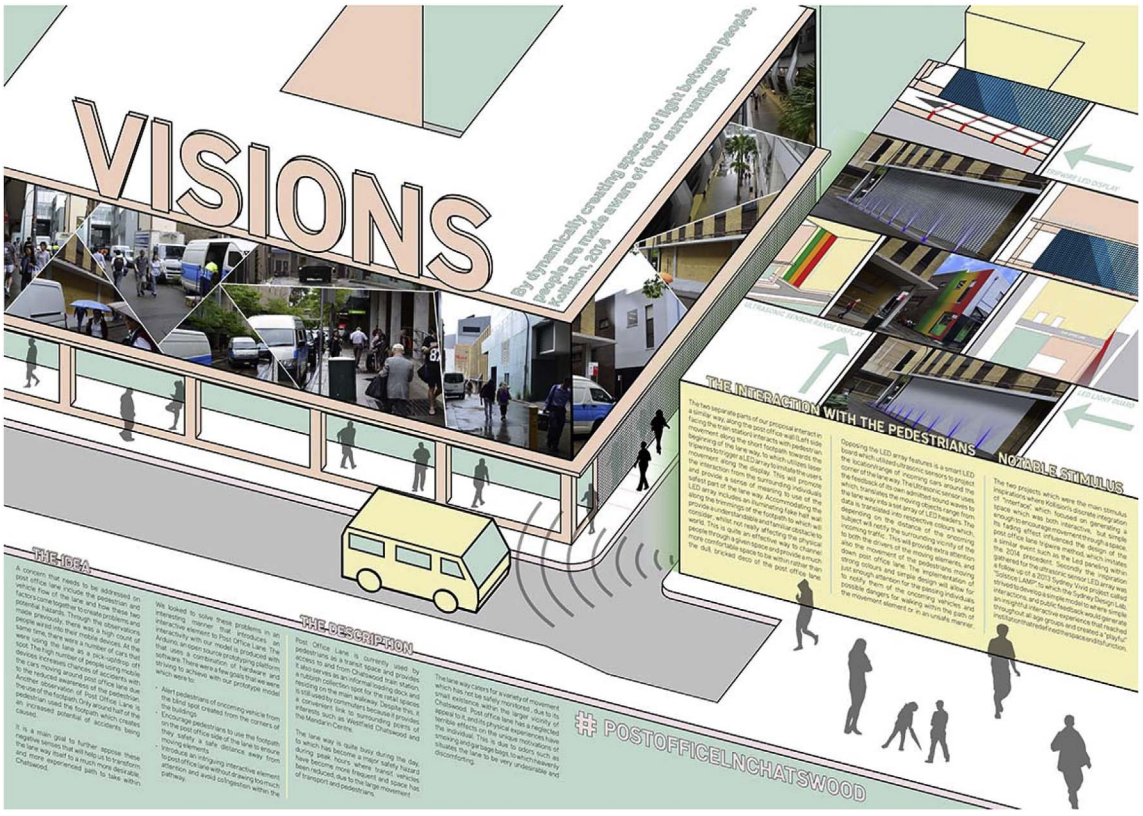

Fig. 4. *Visions* by Harris Paneras and Kingsley Castillo.

offer to improve user conditions, including safety, and moreover, the overall amenity and experience of the laneway.

Drawing from the outcomes and aims of the Ubiquitous Cities course, and detailed further in the following section, we propose an analytical model for classifying urban initiatives in terms of the depth of engagement they provide to communities and individuals. We further argue that the significance of this model lies in its potential to gauge the actual involvement of people in the design of digitally mediated initiatives in smart cities.

4. A proxemics-based model for user-centered smart city design

The Ubiquitous Cities course brings together the research communities of architecture, urban design, human-computer interaction (HCI) and interaction design. This has involved a blend of different and similar disciplinary approaches, methods, concepts, and theories. Chief among these is the theorization of ‘space’ from the perspective of experience and interaction. Broadly speaking two key ideas of space have dominated spatial theory, the idea of ‘absolute space’, where space is understood as a prefigured, pre-existing container of action, and ‘relational space’, that understands space as constituted through multiple

Fig. 5. *Shape Shifting* by Narissa Bungbrakearti & Sophie Scott.

Fig. 6. *Shape Shifting* by Narissa Bungbrakearti & Sophie Scott.

relations between objects and over time. In the built environment disciplines such as geography, architecture, landscape architecture, and urban studies, notions of space have been understandably aligned to the absolute space model, and grounded in a measurable physicality and its geometric representation. Edward T. Hall's (1968) theory of proxemics offers a space of negotiation between disciplinary approaches. For the HCI community, proxemics has been instrumental in shifting the design and research focus from the interactional interface to an interactional environment or ecology. Similarly, for architecture and urban design, proxemics becomes a lens to illuminate the ways space is performed and produced through degrees of interaction. As a study of people's perception and use of space, proxemics observes and records how people relate to the environment around them as well as others within it. Significantly, while proxemics is concerned with the measurable geometric relationships between people and built environment features such as walls and boundaries, it is chiefly concerning with interpreting these metrics in interpersonal ways and views interactions as implicit forms of communication (Hall, 1968).

Proxemics is a useful theory to reflect on the outcomes of the Ubiquitous Cities course and forms the basis for the analytical model proposed here. In particular, proxemics offers an alternate way of thinking about the city ecosystem in relation to the use of big data that addresses uniqueness at the same time as catering for various layers of society. While Hall's (1968) initial study may not have described or anticipated digitally mediated interactions, it sets out a framework that conceptualises different intensities of interaction through methods of distance-setting that can comfortably account for them. Thus, for urban interactions, proxemics now draws into relationship features such as architecture, street furniture, and people, as well as the use and deployment of technology within the built environment to determine the perception of the surrounding shared space (Hall, 1968). Recent research in the fields of HCI (Ballendat, Marquardt, & Greenberg, 2010; Marquardt & Greenberg, 2015) and urban informatics (Hespanhol & Tomitsch, 2015; Schroeter, Foth, & Satchell, 2012) has referenced proxemics in studies indicating that both the placement and content of digital media in the city can strongly influence people's level of engagement, the type of social interactions they may be conducive to, and the level of citizen agency.

In the context of designing smart cities for people, not simply systems, it makes sense to draw on research that evidences the positive role that urban digital media technology can play in catalysing public engagement in shared urban spaces. Given this, proposed here is a model for categorising urban digital-based and/or data-informed initiatives and programs, hereafter referred to as smart city initiatives, based on their spatial scale and social reach. From this, other essential design aspects can also be inferred, mainly (a) the scope of their features and size of their audiences, and (b) who is accountable for their deployment and maintenance. These two aspects are defined here respectively as *granularity* and *accountability*, and we argue that both can be perceived as dimensions of citizen engagement. In regards to the 'proxemics of the smart city', i.e. the spatial reach of urban initiatives – we propose four broad *urban scales*: (1) metropolis; (2) community; (3) individual; and (4) personal. Finally, we relate the two initial concepts of urban scales and dimensions of citizen engagement to the notion of *plasticity*, or, the ability the city has of re-shaping and adapting the design solution to different urban scenarios and precincts [Fig. 6].

4.1. Dimensions of citizen engagement

For smart city initiatives citizen engagement can be articulated through two dimensions: granularity and accountability. Granularity refers to the level of personalisation, such as the extent to which a service or program is designed to address all citizens equally, or at the other end of the scale, individual citizens through tailored or personalised interaction. For example, this understands train, buses or ferry timetables as 'coarsely-grained', as they are generally designed to be 'citizen-agnostic', that is they provide the same information to a wide cross-section of the population. Conversely, 'sharing economy' urban service providers such as Uber[2] (for car sharing) or AirBnB[3] (for short-term accommodation rentals) are considered to be 'fine-grained' services as they offer a marketplace platform that pairs suppliers and consumers in ways that allow them to choose and negotiate the terms of service with each other.

Accountability here relates to the ability and responsibility for initiating, planning, implementing, deploying and maintaining an urban initiative, service, or program. Referring to the examples aforementioned, the accountability for designing and rolling out public infrastructure is usually in the hands of the government, while each renter or tenant is responsible for initiating an AirBnB transaction, as well as resolving any dispute that may arise as a consequence. In the context of the design studio, the service provider, and consequently accountability, is assumed as the local council. Consequently, the design studio projects are considered to exhibit an intermediate granularity as they operate at a level of situated (yet impersonal) public space interaction.

[2] https://www.uber.com.

[3] https://www.airbnb.com.au/.

4.2. Urban scales

Mapping the scales of smart city design thinking as outlined in Section 3 above, we can articulate the 'proxemics of the smart city' in terms of three core urban scales: *metropolis*, *community* and *individual*. Here, for the sake of completion, we would also like to propose a fourth scale—*personal*—which while not resolutely addressed in the design studio, holds clear significance when considered within a proxemics-based model for smart city design. The metropolis scale comprises initiatives concerning the provision and management of resources shared by all citizens, encompassing city-wide initiatives and large-scale urban infrastructure such as roads, public transport, garbage collection, sewage, etc. The cross-community nature of those initiatives, coupled with their long-term impact on the urban landscape, implies coarse granularity, and accountability (planning, deployment, regulation and maintenance) on the hands of a higher sphere of power, since it is not possible for any given citizen, within the framework of representative democracy, to affect initiatives on a metropolitan level without achieving consensus through civic debate. Smart city initiatives typically operate at this metropolis level.

However, as argued here, smart city thinking, or smart city principles, can be translated to a finer-scale to address the needs of specific communities.[4] An urban initiative designed for a community addresses a subgroup of citizens, related together by any common trait (e.g. neighbourhood, workplace, cultural or religious affinity, club membership, etc.). Community initiatives address members of the community equally, without distinction or direct interaction at an individual level. An example of this is the widely popular open-source platform FixMyStreet,[5] as well as the two community engagement orientated design studio project examples discussed her such as *Quadendro* and *Ripples of Sustainability*.

Finally, the individual scale refers to how smart city initiatives can operate at an individual-citizen level without making use of personal data. *Shape Shifting* and *Visions*, for example, operate on this level. This can also be likened to self-service electronic checkouts in supermarkets that interact to provide an individual service, yet do not demand personal data, with the exception of supermarket loyalty card use that then enters the personal scale. Public transport smart card systems also operate within a personal scale, as they report back to the commuter how much credit is left in their personal account upon tapping their card.

4.3. Plasticity

Plasticity refers to the extent a smart city service can be adapted to alternate scales (e.g. from metropolis to community), precinct (e.g. across suburbs or cities, like the Open and Agile Smart Cities initiative[6]) or even purposes (e.g. using a mobile messaging app as payment instrument, as is the case with the WeChat platform in China [34]. The degree of plasticity becomes higher the more the service is designed as fine-grained, for two key reasons: (a) they speak to shared cultural values, which would resonate with similar communities (e.g. across the same country or cultural background); and (b) they are largely implemented as software running on low-cost and non-invasive hardware, and are therefore often cheaper and easily customisable to other contexts (e.g. open sourced citizen-led placemaking platforms) and regulations than other initiatives relying on heavy infrastructure or civil construction. Among the design studio project examples presented here, *Ripples of Sustainability* and *Shape Shifting* are regarded as having a higher level of plasticity than *Quadendro* and *Visions*, due to the site-specific strength of the latter.

5. Discussion

The user-centered smart city model presented here defines a structured approach to analysing and designing smart city initiatives with consideration of the granularity of citizen involvement in service provision, governance, and use. By considering granularity and plasticity, this model can better account for the nuances observed in the wide variety of public services and human experiences mediated by digital technology in 21st century urban environments, and in so doing, can more accurately reflect their purpose and role within the broader smart city ecosystem.

The focus of the smart city has typically been on services designed for the metropolis scale, often in the form of retrofitting existing city services. For example, the Climate Neutral Urban Districts (CLUE),[7] a joint project of numerous European cities that aimed at promoting innovative emerging technologies and building techniques to reduce the urban carbon footprint. Yet, of course, regardless of the physical, geographic and demographic scales of implementation, urban services are always experienced at a personal level. We have long experienced traffic lights, sewage, garbage disposal or electricity as individuals, even though they are designed to address the wider population. Increasingly, we also experience novel, digitally-based and data-driven urban services purposefully designed to speak to us on a more direct level as exampled by the LinkNYC public wi-fi kiosks in New York City. LinkNYC provides a fitting example of a 'hyperlocal' smart city experience that uses data mined from an online streaming service, and displays advertisements of music popular among local citizens (Kushner, 2016). Yet, case studies of successful bespoke smart city services, articulating a greater level of sociability and care for the individual, are still generally lacking, despite reflecting integral aspects of what primarily makes up the city; the people within (and the opportunity of joining) groups of other like-minded human beings. In other words, services designed to address the needs and values of individual and communities.

Fine-grained urban initiatives seek to empower citizens through greater civic agency, by assigning them increased access to city-level decision-making processes. In those scenarios, citizens effectively function as co-designers of urban initiatives, with the design process expressed through a much more nimble and agile approach. At the community scale, City Studio Vancouver,[8] for example, has incubated various cross-disciplinary projects bringing together teams of students, city staff and community members. As instances of hyperlocal digital urban solutions designed to address individual and personal scales, various recent experiments in the USA where local governments partnered with car sharing companies to provide a platform that enabled people to travel between their homes and rail stations, serve as useful examples (Bliss, 2016a, 2016b; Marshall, 2016). Given a high level of personal interaction and recurrence in terms of user preference (given each individual typically travelled to the station at the same time of the day), such services are prone to a higher degree of personalisation, effectively moving them to the third scale. Moreover, while they are currently dependent on existing (human) drivers, such services constitute a ripe scenario for replacement by driverless car technology, that many consider will be an inevitable eventuality. Tellingly, Tesla has recently proposed precisely such a model as part of their new 10-year business strategy plan (Musk, 2016).

Within this context, even the global government-led advocacy for open-data—despite its potential flaws as discussed earlier in this article—can also yield significant results. When subsets of big data collected through top down initiatives are combined with data, opinions, and ideas sourced from in 'bottom-up' ways (Caldwell, Guaralda, Donovan, & Rittenbruch, 2016; Fredericks, Hespanhol, & Tomitsch,

[4] The term community is admittedly quite loosely applied here, and refers to community as a collective of people within the city.

[5] http://fixmystreet.org/.

[6] http://oascities.org/.

[7] http://www.clue-project.eu/.

[8] http://citystudiovancouver.com/projects/.

2016; Fredericks, Caldwell, & Tomitsch, 2016; Koeman, Kalnikaite, & Rogers, 2015), they can offer a much richer picture of the city across its various urban scales and accountability levels. With the data gathered and then made widely available back to citizens and organisations, it can be put to use through novel design solutions that are relevant and meaningful to each different urban scale. Furthermore, as illustrated by emerging networked cities initiatives such as the Open and Agile Smart Cities[9] or the 100 Resilient Cities[10], this data and the subsequent learnings from the co-design initiatives enabled by them, can then be shared between cities to promote collegial, international and participatory design of public digital solutions across the various urban scales. More than enacting an agenda of transparency (as opposed to one of surveillance), those initiatives enable co-design initiatives to flourish by allowing citizens to gain insights on their own collective behaviour and then use those to develop new programs to facilitate human interaction within – and across – cities. This, in our view, points to a new governance model where government and citizens collaborate towards 'smarter' urban design outcomes that address community, individual, *and* personal scales. Those 'smarter', human-centered services can benefit from greater plasticity (to become potentially cheaper in the long run), while encouraging wider and continuous use by citizens through increased shared accountability that equally promotes a sense of ownership, agency and belonging.

6. Conclusion

The smart city needs to be understood in differentiated ways, and based on more than ICTs alone. Goodspeed (2015) argues for an understanding of the smart city as a "sociotechnical theory of action" (p.3). Elsewhere, scholars have argued a city's 'smartness' should be determined by the degree to which it fosters the capacities for learning and innovation. Finally, Hollands (2008) argues that if cities and local governments really want to be considered 'smart' that conventional structures of power and decision-making about the built environment needs to be disrupted, and moreover, that they need to take risks, and invest in, emerging technologies. These views implore us to understand city's relationship with ICTs more in relation to interaction, engagement, and practices, and that databases, sensors, and networks become embedded within broader organisational and social contexts in ways that can affect significant change. Yet, design ideas about how to enable and implement this shift in smart thinking and strategisation have, to date, received far less attention.

The Ubiquitous Cities design studio, that is contextualized here in relation to a proxemics-based model for the user-centered design of smart city initiatives, is argued to contribute an alternate approach to smart city thinking by addressing—through design practice—the key question of what kinds of urban experiences smart initiatives can offer? This has involved an approach to designing with, as well as through data, at various scales of design thinking, and in ways that always centralise people and their experience of place. More specifically, this relates to complementing the analysis of material-physical data (measurable or quantifiable features of place and people) with qualitative data from social media sentiment analysis. Equally, this concerns various types of real-time data that can be captured by urban interaction design projects that integrate responsive sensing and actuating technologies in ways that reveal and draw focus to the inherently dynamic nature of the built environment. And by extension, and given their sensor-driven nature, this relates to the capacity for these projects to—in the longer term—aggregate site-specific, yet a-personal data, to feed back into both large-scale smart thinking and smaller-scale examinations of the on-going use and experience of specific places.

The question of scale has significant implications for modes of design analysis and decision-making, and as indicated by Moritz (2016) and Rose (2015) on what is 'seen' and 'not seen', and thereby understood. In this way, rather than big data perhaps it is more useful to think of the smart city in terms of 'diverse data', spread across various urban scales and relating to different levels of citizen engagement. This offers a way to better account for the relationships between different scales of data collection and use, and equally the scales of experience that such data might inform. The Ubiquitous Cities design studio and the conceptual model discussed here address a necessary shift in the discourse around smart cities thinking from general city automation and infrastructure-related services performance towards the specificities of place and people. Informed by the design thinking observed in Ubiquitous Cities design studio, this article proposes a conceptual model that takes account of people's engagement in the design of digitally mediated initiatives in smart cities. This argues, that regardless of scale, digitally-based and data-driven urban initiatives can be designed to engage with people more directly. While they may be small-scale from a data perspective, they are still 'smart' initiatives that articulate a greater level of sociability, as well as attention to the individual.

[9] http://www.oascities.org.

[10] http://www.100resilientcities.org/.

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