Whose "City of Tomorrow" Is It? On Urban Computing, Utopianism, and Ethics

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ABSTRACT

In this article I discuss some ethical and moral ramifications of the future envisioned by urban computing. In doing so, I make analogies to twentieth century utopian visions of the "city of tomorrow," so that we might see the historical context of a similar field with similar utopian instincts. I hope this context helps us better understand how our work might affect the lives of city dwellers in profound ways that we may never fully foresee. I discuss ethical questions related to using urban computing for policy making, for real-estate development, and for surveillance. I also define the concept of distributed sensing, and discuss some difficult regulatory questions that surround it. I hope this work inspires urban computing researchers to think critically in order to assess societal implications of the technologies they develop.

Categories and Subject Descriptors

K.4.1 [**Computing Milieux**]: Computers and Society—*Public Policy Issues, Ethics*

General Terms

Human Factors

Keywords

Urban Computing, Smart Cities, Ethics, Utopias, Urban Design, Architecture

1. INTRODUCTION

Lewis Mumford once said "the city multiplies man's power to think, to remember, to educate, to communicate," referring to the nexus of resources, support, people, and ideas that the city imparts on its inhabitants. "This mixture," he continued, "this cosmopolitanism, is the chief source of the city's vitality. And we must enlarge it and enrich it as we move towards a new urban form [17]." He was speaking in reaction to the golden age of experimentation in urban design that flourished during the first half of the twentieth century,

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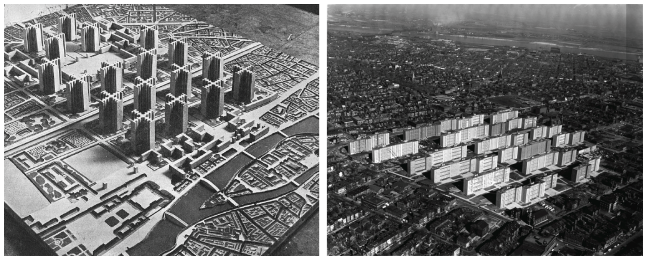

Figure 1: (Left) A photograph of a model of Le Corbursier's theoretical concept city, *Ville Radieuse*, or the Radiant City. (Right) An arial photograph of the Pruitt-Igoe housing projects in St. Louis, Missouri. Image sources: [1, 2]

when thinkers such as Ebenezer Howard [9], Le Corbusier [13], Frank Lloyd Wright [29], and others dreamt up radically different *utopian* visions of the ideal urban form (see Figure 2 for examples). More than just reflections of aesthetic ideals, each of these designs of the "city of tomorrow" enforced a set of rules on the denizens, subliminally governing their actions and behaviors through the shapes the designer sculpted out of the urban landscape. They were what Mumford called *utopias of reconstruction*, fantasies of a better world seeking not just to mentally escape the current one, but to transform it—physically, socially, and culturally [15]. Indeed, the ordered, structured, planned utopianism inherent in these visions captured the imaginations of city planners, architects, designers, and builders, and soon ideas that began in the abstract would radically shape urban landscapes across the United States and the world.

Yet, like all utopias, these twentieth century "cities of tomorrow" were naturally imbued with the biases, values, and priorities of their creators, and not necessarily those of the people who would ultimately inhabit them. It is perhaps because of this, that their physical realizations far too often had dire consequences on the social fabric of city life [21, 22]. For example, with his Ville Radieuse (Radiant City) utopian concept, Le Corbusier imagined an ordered urban landscape that maximized access to the pleasantries of life. He despised cities with meandering, curved roads, calling them the "the pack donkey's way." "Man's way," he believed, was the way of the straight line "because he has a goal and knows where he is going [14]." He designed high residential towers, cruciform in shape to maximize access to light and

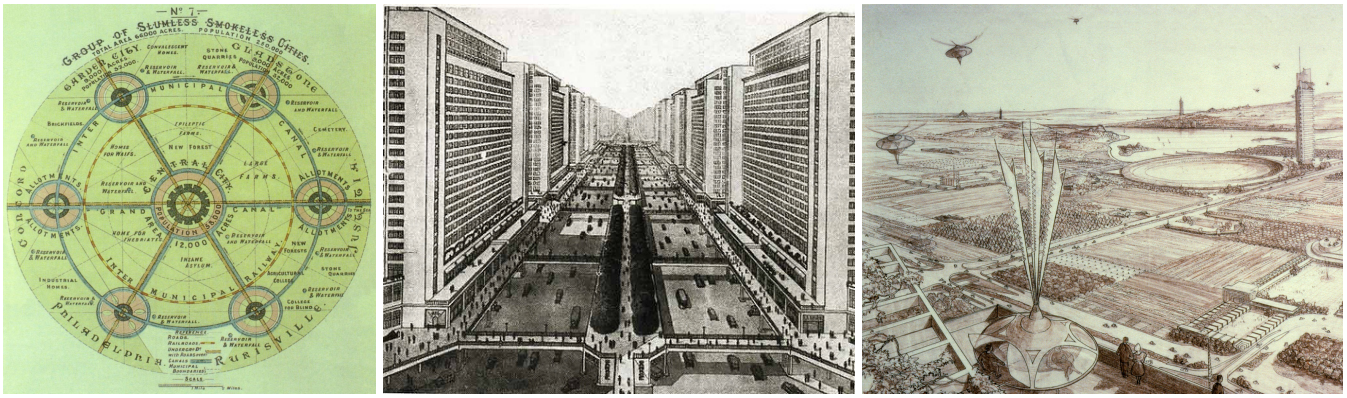

Figure 2: Three twentieth century utopian visions of the urban form. (Left) Ebenezer Howard's Garden City envisioned fully planned cities organized into self-contained units of a fixed population, which were set apart from one another by park and agrecultural land, and connected by a radial network of raills and roads. (Middle) Le Corbursier imagined the Radiant City, a metropolois with large towers set in the midst of park lands and spread out from one another to maximize light and air-flow. Connecting the towers were pedestrain walk-ways through the parks, which were raised above designated roads for automobiles. (Right) Frank Lloyd Wright's Broadacre City was a dramaitc vision of a decentralized city spread out across a vast landscape of pastures and parks and agricultural land. Residents would commute across this great span using a high speed arial transportation system. Image sources: [3, 4, 5]

fresh air, and he set them along the straight lines of a grid, spread out from one another to minimize overcrowding and maximize communal access to the lush park space he put between the towers. This concept of "towers in the park" was widely influential, and was a common architectural form chosen for lower and middle-income housing projects in the United States in the 1950s. Many such developments resulted in infamous failures, such as the Pruitt-Igoe projects in St Louis (see Figure 1) or the Cabrini-Green projects in Chicago [27]. In practice the vast open spaces that typically separated residential towers were devoid of any shops, attractions, or destinations, and so were devoid of people too. As Jane Jacobs put it, they were "promenades that go from no place to nowhere and have no promenaders [10]." What began as Le Corbusier's grand vision of a city that maximizes access to light, fresh air, park space, and convenient transportation, in practice created neighborhoods of heightened isolation and anonymity, conditions that bred high crime, concentrated poverty, and stifled economic mobility. Although it is perhaps unfair that most of history's blame falls on Le Corbusier, when the reality behind these failures was much more complex, this example nevertheless reminds us to ask the question, whose "city of tomorrow" was it? Was it a city designed by Le Corbusier for Le Corbusier? Or was it one designed for the people?

There are parallels to be sought between these utopian experimentations in urban design, and current trends in urban computing. At its heart, urban computing has a utopian instinct: we dream of utopias of reconstruction, visions of tomorrow's cities with their forms, and their cultures, and their processes rebuilt by recent revolutions in social computing, ubiquitous computing, and machine learning. This rebuilding process has already begun; like virtual versions of the sidewalks in Jane Jacobs's city, new mobile and social technologies connect us to one another and to the places, resources, and ideas around us in previously impossible ways.

As these technologies begin to alter nearly every aspect of city life, it has become clear that we are not only witnessing the dawn of a new area of computing, but also the birth of a new urban form—one imagined not just by architects and planners, but also by computer scientists, statisticians, and engineers. This is the age of urban computing.

In this short essay, I examine recent trends in urban computing research, paying particular attention to the broader, sometimes utopian visions espoused by the field as a whole. Throughout, I attempt to bring to the surface some of the ethical ramifications of the future that urban computing portends. In doing so, my central goal is to make explicit the civic responsibility we have as urban computing researchers to understand how our visions alter the landscape of the city, and so too alter the social realities of the city's people. Although the utopian instinct of our field can propel us by way of individual creativity to a better collective future, it also endows the creator with immense power over our society. If urban computing dreams of this generation's CITY OF TOMORROW, in this work I ask *whose city of tomorrow is it*?

2. USING DATA TO OPTIMIZE THE CITY

Far too often decisions are made by the various actors and stakeholders of a city that affect the lives and livelihoods of its inhabitants in negative ways. From zoning decisions that fragment or isolate neighborhoods, to the large scale renewal projects that fail to attract visitors, errors in judgement in city planning can often be prevented if only those empowered to make these decisions had better data.

One promising research focus in urban computing is beginning to take shape to address this challenge. With the mass-proliferation of smart-phones and the increased availability of low cost sensors, rich sources of large scale data revealing how people and traffic flow through the city are becoming increasingly easy to obtain. These data can be used

to help planners and developers make more informed decisions about the city. From solving congestion problems, to optimizing public transportation timetables, taking a data-driven approach to planning could save municipal governments and local organizations money, and could prevent the hardship on denizens that often ensues from uninformed planning.

The potential impact of data driven planning can already be seen in recent research. There is a large body of work on using sensor data to estimate traffic flows in the city in hopes of optimizing navigation, and identifying problem areas. Thiagarajan et al. give an energy efficient method for determining commute times in cities based on cell phone data [25]. Zheng et al. instrumented 30,000 taxi cabs in Beijing with GPS sensors to collect detailed location trajectories depicting the pulse of activity within the city [32]. With this data, they developed a model of traffic in the city and a rule-based algorithm to identify areas of high congestion, potentially indicating flaws in the city's layout. Cranshaw et al. use Foursquare check-ins to redefine the notion of a neighborhood by clustering city venues into contiguous areas to reflect the collective activities of like-minded people [6]. Still other works works have sought data-driven approaches to characterize the semantic qualities of a place, for example by discerning its functional category using social media [7, 18, 31].

2.1 Risks of Mechanical Decision Making

Yet, we must be cautious as we begin to develop automated tools for optimizing cities. Using machine learning to mechanically decide where to build a bridge or a highway that minimizes congestion potentially ignores the complex social realities on the ground, and any disruptions to the social fabric of the city that such a construction could cause. Even if the project dramatically improves congestion, are the costs worth the benefits if the project destroys neighborhoods?

This tension echoes a battle fought in New York in the 1960s between developers, led by Robert Moses, who wanted to build an expressway through Greenwich Village, and community organizations, led by Jane Jacobs, who argued that the expressway would tear apart the neighborhood. In the end, after a famously dramatic debate, Jacobs was the victor, and Greenwich Village remains the vibrant neighborhood it was when she called it home.

Recently, urban computing has identified potential tools that could be used to measure the sort of disruption that Jacobs spoke about. For example, the Livehoods maps of the social "neighborhoods" of cities provides visual evidence of the disruptive effects of urban freeways on city neighborhoods [6]. In Figure 3 the Bronx-Queens Expressway serves as a hard boundary between Livehoods, reflecting the effect the highway has on restricting moments and social mixing on either side of the highway. Yet, even this project raises several important questions about data provenance (see later sections) that must be resolved before it can be applied to sensitive urban policy decisions.

Building data-driven tools to help officials make better decisions could revolutionize city planning, but such tools cannot be viewed as a replacement for traditional methodologies,

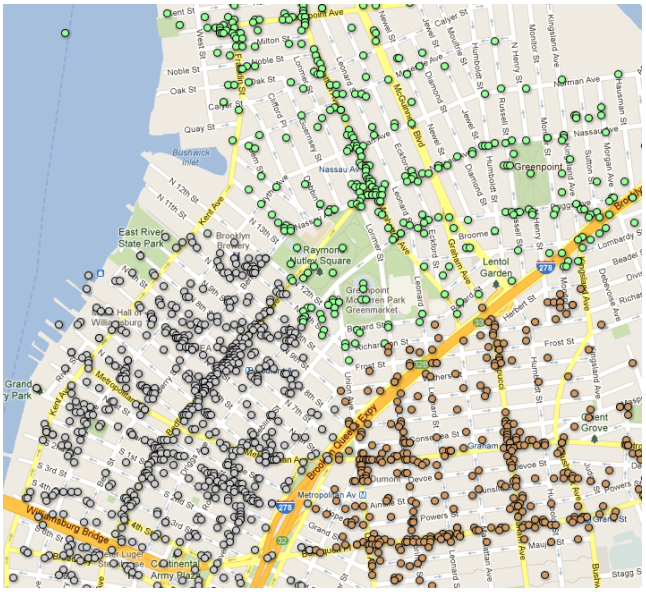

Figure 3: An image of the social disruption caused by the Bronx-Queens Expressway as seen by the Livehoods Project. Image source: http://livehoods.org/.

such as neighborhood surveys, and town hall meetings. Ultimately, good urban design is a collaborative and iterative process between the city and the citizens.

2.2 Whose data is it? Who is left out?

The use of urban computing tools to aid in city policy making also raises important questions about biases in the data. Urban policy decisions affect all residents of the city, regardless of socio-economic status, or of access to technology. Planners and policy makers therefore have a civic duty to reach out and gather insight from all potential affected communities of proposed projects, often at great cost and effort. If urban computing tools continue to rely on data collected from highly tech-savvy users (e.g. smart-phone users, or social media users), their ability to effectively aid in the creation of urban policy will remain questionable. If we want our research to be applicable to good urban policy, more attention must be paid to addressing and understanding the biases in our data. We must understand which socio-economic groups are being over represented in our data, and which are being left out entirely.

2.3 Urban Computing for Gentrification?

There is a great deal of interest in using urban computing tools to aid in the real-estate development life-cycle. From identifying which sites to build on, to helping business choose expansion locations, to managing large portfolios of investment properties, the real-estate business is an extremely sophisticated enterprise that succeeds or fails at many ventures based on how accurately it can predict changes in property values. Urban computing could be used to create machine learning models that forecast property value changes based on trends in how the populace moves throughout the city. Such models could potentially be extremely valuable to real estate developers, allowing them to

more confidently assess the (real or potential) value of a site, and take swift actions accordingly based on the data.

And yet, again there are complex moral and ethical questions that surround the design of such systems. Are they improving the city by allowing for smarter development, or are they simply further empowering the forces of gentrification and displacement? How do we build urban computing tools to help with community development in low-income neighborhoods, when existing urban sensor and social data are often biased towards higher income, more tech-savvy individuals? Will urban computing lead to a physical embedding of the digital divide?

3. DISTRIBUTED SENSING

Sensing the actions and activities of an urban populace is often a critical component of urban computing applications. Today, this typically involves putting sensors directly on the tracked entities which communicate the sensed data directly to a central location (e.g. the application server). Examples of this sort of sensing architecture, which I call **centralized sensing**, range from applications that track taxi-cabs, to applications that sense environmental data (for example noise pollution) using smart phones, to social applications such as Foursquare that sense people's location. In these cases the user is in complete control of a device that he uses to actively share his data with a central server. If he doesn't want to be sensed anymore, he can always turn the application off.

As sensors begin to permeate the urban landscape, we will see a rise in **distributed sensing**, where the target entity is being sensed by several distributed sensors in the environment, and is not necessarily in full control of the sensing. For example, imagine hundreds of thousands of inexpensive sensors embedded throughout the built environment of the city—in the buildings, the busses, the subways, even the public spaces. As people move through this field, the distributed sensors could coordinate to monitor a person's activities throughout the city.

Although it may sound far off, we are already starting to see this sort of sensing emerge in urban environments. One perhaps innocuous example is the Mood Meter from MIT, which uses computer vision algorithms to anonymously sense the facial expressions of people in a crowd [8]. There are also a number of start-ups actively working on re-inventing the check-in concept by making it more passive, for example by performing a check-in without the user having to take any action on her device [26]. Thinking beyond our current smart-phones, one can imagine future personal devices that are designed to passively communicate with the various embedded sensors in the physical environment, for example through NFC chips, or perhaps even distributed bio-metric sensors that track us by the unique biological signals we emit.

3.1 Wearable Computing

Wearable computing devices, such as Google Glass, could enable a peer-to-peer realization of distributed sensing. One unsettling vision of wearable computing pairs the on-device cameras with face recognition or other bio-metric sensors, for example computer vision algorithms that can sense vital signs [30]. In this setting, any user of Google Glass could act as a distributed sensor node able to detect the identity, location, vital statistics, social connections, and more of any other person he encounters in public (whether or not that person has Glass herself). In effect, the crowd-becomes a sensor of itself. The risk for abuse in such a system is huge. Furthermore, incorporating this technology into our daily urban lives would would fundamentally, and irrevocably alter our definition of public space, and our urban social norms of privacy, anonymity, and identity. It is impossible to forecast what drastic new forms our society will evolve into in order to assimilate such powerful technologies, and yet they seem just around the corner.

3.2 Can I Opt Out?

One critical question surrounding distributed sensing is how does a person opt out? If an individual does not want to be sensed by the distributed sensors throughout the city, does she have that choice? If she does not control any of the devices sensing her, opting out seems hopeless. Navigating these complex moral and ethical questions will require a mix of legislation, privacy enhancing technologies, and industry self-regulation. Crafting effective regulations that balance the rights an individual not to be sensed, and yet do not stymie innovation will be a complex and lengthy process.

3.3 Privacy in Cities

Does a person find more more privacy in small towns or big cities? This is a complex question, to which there are no doubt several distinct and nuanced answers. On the one hand, people live so close to one another in great cities, that it might seem to an outsider that city residents have no privacy. On the other hand, in the city, everywhere we go, we are accompanied by a sea of strangers. In order for the individual to survive in such a chaotic environment, complex social norms of privacy and anonymity have developed. As Jane Jacobs describes:

> Privacy is precious in cities. It is indispensable. Perhaps it is precious and indispensable everywhere, but most places you cannot get it. In small settlements everyone knows your affairs. In the city, everyone does not—only those you choose to tell will know much about you. [10].

As the devices we carry, the services we use, and even the environments we inhabit continue to learn more about us through the data that we leave behind, how might urban computing threaten these complex norms of privacy in cities? What happens when the sea of people that surround us everywhere we go are no longer strangers, or conversely when we are no longer a stranger to them? Will the city even be habitable anymore?

4. THE CITIZEN AND THE STATE

Even in the most harmonious of political systems, the relationship between the individual and the state[1] is one fraught with tension, as the state seeks to balance individual liberties with the collective needs of the populace. While the

[1]Here by "state," I mean any civic organization with authority over the individial. The state could be a muniicpal law enforcement agency, or it could be a national government.

promise of urban computing could revolutionize a number of civic institutions, potentially making the city a drastically safer, cleaner, and more efficient place, there are also great threats to the freedoms of the individual that are inherent in state-operated urban computing technologies.

4.1 Smart CCTV Surveillance

Consider for example, state-operated closed-circuit television (CCTV) surveillance programs, such as the city-wide system implemented by London, to great controversy. While studies have found evidence that CCTVs do result in small decreases in crime [28], and they are often quite useful in solving and prosecuting crimes once they occur, some question whether the presence of the cameras is an unnecessary invasion of the state into the personal liberties of the individual.

This debate is made even more complex if one envisions how urban computing might modernize this civic technology. One can easily imagine applying computer vision and machine learning to CCTV networks for tasks such as object recognition and tracking. Such technologies would enable the system to track an individual's path through the entire city as she moves from the range of one camera to the next. Systems like this could be built with relatively little effort with today's technologies, and may even be currently in use by states to track their populace. Pairing the system with facial recognition technology and a government photo ID database of the citizenry, and the state would be able to reconstruct the identities of the public as they move through the city. Other states have proposed using cameras on traffic signals to extract the license places of cars as they pass through intersections, regardless of whether the owners have committed a crime or a traffic violation. Such as system could be used by law enforcement to easily track suspects or fugitives in real time wherever they drive throughout the city.

Where is the line between oppression and benevolence in the use of state-operated urban computing for controlling the populace? If the above scenarios are ones proposed by democratic states, what kinds of ways might more dictatorial or militaristic regimes employ urban computing technologies on their people? How might state operated drones (remote piloted aircrafts) be used in sensing, tracking, and engaging with the populace?

Such scenarios, which were once the subject of dystopian science fiction, are either possible or nearly possible with today's technology. While the state may have nothing but benevolent uses for urban computing, it nevertheless enables a vast erosion of individual freedoms, and creates innumerable opportunities for abuse. The societal and cultural consequence of such a rapid shift in power to the state over the individual have yet to be fully explored.

4.2 Crowd-sourced Surveillance

The advent of social media has also enabled a decentralized and crowd-based approach to surveillance and law enforcement. Although this approach gives less power to the state over the individual than direct surveillance, the ethical ramifications are no less complex. In the wake of the 2013 Boston Marathon bombing, users of the website Reddit self organized an effort to find the identity of the suspects, with users combing through the thousands of social media images and video taken by marathon spectators. Their efforts resulted in the false public accusations of several individuals [11]. How do we build systems to involve the crowd in law enforcement, yet stop them from enacting vigilante justice? How to we protect lives and reputations of the innocent when the crowd goes wrong?

5. CONCLUDING THOUGHTS

Urban computing is an emerging field with immense promise. With global urbanization trends projected to continue, and with ubiquitous and sensing technology beginning to saturate city life, technologies designed for cities have great potential to improve the lives and well beings of a significant fraction of the world's population. And yet, as with any new technology, there are also associated risks and deep ethical questions raised by urban computing. In this work I highlight some of these risks. Although the questions I raise here are by no means exhaustive, I believe that they are deep and fundamental questions at the heart of some core urban computing research being done today.

As it matures as a field, urban computing will need to develop an ethical framework for self-regulation. There is no easy solution for this; it will take concerted effort as a community. We need to consider the broader impacts of the contributions our field makes at all levels, from the research we conduct, to the systems we build, and the classes we teach.

Urban computing began as a discipline of human-computer interaction, examining the relationship between new technologies, and urban societal processes [12, 20, 19]. As we have entered an era where massive sources of urban data are becoming commonplace, attention in the field has shifted to focus on opportunities in data mining and machine learning. As we embrace this shift, we need to resist any and all temptations to abstract away the *human* elements of the field. The data-mining side of the community needs to reengage with the HCI side of the community, and vice versa, so that as we move towards this new urban form, we might better understand, and better evaluate the technologies we create.

By drawing parallels to works of utopian experimentations in urban design, I hope to convey the responsibilities that we as urban computing researchers must take in understanding the social and societal implications of the technology we build. Just like works of architecture and urban design, the urban technologies we build today will have big and *permanent* impacts on the cities we live in tomorrow. While some might take issue with this claim, arguing that the transient nature of digital creations cannot have such permanent impacts as the physical built environment, I hope this essay serves as a strong advocate for the counter point. By changing our habits, our culture, our relationships, our social norms, our infrastructure, and our very identities, urban computing is building *permanent digital edifices* that will touch nearly every aspect of our urban lives in the future.

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