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Home > Volume 18, Number 11 - 4 November 2013 > **Forlano**

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Making waves: Urban technology and the co-production of place
by Laura Forlano

Abstract

Over the past several years, as cities in the United States have faced increasing fiscal pressures, there has been a reinvigorated interest in the promise of smart cities, intelligent cities, digital cities, open source cities and media cities, which advocate the use of digital technologies to make cities more efficient, productive, innovative and attractive. However, the appropriation and use of urban technologies have transformed the aesthetic, symbolic and lived experience of cities in important ways, which have not been well described or theorized. Based on theories from communications, science and technology studies as well as more specialized fields such as urban informatics, this article attempts to understand the ways in which urban technologies are appropriated and used to co–produce place relying on empirical examples from art and design, social science, and information and computer science. Finally, it illustrates the ways in which place is constituted at the intersection of socio–technical practices as dynamic, relational and interdependent.

Contents

Introduction
1. Background
2. Methodology
3. Discussion
Conclusion

Introduction

Over the past several years, as cities in the United States have faced increasing fiscal pressures, there has been a reinvigorated interest in the promise of smart cities, intelligent cities, digital cities, open source cities and media cities, which advocate the use of digital technologies to make cities more efficient, productive, innovative and attractive. Both city leaders and civic technologists have promoted a series of policies and technology platforms in order to solve a myriad of city problems. In the name of citizen

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engagement through crowdsourcing platforms and hackathons, cities themselves have become the focus of a unique set of digital technologies from urban screens to networked traffic signals and location–based social media applications that have become known as urban technologies. These activities and emerging technologies get at the heart of important theoretical debates related to the issue of "Media and the City," which is the topic of this special issue.

The appropriation and use of urban technologies have transformed the aesthetic, symbolic and lived experience of cities in important ways, which have not been well described or theorized. Based on theories from communications, science and technology studies as well as more specialized fields such as urban informatics, this article attempts to understand the ways in which urban technologies are appropriated and used to co–produce place. Finally, it illustrates the ways in which place is constituted at the intersection of socio–technical practices as dynamic, relational and interdependent.

To a great extent, our understanding of cities in the twentieth century was primarily shaped by architectural notions of space in urban environments that focused on the built environment and technological infrastructures while excluding the socio–cultural practices of their inhabitants. These notions were perpetuated by the discrete separation of reified dichotomies that divided the physical from the digital, which continue to persist in much academic scholarship related to technology and cities. Currently, physical objects are embedded with digital information and interfaces and connected to the Internet in what is known as the 'internet of things' and physical spaces in cities are layered with digital networks and infrastructures. While the metaphor of 'the layer' (which is the basis for Internet protocol stacks such as TCP/IP and architectural software such as CAD) is common in discussions of urban technology, it further underscores the notion of discrete categories rather than more organic, intertwined systems. In addition, the availability of digital networks and infrastructures is unevenly distributed on an urban, regional and global level. In fact, in many cases, the lack of connectivity is what defines a particular building floor, street corner, zone or neighborhood.

Over the last several years, there has been a shift in thinking about the virtual, distributed and online qualities of digital technologies and towards their material qualities. The digital and material are no longer considered to be separate and discrete entities but rather, they have been integrated into hybrid forms such as the digitally material. However, it is not enough to state that we are now living in a world of hybrids. There is a need for emergent notions of place that specify the ways in which people, place and technology are interdependent, relational and mutually constituted. It is necessary to create a new lexicon for discussions of media and the city in order to develop a nuanced understanding of how these theoretical concepts play out in everyday work and life in cities.

With respect to urban technologies, it is common to emphasize a set of mythologies that have entered mainstream media, public policy and academic scholarship alike. Specifically, urban technologies are often described as invisible, congruent, seamless and "anytime, anywhere." Such technologically deterministic notions deny the lived experience of people as they are increasingly aware of the ways in which digital technologies are actually: 1) visible or visualizable; 2) incongruous with architectural boundaries; 3) imbued with tensions, disjunctures, seams and frictions; and, 4) contextualized within daily routines, relationships and practices. These digital realities of urban technology suggest a set of emergent research questions, which will be discussed in relation to the empirical examples that follow. In what ways can the digital materiality of urban technology be made visible through art and design, lived experience and/or emerging technology platforms? What evidence is there that urban technologies do not map onto architectural boundaries? How do emergent hybrid spaces of connectivity and connection in urban areas shape our experiences? How is place being coproduced by digital and material artifacts, interfaces and networks as they are appropriated and used in cities?

In order to answer these questions, this paper presents empirical examples from art and design (coproduction through visualization), social science (coproduction through lived experience), and information and computer science (coproduction through imagination). First, I will discuss several art and design projects. Second, I will discuss the social practices of mobile

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workers. Finally, I will discuss an augmented reality campus tour application that I had the opportunity to experience and test with users.

1. Background

Architectural notions of space have largely been devoid of human activity — building and public space plans include details that make them seem usable but without a careful consideration of people (Whyte, 2000), architectural photos focus on empty structures (Abrahamson, 2008), or use 'scalies' (small images of people, often with blurred out features) to attempt to animate the space. Other examples of these discrete understandings of space include Castells' (1996) notions of has emphasized the difference between the 'space of flows' and the 'space of place', which fails to account for the possibility that a 'space of flows' can simultaneously be a 'space of place.' In addition, the notion of third spaces (Oldenburg, 1989), which originally referred to space distinct from home or work, is complicated by the fact that cafés that were considered to be the ideal third space, are currently heavily used for work purposes as private live and working life has become increasingly blurred. In order to develop an operational theory defines place as distinct from space it is helpful to draw on literature from communications (Carey, 1988; Innis, 1951), design (Bleecker, 2009; Gibson, 1977; Norman, 1990; Sanders, 2008) and science and technology studies (Bijker, *et al.*, 1987; Latour, 2005; Nissenbaum, 2001; Star, 1999). As a result, it is possible to understand the ways in which social practices and technological actors work together to refute simplistic understandings of space and, rather, mutually constitute meaningful interactions that happen in place.

Specifically, Carey's 'ritual view of communication' is employed as a key theoretical framework. Carey argues that most American studies of communication employ a 'transmission or transportation view of communication' and the 'effects' tradition that views communication "basically as a process of transmitting messages at a distance for the purpose of control," [1]. In the last decade, since the mainstream adoption of the Internet, there has been an overwhelming emphasis on the ways in which communications transcends geographic constraints. Carey writes that such studies focus on "persuasion; attitude change; behavior modification; socialization through the transmission of information, influence or conditioning," [2]. In contrast to the 'transmission view', Carey advances a 'ritual view', which builds on earlier studies of communication by Harold Innis as well as concepts of culture advanced by Clifford Geertz, Raymond Williams and Stuart Hall. Innis (1951) theorized that all media could be identified as either *time–biased* or *space–biased*. Time–biased media such as oral tradition assert their control over the maintenance and preservation of ideas in time while space–biased media such as paper expand the reach of ideas in space for the purposes of control.

From the perspective of actor network theory within science and technology studies, it is important to consider urban screens, networked objects and mobile applications as a new set of digital actors that have agency in a network of human and non–human actors. These digital actors, together with their appropriation and use by people, allow for the creation of meaningful experiences in cities — thereby turning abstract, objective spaces into significant places of interaction. This relational view (Star, 1999) is powerful in that it is interdependent and dynamic rather than separated into discrete layers of activity as is purported by much research on urban technology.

More specifically, the emerging field of urban informatics defines the intersection of place, people and technology (not only one or two of these factors) as critical for developing a sound understanding of the role of media in cities (Foth, *et al.*, 2011a; Foth, 2008). Referring primarily to virtual and online collaboration spaces, Harrison and Dourish (1996) have differentiated between spatial features (access, proximity, movement) and place–related features (discussion, intimacy, ownership) arguing that:

> it is a sense of *place*, rather than the structure of space, which frames our behaviour. Our sense of place is a cultural or communally–held understanding of the

appropriateness of styles of behaviour and interaction, which may be organised around spatial features but is, nonetheless, quite separate from them.

They also define hybrid spaces, which are comprised of both physical and virtual space. More recently, many scholars have introduced hybrid concepts that integrate the digital with the material world to describe emergent forms of organizing (Humphreys, 2007), new modes of citizen engagement (Foth, 2008; Foth, *et al.*, 2011b) and novel ways of experiencing and navigating cities (Ito, 2005). Specifically, terms such as net locality (Gordon and Silva, 2011), code/space (Kitchin and Dodge, 2011), situated technologies (Shepard, 2011), media spaces (Couldry and McCarthy, 2004), Hertzian space (Dunne, 2005), neogeography (Turner, 2006), radical network empiricism (Mackenzie, 2011) and codescapes (Forlano, 2009a) have been introduced in order to better articulate the ways in which the socio–technical practices around digital interfaces, networked objects and artifacts, locative and social media, and networks enable an emergent understanding of place.

Based on these theories, place is understood to be a sociotechnical practice that embedded space with interaction, meaning and lived experience. It is this understanding of place that has been used to frame research in urban informatics more recently (Foth, *et al.*, 2011a). Unlike Western notions of space that are based on Cartesian dichotomies, this more nuanced understanding of the socio–technical construction of place is compatible with Japanese and other non–Western concepts that emphasize the importance of human habitation in order to create meaning and significance (Abrahamson, 2008; Escobar, 2012).

However, hybrid notions do not go far enough in advancing theories around urban technology and the role of place. Dourish and Mazmanian (2013) offer five frameworks around the materiality of digital media and information technology, which cover information goods, information infrastructures, information production, information metaphors and information representations. In particular, this paper is concerned with what Dourish and Mazmanian refer to as "the transformative materiality of digital networks," which cover the ways in which digital media and information infrastructures are embedded in objects, processes and places. In order to fully understand the ways in which place is mutually constituted through socio–technical practices, it is necessary to understand urban technologies as visible and visualizable (Star, 1999), seamful (Chalmers, *et al.*, 2003), sites of friction and contention (Kang and Cuff, 2005; Leshed, *et al.*, 2008), and contextualized in everyday experience (Dourish and Bell, 2011; Forlano, 2009a). Thus, from this view, urban environments are not composed of smooth layers of social, digital and spatial information but, rather, in stark contrast to this view, they are composed of interdependent interactions and relations between people, technologies and places.

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2. Methodology

This paper presents empirical examples from a variety of projects from art and design, social science, and information and computer science. First, I will offer a few examples form art and design, which illustrate the coproduction of urban place through visualization. Art and design projects are particularly important because they often serve to question and critique emerging technologies for which there is little available empirical evidence due to the lack of adoption or recent adoption of a particular digital platform, application or device.

Second, I will draw on my previous social science research on mobile work practices, which illustrates coproduction of urban place through lived experience. This research employed qualitative interviews with 29 Wi–Fi users in cafés, parks and public spaces in New York City between October 2006 and April 2007. The interviews were one–hour, open–ended interviews, which were conducted at the locations in which the informant reported that they used the wireless Internet most frequently whenever possible. All interviews were documented with notes and recorded digitally. On several occasions, interviews were conducted by phone and recorded via Skype since the informants had moved to new cities since they took the

survey. The interviews were transcribed. Of the 29 interviews with users of Wi–Fi hotspots, the following breakdown emerged for the three types of research sites: cafés (19), parks and public spaces (8), and airport lounges (1). In addition, one interview was conducted with a neighbor who is using my Wi–Fi hotspot. It is important to note that individuals often had used Wi–Fi hotspots in a number of different locations including cafés, parks and airport lounges so the interviews often reflect their experiences at a number of sites. Among those interviewed, 24 were men and five were women. Interviews focused on informants that reported in response to the survey that they were full–time or part–time employees, self–employed or entrepreneurs. Fourteen of the informants are full–time employees; 13 are freelance, self–employed or entrepreneurs; and, two were unemployed during the time that they reported using Wi–Fi hotspots. Informants worked in a range of occupations including education, graphic illustrator, hospitality, law, media production, non–profit organizations, public relations, technology, translation, Web design and writing.

Third, I will report on the results of a user study an augmented reality campus tour application, which illustrates coproduction of urban place through imagination (since these applications are often experimental versions of future technologies). The study was conducted at the Interaction Design Lab at Cornell University between May and July 2010. Participants were engaged in 90–minute sessions in which they walked throughout the campus accessing and creating digital tags for the system, which included photos, notes, videos and links. There were 34 participants — 17 men and 17 women — in the experiment over the course of four weeks between mid–May and mid–June 2010. About half of the participants were employees of the University's Alumni Affairs office, the other half were faculty and students. Participants ranged from freshman year undergraduates to faculty and staff in their late 50s and early 60s. Participants were not compensated for their participation. This study incorporated qualitative interviews, which were conducted while the participants were on the campus tour. The researchers' observations and interactions with the participants were recorded in detailed notes, resulting in 30 pages of field notes. The qualitative data was analyzed using discourse analysis in order to identify common themes.

3. Discussion

As the following empirical examples will show, the concept of place is constituted through socio–technical practices; rather, in accordance with frameworks from urban informatics, place, people and technology must be considered to be interdependent, dynamic and relational. Furthermore, it is impossible to understand emerging notions of place without a nuanced understanding of digital materiality as they play out with respect to urban technologies. Specifically, urban technologies are visible and visualizable, incongruous, full of conflict and negotiation, and contextualized in everyday practices.

Co–production through visualizing digital materials

Recent art and design projects are helpful in visualizing the ways in which digital artifacts, interfaces and networks are currently playing and important role in the co–production of place as well as questioning the values embedded in urban infrastructures. For example, Mark Shepard's "Sentient City Survival Kit" uses a design fiction (Bleecker, 2009) approach to propose a range of "artifacts for survival in the near–future sentient city" [3]. These include an *ad hoc* network travel mug, an umbrella visible only to surveillance cameras, a pair of underwear that detects hidden RFID (radio frequency identification tags) and a mobile application called "Serendipitor" that introduces alternative pathways to navigation in cities. These artifacts both illustrate the hybrid nature of place by integrating digital technologies into physical objects but also challenge the existing paradigms related to security and surveillance in a post 9/11 context in which information flows and big data are being collected, analyzed and acted upon. For example, the travel mug is envisioned as inconspicuous communication device in a future world where all communication is monitored. From an actor network theory perspective, these non–human artifacts are understood of be participants in socio–technical systems in which they carry out specific 'programs of action' in collaboration with

humans. By carrying the *ad hoc* network travel mug, the human actor herself becomes part of the socio–technical infrastructure as a sender and receiver of information. According to actor network theory, digital artifacts such as surveillance cameras, RFID chips, Wi–Fi networks are as important as people and animals, parks and plazas, taxis and buses, and buildings and structures that inhabit them (Latour, 2005; Salamanca, 2013). It is this practice of becoming the network and, in particular, the ways in which the wireless network is visualized *i.e.*, through SSIDs, 'splash pages' and login names, etc. that embed places with significance and meaning according to the definition of place. In addition, it is also possible to argue that the messages that are sent through the network populate places with significance and meaning, which further emphasizes the socio–technical construction of place.

Chicago's Crown Fountain as well as earlier examples such as the Chaos Computer Club's Project blinkenlights [4], which went live in Berlin in 2001, is another example of the ways in which digital interfaces co–create place. Like other public art pieces these digital displays have become symbols of pride in one's city, evidence of the importance of specific places as well as iconic destinations for tourists and citizens alike. They are captured in photos, discussed in conversation, and can justify long hours spent enjoying the atmosphere of a public space.

Finally, digital networks, while often invisible to the naked eye are important to the kinds of sociotechnical practices that can occur in urban spaces. One design project that is helpful in illustrating the digital materiality of such networks is Timo Arnall's "Immaterials: Light Painting WiFi" [5] project, which uses Arduino boards equipped with sensors to illustrate the shape of wireless networks on the streets of Oslo. In contrast to the depiction of digital networks of pervasive and seamless layers, this project illustrates that digital networks do in fact have a specific shape, structure and materiality, which can be visualized. The materiality of the network, and the practice of making it visible along with its unique gaps and seams, is important in order to better understand the socio–technical nature of place in urban environments. Without such efforts, Arnall writes we continue to "propagate the myth of immateriality" (Arnall, 13 March 2013). Expanding on his technique, it is possible to visualize even more specific aspects of the networks that render them important for the construction of place. For example, it is possible to conduct a similar analysis of Wi–Fi networks in different neighborhoods to uncover disparities among demographic categories based on age, race or class. It is also possible to query the nature of open and closed (password protected) networks and understand how much and when they are being used most frequently without exposing the data that is being transmitted.

In my own research, I have used spectrum analysis in order to conduct a kind of network ethnography (Howard, 2002) of physical spaces. As a result, on one instance, I found that despite the fact that I could not see anyone using a particular Wi–Fi network at City Hall Park in New York City, the network was, in fact, populated with a huge amount of traffic. As an ethnographer, this led me to create alternative interpretations about how a particular public park, and its associated wireless network, was being used. Specifically, not everyone using the network is necessarily present within the geographic boundaries of the park since it is possible to access the network from nearby buildings, for example (Forlano, 2008b). While the mere availability of a Wi–Fi network in a neighborhood or public space is not the only evidence (due to the myriad of ways to connect to the Internet) of certain kinds of socio–technical practices such as using a mobile phone, tablet or laptop, the speeds enabled by such networks may afford certain practices and constrain others.

There are two additional projects that are worth mentioning here, which were included in an exhibition as part of the 2013 MEDIACITIES conference at the University of Buffalo. First, Paolo Cirio's "Street Ghosts" project is described as a social sculpture that uses the ready–made material of Google StreetView images in order to reintegrate life–sized, full–color images of people that have been capture in the database onto the streets where the images have been taken (the images are anonymized by blurring the facial features). In this sense, he relies on the "passive participation of the public" in order to reveal "multiple aesthetic, biopolitical, tactical and legal issues that emerge when the real and the virtual take place in the city," (Cirio, 2013). Second, Julian Oliver's (2013) "Border Bumping" is a "dis–locative" media project that uses a smartphone application to collect

cell tower and location data in order to challenge "the integrity of national borders". The project visualizes the "moments of discrepancy at the edges" as the body moves into territory that is incongruent with the cell tower's national identity and vice versa (Oliver, 2013).

While this section has discussed the ways in which art and design projects such as digital artifact, interfaces and networks play a role in the co–production of place thorough visualization, urban spaces are also being created online for the purpose of citizen engagement and community planning. One such example of this "urbanization of the Internet" [6] is Betaville, which is "a collaborative online platform for proposals on urban design" that is based at Brooklyn Experimental Media Center at Polytechnic Institute of New York University [7]. Such platforms suggest that digital technologies that are not physically situated in urban spaces have the potential to contribute to the co–production of specific, streets, neighborhoods and cities through participatory processes that are coordinated online. For example, citizens might annotate the map with local folksonomies, favorite locations and discussions of ongoing conflicts as they play out in the city thereby rendering it meaningful and giving it a sense of place.

Co–production though lived experience

The last example of the ways in which digital technologies are co–producing place lies in the lived experiences of mobile workers based on a qualitative study of Wi–Fi users. Using Innis' (1951) definition, wireless networks can be understood both as space–biased and as time–biased media. This is because while wireless networks allow people to connect to the Internet and reach out across the globe to communicate, they are also located in bounded physical and digital spaces where people often gather. While this gathering is enabled by an invisible network, it is not unlike group television viewing or going to the movies, practices which Carey (1988) refers to as cultural rituals in his "ritual view of communication". Thus, digital networks co–produce place in that they enable a certain kind of socio–technical practice around mobile work; namely, going to a café, park or public space with one's laptop or other device in order to work side–by–side with other people but not together with them. This practice, which emerged in the early 2000s with the advent of portable computing and the availability of Wi–Fi, has only accelerated in many cities in the United States as a wider range of devices such as tablets and mobile phones have become Wi–Fi–enabled and/or with the increased speeds of cellular networks. In addition, in recent years, a wide range of physical spaces such as coworking spaces have been created in order to support emergent ways of working which are more mobile and flexible (Forlano, 2009b; Spinuzzi, 2012; Townsend, *et al.*, 2011). According to Deskmag, there were 1,300 coworking spaces worldwide at the beginning of 2012 (Cashman, 2012; Cashman, *et al.*, 2012).

In examining these socio–technical practices, a number of interesting findings emerged with respect to the ways in which digital networks shaped the use of urban place. For example, for mobile workers, the availability of Wi–Fi is a key factor in choosing where to spend their day. However, it is not only the digital network that determines where someone might decide to work. For example, a technology consultant chose to work at Wall Street Public Atrium, an indoor public space in the financial district, because of its proximity to transportation. More specifically, the atrium is located on top of a subway station. When he received instructions about the location of client meetings, he is able to quickly hop onto the subway, thus eliminating the need to walk to a train station. Mobile workers may have one or several places, where Wi–Fi is available, that they frequently use as offices spaces. In addition to the availability of Internet access, their choice may be based on the location, the type of work they are planning to do or the type of people that they might be surrounded by (or even specific friends or familiar strangers). At the micro–level, one's distance from the Wi–Fi router may constrain or even prevent access to the network. As a result, it is not uncommon to find people grouped together in a particular part of a place in order to improve the strength of the signal.

Similarly, people often make decisions about where to spend their day based on the proximity to an open wireless network. For example, a blogger that I interviewed who happened to be homeless had identified the exact Starbucks coffee that was across from a free and open wireless network. Since he was working on his laptop like many others at the café people did not suspect that he did not have any money to purchase coffee. In addition,

since 80 percent of Starbucks business at the time was take–out in the United States according to an interview that I did with Joseph Michelli, author of *The Starbucks Experience*, the company was able to tolerate a certain amount of free riders unlike smaller, independent cafés. Another blogger who wrote about food and wine online while working in the hospitality field for a university club enjoyed using the Wi–Fi network at Bryant Park because he found it "comfortable," mentioning the custom–designed street furniture in the park that included a desk and cupholder. On weekends, he commuted 20 minutes from Queens in order to use the network.

Finally, a Web site designer, described three different cafés where he worked, which he described as his pre–production space, production space and deadline space; all of were Starbucks but in different neighborhoods and with different socio–technical affordances (Forlano, 2009a). In this case, his work routines, project phase, social network and technological needs shaped his choice of a place to work. This example further illustrates the ways in which place is constructed at the intersection of contextualized socio–technical practices and counters the claims of 'anytime, anywhere' that are frequently repeated in the mainstream media, public policy, business and technology as well as in academic discussions about emerging technology.

Another example of the ways in which digital networks co–produce place is that they are often themselves the topic of conversation between strangers. For example, it is not uncommon to ask someone for the network name or password, or, even, "Can you watch my laptop while I go to the bathroom?" In many places, the availability of Wi–Fi has become so commonplace that when it is not available or when it is password protected, something essential is considered to be missing from the space. This is considered to be an important aspect of technology infrastructure according to Star (1999) in that it is only noticeable when it breaks down.

Co–production through imagination

While originally prototyped as head–mounted displays such as the Mobile Journalist's Workstation, which was created in the late 1990s at Columbia University (Höllerer, *et al.*, 1999), augmented reality platforms are currently being embedded in mobile technologies as applications. For example, Yelp Monocle, became the first augmented reality platform for the iPhone in 2009. These platforms offer the possibility of viewing and accessing digital information in real–time as an overlay on the physical environment. While current applications are still quite awkward to use while navigating the city, in particular, due to the need to focus on the screen of the mobile phone, emerging prototypes such as Google's Project Glass illustrate that such capabilities may be integrated into common artifacts such as glasses or apparel. Project Glass, which incorporates a small lens onto wrap–around frameless pair of glasses, allows for continuous recording and sharing of one's visual environment via the Internet.

In the user study of the augmented reality campus tour, many users tested the physical boundaries of the digital application by wondering about the possibility of creating and accessing tags without actually being in the locations themselves. For example, Jessica noted that, "Hypothetically, you could sit and tag all the places you want to tag from one spot." This illustrates that participants have come to expect the rhetoric of "anytime, anywhere" access to and creation of data and information (Forlano, 2008a), which may be disrupted by applications that provide only contextual, location–based information. From a practical perspective, while it is technically possible to create tags from a distance, it is only possible to access them when in proximity to the tagged locations. In this way, the application both extended human traces into digital domains while, at the same time, constraining their reach across physical terrains.

The application allowed two ways in which to view the tags. While augmented reality view only allowed participants to view the most relevant tags for that location, the augmented map view gave a more holistic display of the entire campus with all of the associated tags. As a result, participants sometimes switched to map view in order to view tags and locate specific places on campus with greater ease. This illustrates the ways in which augmented reality applications, regardless of their accuracy, are disruptive to common understandings of geography and space. The augmented reality view is a way of seeing the world that expands our perspective beyond the edges of maps and camera lenses, and, instead, as a panorama of digital

tags and information. In this way, such applications expose digital seams (Chalmers, *et al.*, 2003) that interrupt our lived experiences, and offer new possibilities, while at the same time neglecting to smooth boundaries and disrupting layers of information and connection as might be expected.

Participants used their tacit knowledge of the campus in combination with the digital tags in order to navigate the physical environment using the application. In doing so, participants engaged in a "matching" process to connect the digital tags with the built environment. Rather than being a seamless experience, this matching process exposed the disjointed nature of linking digital information with physical place. As a result, participants co–created their sense of place using a mix of socio–technical understandings including physical cues in the world around them, tacit knowledge in their minds, and digital information residing as tags on mobile devices.

From the perspective of the participants, digital tags appeared to be floating, sometimes in clusters, in the general location of the physical structures and objects that they represent. The locations of the tags was socially constructed in that official tags were placed by the research team using GIS coordinates as well as knowledge about the campus while user–generated tags were less exact, sometimes being located far away from the object being tagged. This is because the user–generated tags were manually placed by participants by moving the crosshairs on the Google Map interface, which required participants to "read" their physical location and translate this information into the digital map. While many users were able to place their tags with a great degree of accuracy, it was not always easy to estimate the exact location on the digital map. This illustrates the ways in which the social construction of the digital tags further challenges the construction of a seamless experience through augmented reality.

Molly, an employee from Alumni Affairs, recalls a recent conversation with an alumnus about a less known fact about the campus. She sees the official university tag in the application referring to the story but does not immediately see the related physical structure on campus. Since the application is very sensitive to small movements, sometimes tags could only be viewed when holding the phone in certain directions or at certain heights. Similarly, when Ellen sees a photo associated with a certain bagel shop, she exclaims, "That's not the [name of the bagel shop]." For the most part, participants expect to be able to see the physical manifestations of the digital tags through the viewfinder in the same direction that they are facing when they see the digital tag, *i.e.*, when a tag for the Law School appears, they expect to see the Law School through the viewfinder. In order to augment the system, participants must again rely on their senses and tacit knowledge in order to translate the digital tags into their physical environment. In Molly's case, she was interested in finding a physical structure that had embedded sound effects that were invisible to the naked eye. She commented that the application allows people to see "a combination of places and things that aren't necessarily *there* that no one else might know about." In this case, the application makes it possible to visualized attributes of the physical campus that are known to the community but invisible to visitors. As such, it allows people to capture this tacit knowledge, which gives the campus a special aesthetic quality that is appreciated by the community. It is such evidence of embedded meaning that can now be mediated by the digital technology platform in order to allow visitor to experience a sense of place.

Finally, participants explored the architectural and digital boundaries of the campus using the application. For example, Danica tagged a famous collection of human organs that was on display inside a building on campus. Another participant, Katherine, upon seeing a tag for a famous restaurant in the town while walking across the campus, questioned the validity of the tag. However, she quickly realized that the tag referred to a franchise of the restaurant that is located inside a university building. The ability to tag objects, departments, and resources located within buildings, and not visible from the outside, added an interesting dimension to the use of digital tags in augmented reality systems. Specifically, the digital information explodes architectural boundaries in a way that is not possible in physical space yet the tags are contextually linked to and accessible in the surrounding geographic area.

While users were aware that tags existed digitally, they experienced tags as being in or on specific buildings since the tags appeared to be floating over physical landmarks in the viewfinder. Molly said, "There's far more *on the*

door," illustrating that the tags appeared to be physically attached to the door in the way that a flier might be posted on a lamppost. Dawn said, "If you look in the direction [of the physical building], the tag, is not necessarily there." Bob commented, "I saw that stuff there [referring to the tags], which I know is back that way, but not over here." Rather than advocating for the adoption of augmented reality platforms such as Google's Project Glass, this user study of an experimental technology illustrates the ways in which people and digital technology coproduce a sense of place through their tacit knowledge and experience of their surrounding built environment and physical geography.

Conclusion

This article has argued that place is currently being coproduced through sociotechnical practices in three ways: visualization, lived experience and imagination. Furthermore, the empirical examples from art and design, social science, and computer and information science have helped to clarify the specific ways in which urban technologies — a new set of digital actors including urban screens, networked objects and information networks — contribute to the shaping of place. While urban technology is often portrayed as ubiquitous, frictionless, seamless, congruent and 'anytime, anywhere,' this paper argues that in order to have a nuanced understanding of urban place, it is necessary to expose the seams and frictions in order to illustrate the ways in which lived experience of urban technology does not occur in layers but is rather quite incongruous. It is no longer enough to claim that we are living in cities composed of hybrids. Rather, it is necessary to develop a new lexicon that attempts to account for the nuances that can be observed through a careful comparison from a variety of methodological approaches including design fiction, empirical case studies and users studies. Such comparison also allows for the bridging of temporal categories such as the recent past and current present as well as possible future trajectories. Just as digital technologies have been integral in the experience of place in online settings, our experimentation and use of urban technologies is enabling a deeper understanding of the sociotechnical construction of place in cities.

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Laura Forlano is a tenure–track Assistant Professor of Design at the Institute of Design at Illinois Institute of Technology. From June 2012–2013, she was a Visiting Scholar in the Comparative Media Studies program at Massachusetts Institute of Technology. Her research is on emergent forms of organizing and urbanism enabled by mobile, wireless and ubiquitous computing technologies with an emphasis on the socio–technical practices and spaces of innovation. She is co–editor with Marcus Foth, Christine Satchell and Martin Gibbs of *From social butterfly to engaged citizen: Urban informatics, social media, ubiquitous computing, and mobile technology to support citizen engagement*, which was published by MIT Press in 2011. Forlano was part of a collaborative project "Breakout! Escape from the Office' that was included in the Architecture League of New York's *Toward the Sentient City* exhibition in 2009. Forlano received her Ph.D. in Communications from Columbia University in 2008. Her blog can be found at http://www.lauraforlano.org and abstracts of some of her current writing can be found at http://designingorganizations.org.
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Notes

1. Carey, 1988, p. 15.

2. *Ibid.*

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4. http://blinkenlights.net, accessed 10 October 2012.

5. http://www.nearfield.org/2011/02/wifi-light-painting, accessed 10 October 2012.

6. https://twitter.com/sunday9pm/statuses/114060580335271936 Marcus Foth's (@sunday9pm) Twitter feed from 14 September 2011, accessed 10 October 2012.

7. http://betaville.net, accessed 10 October 2012.

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