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Layar-ed places: Using mobile augmented reality to tactically reengage, reproduce, and reappropriate public space

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Abstract
As augmented reality (AR) is becoming technologically possible and publicly available through mobile smartphone and tablet devices, there has been relatively little empirical research studying how people are utilizing mobile AR technologies and forming social practices around mobile AR. This study looks at how mobile AR can potentially mediate the everyday practices of urban life. Through qualitative interviews with users of Layar, a mobile AR browser, we found several emerging uses. First, users are creating content on Layar in ways that communicate about and through place, which shapes their relationship and interpretations of places around them. Second, we found a growing segment of users creating augmented content that historicizes and challenges the meanings of place, while inserting their own narratives of place. Studying emerging uses of AR deepens our understanding of how emerging media may complicate practices, experiences, and relationships in the spatial landscape.

Keywords
Augmented reality, Layar, mobile, place, space, tactics

Introduction

Augmented reality (AR) is defined as a technology that mixes the real environment with the virtual, is registered in three-dimensions, real-time, and interactive (Azuma, 1997). After decades of development (Zhou et al., 2008), many AR browsers are publicly

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Figure 1. "WashingtonMall AR," Mollejuo.

available and on the market through mobile handheld devices (Butchart, 2011). As mobile smartphone usage increases rapidly (Rainee, 2012) and mobile AR is projected to reach 2.5 billion installs (Miller, 2012), the development of mobile AR usage is one that bears watching for new media scholars.

Like other emerging technologies, early research surrounding AR has focused almost exclusively on technological development efforts, most notably the tracking, user interaction, calibration and registration, and display techniques (Zhou et al., 2008). While this is not surprising given that these capabilities are fundamental prerequisites for AR technologies to function, much of the attention has been geared toward building AR technologies rather than analyzing the uses and sociological implications of AR. Recent studies aiming to improve technological design have surveyed current users on the overall acceptance, user experience, and perceptions of usefulness of mobile AR applications (Olsson and Salo, 2011), or conducted experiments to test how mobile AR applications can be useful for certain applications such as navigation (Lee et al., 2012; Rehrl et al., 2012).

While these provide important early snapshots of mobile AR usage and applications, less well understood is how people outside of an experimental setting are engaging with mobile AR technologies, deploying mobile AR in ways to interact and experience space, and creating AR content in ways that can potentially change people's experience in and with surrounding spaces. To solicit rich accounts of mobile AR use, we employ an iterative, qualitative approach to understand "media practice," or what people are doing in relation to media in the contexts in which they act (Couldry, 2012). This study examines the media practices emerging around mobile AR and seeks to understand how augmentations become acts through which people annotate, experience, and enact place.

This study focuses specifically on users of Layar, one of the most widely used mobile AR applications. Layar displays points of interest (POIs), user-created annotations, or graphics based on the Global Positioning System (GPS) location of the device and orientation of the built-in camera, compass, and accelerometer. Users can download different content layers (e.g. restaurants, apartment listings) and view that content overlaid on the physical world by pointing their mobile device at a location (Figure 1). Layar also allows

users to create content and place them on particular locations. Through a series of in-depth, qualitative interviews with a particular community of Layar users, we found two distinct practices surrounding Layar. First, users are creating content on Layar to think about and communicate about place. Second, users are deploying AR to raise questions regarding who has authority over space and to reconstruct political and historical meaning in place. In analyzing these findings, we apply De Certeau's (1984) theory of social practice, strategies, and tactics to reveal the complexities of these technological uses and how they (re)produce place.

Literature review

The relationship between place and space is complex, and their distinctions need to be made. For this inquiry, we adopt Harrison and Dourish's (1996) definition that "space is the opportunity; place is the (understood) reality" (p. 69). Space can be thought of as the more abstract term that describes the broader three-dimensional (3D) realm in which we live, whereas place is more socially constructed.

Often times, people use physical artifacts to navigate through space. Whether through guidebooks (Spring, 2006), subway maps (Vertesi, 2008), or heritage walks (Crang, 1996), mobile representations become tools for consuming places (Urry, 1995). These analog technologies presented narratives of space, ways of moving through the city, and sequential orderings of space without the presence of a physical person to guide you, but were also materially bounded and finite (Spring, 2006). Studying these tools reveals how people experience cities, engage in practices through cities, and negotiate representations of culture and history (Knudsen and Waade, 2010; Spring, 2006; Towner, 1996; Urry, 1995; Vertesi, 2008).

Mobile technologies enable digital recreations of those physical artifacts, often surpassing them in terms of their locational awareness, scope/timeliness of the content, and real-time possibilities. Because of this, mobile technologies raise new opportunities for the creation of place, allowing people to reencounter everyday space and understand the structure of those settings (Dourish, 2006). Advances in ubiquitous computing, mobile and wireless technologies, and the Internet are enabling augmentation of spaces and broadening the informational possibilities that people have as they experience and encounter lived place (Aurigi and De Cindio, 2008; Brewer and Dourish, 2008; De Souza Silva and Frith, 2010; Sheller and Urry, 2006; Thrift and French, 2002).

In particular, mobile AR is made possible by a convergence of several enabling technologies, which are important to consider for emergent practices surrounding AR. While augmentation of information through mobile devices is nothing new, the visual, interactive, and real-time nature of digital augmentations offer fundamentally new ways of experiencing, moving through, annotating, and enacting place (Graham et al., 2012). This study first reviews previous literature on location-based services (LBS) and practices of mobile geotagging and content creation that inform our understanding of current practices. Then we turn our attention to the relationship between code and space. Finally, because we are looking at people's practice in and through space, we apply De Certeau's (1984) theoretical and analytical framework to understand mobile AR uses as tactical spatial practices.

LBS

Mobile AR can be considered a specific subset of LBS, in that they use the location of people, places, and things to enhance the applications (Wang and Canny, 2006). In its current form Layar is distinct from locative mobile social networks, in that it provides information about location but does not visualize information about other users' positions (De Souza e Silva and Frith, 2010). It is also distinct from hybrid-reality games, which actively direct people to particular areas (De Souza e Silva, 2006). Mobile AR browsing applications such as Layar are extensions of traditional LBS in that they also deliver place-based information to users, but do so with specific visual displays. Applying Azuma's (1997) definition, the display must combine real and virtual content in 3D, interactively and in real-time.

For example, the online recommendation site Yelp released an AR version called Monocle, which displays information about places on top of the physical space through the mobile screen when the phone is held up. The mobile Yelp application is a LBS, whereas holding up the phone using Yelp Monocle is specifically AR. The difference lies in a specific definition of how the content is displayed, but existing research into LBS can inform our study of AR applications.

LBS are typically services for navigation, planning, and information delivery (Schiller and Voisard, 2004). People choose LBS because they are perceived as highly useful and more efficient for certain tasks (Chang et al., 2007; Junglas and Watson, 2008). One application area for LBS is for people to explore their surroundings. A growing body of research has focused on the commercial potential, design features, and adoption of mobile tourism guides (Cheverst et al., 2000; Kjeldskov et al., 2005), as well as how people organize and experience urban spaces utilizing these applications (Bilandzic et al., 2008; Brown and Chalmers, 2003; Foth et al., 2011; Sutko & de Souza e Silva, 2011). Mobile AR has been theorized as a technology that can further complicate the relationship between space, navigation, and commercialism because it allows for virtual content to become part of that place, allows people to see different representations, and allows those representations to be stored (Spohrer, 1999). Early research that empirically tested the benefits of mobile AR in an experimental field setting found that mobile AR can improve peoples' navigation and experience when deployed in urban areas (Lee et al., 2012; Rehrl et al., 2012). As mobile AR applications integrate location as an enabling piece for more complex displays and activities, our study builds on existing LBS research by analyzing how users are deploying mobile AR to change representations of space and add content to specific locations.

Mobile geotagging

In addition to browsing content, Layar also allows users to create content on their platform. This practice is similar to mobile geotagging, which refers to the process of linking online materials or digital objects content to a physical location (Casey et al., 2008). In looking at how geotagging might engender a new set of practices, Erickson (2007) studied photo-sharing on Flickr as well as locative and nonlocative microblogging, observing a greater awareness of virtual and physical interactions in creating a hybrid social space.

Specific users of mobile geotagging services have been further explored, analyzing how users interact and communicate about and through places (Humphreys and Liao, 2011).

The content creation possibilities on Layar encompass mobile geotagging, but offer new display possibilities and ways for people to experience that content. With Layar's publishing tools, people are able to publish augmented content in ways that visually overlay two-dimensional (2D)/3D representations onto physical locations. Additionally, these augmented creations become visible only when accessed by someone physically in that location.

Code/space

The use of these mobile technologies not only influences how people consume space, but creation of augmentation has the potential to reproduce space with code. As more spaces of everyday life are embedded with code that automatically (re)produces the order of those places (Thrift and French, 2002), the processes and politics by which content and code (re)produce meaning in physical places are beginning to be explored socially and spatially (Graham, 1998). Kitchin and Dodge (2011) argue that the relationship between code/space is mutually constitutive, as evidenced by the ways the place ceases to exist if the code fails (e.g. if the computer check-in system fails at an airport, the space reverts to a chaotic waiting area). While the co-construction of code/space can be seen most clearly in highly regulated and controlled places, mobile AR has the potential to broaden the code/space relationship into public spaces and urban areas (Crang and Graham, 2007).

The mutual constitution of media, code, and space has been articulated by several mobile scholars (De Souza e Silva, 2006; Farman, 2012; Sheller, 2012). De Souza e Silva's (2006) notion of hybrid space conveys the blurring of physical and digital spaces, while Farman's (2012) work extends this to include the embodiment of mobile media and the social production of space. In particular, he argues that the ways mobile media are incorporated into everyday life are part of a "sensory-inscribed" form of embodiment where media, space, and bodies are mutually constituted. The mobile interface theory that Farman (2012) articulates is particularly relevant given that the visualization of AR is one of its distinguishing features within the larger realm of mobile media. In considering mobile AR being embedded in cities, the technology can allow people to become more visible while also allowing individual people to "more fundamentally mediate the everyday practices of urban life, subtly shaping senses of place as particular interpretations of events and locations are foregrounded or side-lined" (Graham et al., 2012: 1). How people understand the embodiment of their augmentations is something this study examines.

Actors in the AR industry are imagining dramatic changes for how the technology will reorganize visual information, recognize real world objects, link objects to databases, and visualize 3D objects in physical space (Liao, 2012). Alongside these claims are concerns, however, that the content of AR might be manipulated through algorithms and the regulatory power of code (Graham et al., 2012; Urrichio, 2011). While there are many theoretical issues and possibilities raised by mobile AR and the power dynamics that underlie the technology (Crang and Graham, 2007; Drakopoulou, 2013; Graham

et al., 2012; Sheller, 2012; Thrift and French, 2002), there has been a relative lack of empirical research done analyzing how actual users of AR are deploying and engaging with the technology, and their accounts and perceptions of their use. This study looks at the early practices forming around mobile AR, to understand how people act in space and how they utilize technology to render that place meaningful. Understanding the lived practice is a critical link in our understanding of mobility and technology (Brewer and Dourish, 2008).

Spatial practices: strategies and tactics

Spatial practice is how people consciously and unconsciously alter, adapt, and appropriate objects and space for their own ends (De Certeau, 1984). De Certeau (1984) theorizes that there are two types of spatial practices that shape the construction of urban space—strategic and tactical. Strategic actions are attempts to distinguish their own place and are typically exercised by the powerful (e.g. government, armies, cities), who have authority to construct, design, create rules, control movement, and shape the organizational norms and disciplines of space. Tactics, on the other hand, are "an act of the weak" and refer to the specific devices, actions, and procedures in which people create meaning for and move through those spaces in subversive ways (De Certeau, 1984: 37). People are able to resist attempts to make spaces transparent and their actions identifiable through tactical spatial practices.

Technology becomes another way to embed spaces with code that enforce strategic power (Kitchin and Dodge, 2011). In the hands of the powerful, AR technologies have the potential to render people identifiable in space and regulate those spaces (Crang and Graham, 2007). People who wish to resist these moves could potentially utilize AR to make the data in the environment transparent, overcode and pluralized the authorship of augmented space, or use AR to promote new practices of direct contact and association (Crang and Graham, 2007). Those possibilities, however, were based on a forward-looking projection of AR technologies and their capabilities. Now, as mobile AR is publicly available, we examine how mobile AR is being deployed to reengage, reproduce, and reappropriate place.

Case and methodology

Layar is a mobile AR browser that first launched in June 2009 and is the largest mobile AR platform with more than 33 million downloads. The company also reports over 1 million downloads a month. They have a content catalog of thousands of different "layers," which are categories of content organized by themes. Layar is available on most major mobile operating systems and is a major player in the mobile AR space and a popular platform for mobile AR.

Recruitment

Because this study focuses on the emergent practices of Layar use, we employed a naturalistic and interpretivist framework (Lofland et al., 2006). This framework

Table 1. Participant information.

Name/pseudonym	Country	Gender	AR creator/artist
Chris Manzione[a]	United States	M	Y
John Craig Freeman[a]	United States	M	Y
Kristin Anderson	United States	F	Y
Sander Veenhof[a]	The Netherlands	M	Y
Tamiko Thiel[a]	Germany	F	Y
Charles	Australia	M	Y
JD	United States	M	N
Joseph	Canada	M	Y
Lester	The Netherlands	M	Y
Matthew	United States	M	Y
Nicholas	Germany	M	Y
Thomas	United States	M	N

AR: augmented reality.
[a]Manifest.AR Founding Members.

allows us to examine users' practices, experiences, interactions, and perceptions of mobile AR in their everyday usage. We employed multiple recruitment strategies. First, we posted recruitment messages on Craigslist.org in eight major cities in the United States: Boston, Chicago, Houston, Los Angeles, New York City, San Francisco, San Jose, and Washington DC. Second, we identified the popular AR blog, *Augmented Times* (http://artimes.rouli.net/), to post our recruitment message to people who specifically seek out AR information. Third, we posted recruitment messages to the LinkedIn group "Augmented Reality Professionals," which has over 3700 members including prominent executives and individuals working in AR. Fourth, from November 2011 to March 2012 we attended a monthly AR meet-up group in New York City to find and recruit users in person. We also conducted a snowball sample based on our initial recruitment.

Data

We were able to complete in-depth interviews with 12 Layar users, 4 of which were recruited via snowball sampling. Interviews were all conducted over phone or Skype. Of the 12 participants, we interviewed 10 men and 2 women, ranging in age from early-20s to mid-50s. They ranged in experience with Layar from recent adoptees (6 weeks) to those who started using the service shortly after it launched. Of the 12 participants, 10 of them used the open application programming interface (API) to create new layers. Additionally, the snowball sampling revealed a group of artists who founded a group called Manifest.AR. Manifest.AR is described as an international collective working with emergent forms of AR as interventionist public art. Interviews were audio recorded and transcribed for the purpose of accuracy. Names of informants are pseudonyms unless interviewees explicitly waived confidentiality (Table 1).

We conducted semi-structured interviews to allow for both guidance of the interview and flexibility to avoid limiting the field of inquiry (Lofland et al., 2006). The interview guide asked how participants used Layar, how using Layar influences their experiences and decisions, and how Layar changed their relationship with the spaces around them. Follow-up questions asked about specific uses of Layar, depending on whether they were viewing content layers, creating content layers, or both. Creators of content were asked about their motivations for creating layers, what they thought about the relationship between their layers and the physical space, and also how creating layers affected their perceptions of space. Interviews ranged from 30 to 90 minutes, with an average of 55 minutes.

Analysis

We adopt De Certeau's (1984) position that it is important to capture underlying movement or meaning behind those practices as opposed to simply documenting those uses. In those instances, "What is counted is what is used, not the ways of using" (p. 35). Because this inquiry aimed to explore the processes by which users are engaging with an emerging technology, this study gives priority to "detailed narratives, descriptions of the roles that various people play, accounts of the local contexts in which patterns of action occur, and so on" (Hammersley and Atkinson, 2007: 235). Drawing on Lofland et al.'s (2006) analytical recommendations of forming matrices and cross-classifications, responses to similar questions were first compared to form a description and understanding of the informants' perspectives. Uses were categorized based on where and when they used Layar (information about the context of an act), how and why they used it (the intentions and meanings that organize action), and what they thought the use meant (Denzin, 1978). Analyzing these similarities and differences across matrices allowed us to identify the "regularities, variations and singularities in the data" (Dey, 1993: 204). These categories and themes are presented as an account of the different ways participants interpret and explain their uses.

The difficulties in sampling are a reflection of the current state of mobile AR, as other researchers have found technical barriers to adoption and a large number of people who uninstall the application shortly after downloading it (Olsson and Salo, 2011). Thus, the sample for this study was a unique group of early adopters of mobile AR technology (many of whom consume and create layers). The gender difference in our sample is exactly the same ratio found by Olsson and Salo (2011), about 5:1, which suggests that the population of early adopters of AR is predominantly male. Therefore, the findings are not an account of "typical users" of mobile AR in part because the user base is newly forming and there is no such thing as a typical user yet. Rather, the themes accounted for here reveal how the practices of a group of early adopters of mobile AR can inform future possibilities of AR.

Findings

Creating augmented content, thinking about places to augment

Because so many of the early adopters were also creators of content, our findings focus on how and why they create AR content, and how those augmentations interact with

place. For example, Joseph started a company making augmented layers and has already created several, including one for the metro stations in his hometown of Quebec, as well as a historical layer for the Boston Freedom trail. Sander created an application that photographed people and turned those into instant augmentations at a music festival. All the informants who created layers reported that their practices of augmentation and the potential for augmentation changed their relationship with places around them.

First, participants reported that seeing what was possible and then experimenting with augmenting space motivated a deeper thinking about a variety of places. When asked if the ability to augment things has changed his perception of place, Joseph responded resoundingly:

> Absolutely, I can now say everywhere I go, if I'm in a place I think about how this could be improved from an augmented reality point of view. […] I try to think of other uses but then concentrate on the ones that have more of an impact.

Responding to the same question, Kristin Anderson, an artist in New York City, concurred: "Constantly. Constantly. The first night I saw it I was up all night and my head was racing." Sander Veenhof described it as a feeling of empowerment: "I feel more in control. I feel like if I don't agree with anything I can reshape it for those in my own imaginary world." This feeling was not limited only to when they used the technology, but also altered their perception of place across future contexts and settings.

Layers as public/private communication

The different types of augmentation ranged in their intended audience. One common form of augmentation described was making layers that give public information or facts about a place. For example, Joseph described an idea he is working on for a layer:

> We use a carshare service, like Zipcar. The challenge when using that service is to find the parking lot, because many places you want to return a car and you don't know where the legal parking lot is. […] There are a lot of [parking] stations […], but I can never find them. I would use that [layer] for myself.

Many AR layers have this particular motivation—helping a number of people access useful information about their surrounding locations.

Other uses, however, envision more private communication in a particular location to individual people. Kristin explains how she wants to create personalized layers and how she plans to use them to communicate specific messages:

> I can also make birthday presents for people. I put something special in their house. This layer is going to be of interest to nobody but that person, but for me it's a very interesting personal communication. I can do a very personalized type of messaging to people that really is between the two of us. […] My nephews are Star Wars nuts. I'm going to put Darth Vader in their bedroom, and Luke Skywalker. […] They'll only see it on my phone and they'll think I'm magic. But at night they're going to be really psyched that these forces are in their room.

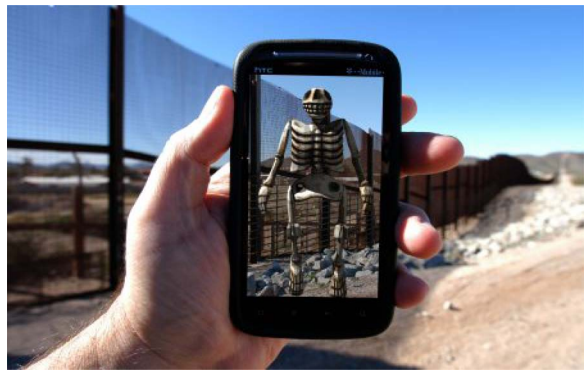

Figure 2. "Border Memorial: Frontera de los Muertos," John Craig Freeman and Mark Skwarek.

This type of communication inserts a personal message through both the layer itself and is specific to the physical location in which the layer is put. These practices illustrate the range of audience that AR can be geared toward. Whereas Joseph is creating layers in public space for anyone who wants to download his layers, Kristin was thinking of specific people to augment for in their homes. Joseph's usage illustrates that creating layers can be personal to a user who chooses to use it in that place without being "from Joseph." Kristin's birthday layer demonstrates a desire to use AR for specific one-to-one communication that is personal to the individual.

Historicizing/memorializing public place

One distinct practice that informants discussed in their production of AR was the creation of memorials. Such projects include John Craig Freeman's *Azadi SquARed* exhibit which flies an augmented flag atop Azadi tower with a picture of Neda Agha-Soltan, a woman killed in Tehran during the 2009 Iranian elections. The artist group 4Gentleman, who are associate members of the Manifest.AR group, have also placed virtual depictions of the Goddess of Democracy and augmented tanks in Tiananmen Square.

One project in particular that highlights the motivations and spatial relationships of these augmentations is *The Border Memorial: Frontera de los Muertos*, which creates augmented calacas (traditional Oaxacan skeletons commemorating the dead) on places where remains have been found near the US/Mexico border (Figure 2). It was created as an AR public art project and memorial, dedicated to the thousands of migrant workers who died along the US/Mexico border trying to cross the desert. John Craig Freeman explains that the Border Memorial intervention was intended to draw attention to the people who died in this particular place and to memorialize and politicize this place:

> What the Border Memorial does is it makes people confront the humanity of the loss of life. […] The sheer number of people who have died out in the desert is perhaps something that

> doesn't surface in the political discourse. If this project were to affect the political discourse so people would consider that then I would feel that the project has been successful on that level.

These practices highlight the mutually constitutive relationship between code and place. If the augmented skeletons were removed from those places, the augmentations would have a different meaning and the place itself would have a different meaning. Freeman, describing his experience of going out to the place to test his application, began to feel that the augmentations became a way of reading the physical landscape, changing the narrative of that place, and understanding objects in the space:

> There's something about the landscape itself and the detail of the individual locations of the border memorial that's sobering. […] Trying to find each of the augments to make sure that they were there, after a while it became apparent you could use the project to read the landscape. […] You could see the way the person must have walked out into that point and so the landscape itself starts to be meaningful. I would all of a sudden come across evidence of a campsite or discarded water bottles and little details that became very specific and you could build this whole story that starts to form out of a very specific location, where before it was just a place in the desert. The physical locality is everything to virtual objects.

As a result of this experience, Freeman explained that augmenting public spaces with these memorials could ultimately reinvigorate the social function of place and alter our relationship to those places:

> You often walk through public parks these days and a bronze equestrian statue might catch your eye, but we've kind of become divorced from the intrigue and the inquiry […], ways in which we've forgotten the role the public square takes. So the fact that these projects always end up back in the public square whether it's the Piazza San Marcos, the Boston Commons, etc., starts recapturing […] that social function that has to do with the ways we form our national identity, our individual identities.

This represents a tactic for walking around a city, where people's use of Layar allows them to alter the nature and degree of their relationship with the places around them. The growing presence of AR content might also call people to access information in the process of experiencing place, potentially even when they are not looking for specific information. The place becomes the prompt to call for information and can be accessed without prior knowledge of the place or what they are looking for.

Questioning authority over place

In addition to memorializing places or events, AR artists in our study also attempted to bring in voices or perspectives to places where they have been implicitly or explicitly excluded. One example of this is an intervention called *Shades of Absence*, by Tamiko Thiel, which explores collecting and disseminating information on censored and persecuted artists worldwide, and displays augmented shadows and faces (Figure 3). One place where this layer was placed was the Venice Biennial, a major contemporary art exhibition. Thiel explained her motivation:

Figure 3. "Shades of Absence: Public Void," Tamiko Thiel.

> We were looking very much at the curatorial statement […]. I was very interested in Venice as a site and the Venice Biennial as an institution. […] In the Venice Biennial a large portion of the works […] are selected by individual countries, each of which has their individual pavilion. […] The curatorial statement was a real provocation because we are breaking exactly the barriers that are romanticized by the concept of nations.

Thiel was particularly motivated to create the AR intervention to problematize traditional notions of curation, physical exclusion from place, and national authority to exclude.

This motivation was common among many of the creators we interviewed, in particular the four who were part of the Manifest.AR group that staged an uninvited augmented intervention in New York City's Museum of Modern Art (MOMA). Veenhof explains how AR allowed them to do so and why he was so excited to be able to stage the intervention:

> I think it was good to […] showcase that there is this new dynamic. Now, choosing where and when to exhibit is not just a matter of someone owning the space, it can be decided by the person wanting to exhibit somewhere. […] For me these systems really have allowed me to do things I could not have done before—exhibiting in the MOMA. For decades people have been trying to put their stuff in a museum, but in the end the museum was taking things away. But this time it was there for real, it was a part of the collection.

In these instances, the curated museum exhibition spaces attempt to control the content and employ strategies to attribute "a proper place to each particular element and through the combinatory organization of the movements specific to units or groups of units" (De Certeau, 1984: 38). Thiel explains that while the motivations might be similar to other artistic forms like graffiti, the technology allows different types of people to engage in the activity:

> Augmented reality is graffiti for people with bad backs. I joke, but it allows us to go places that might be physically impossible or risky to go to, where we can be free to make statements that transcend boundaries and limitations.

The augmented content changed the dynamics of the place because the artists were not invited to place physical objects there. Thiel and Veenhof also noted that this was a conscious tactic; the choice of space was deliberately made as an attempt to problematize who had the authority to speak at that place, to question the authority to curate, and exclude certain types of voices.

Discussion

While thinking about the theoretical implications of mobile AR necessarily focuses on the technological outputs and augmentations themselves (Crang and Graham, 2007; Spohrer, 1999), one distinct finding from this study is that mobile AR affects not only the space that is augmented but also the users/creators of the technology and how they think about space. Informants described a heightened awareness about places even when they were not using the technology, instead thinking about the possibilities for augmentation in that space. This heightened attention to place and feelings of control over space owing to mobile AR is both a change in attitude and perception and illustrates how mobile AR can motivate users to scrutinize strategic places. Identifying the effects of mobile AR on the creators/users themselves and not just the implications of their creations is one of the key contributions of this study.

Of course, mobile AR creations do not alter the strategic production or representation of physical space, which still takes place amidst asymmetrical power relationships with regards to who has the power to bring those spaces into being versus those who move through the space. Our findings suggest that mobile AR instead opens up new tactical possibilities for reproducing and reinterpreting places in three important ways. First, users can modify what representations of the space they choose to see and what the space looks like to them (e.g. changing the front of a building, adding objects to the space). Second, these augmented creations only come into existence when someone chooses to look for them, which allows for a wide range of public and private communications that are simultaneously temporal and personal. Third, the content is embedded in and accessed in place. A person has to be there in order to experience the augmentation. Without each component: the AR object itself, the knowledge/motivation to access it, and being in the physical space, the message is "invisible." Finally, mobile AR is non-exclusive in that one augmentation does not exclude another from being in the same space.

These unique components of mobile AR allow users to create public and private correspondence. Some users are creating public content *about* the places themselves, in an attempt to guide people through that space. Others are instead creating augmentations that communicate *through* places, by creating virtual objects tied to location for the purposes of personally interacting with others. Both these practices expand on existing research in the geotagging literature, specifically that people tag characteristics about places and insert personal narratives through place, demonstrating expertise and ownership of that place (Humphreys and Liao, 2011).

Crang and Graham (2007) theorized that AR could allow for overcoding and pluralized the authorship of augmented space to promote new practices of direct contact and association. In this study, we found a specific type of overcoding, and not necessarily ones that attempted collaborative authoring. First, we found that the applications of AR were typically done over specific types of physical space, and developers consciously chose highly contested public areas or curated spaces. Second, we found that they did not just physically overcode on top of those places, but utilized physical artifacts within that place to tell stories that historicized, made commentary, changed the meaning of, subverted, and reproduced narratives of that place.

In his explication of strategies and tactics, De Certeau (1984) describes how the powerful are able to "master places through strategies such as triumph of place, panoptic practices, and ability to define the power of knowledge" (p. 36). Specifically in contested places like borders, political monuments, and public squares, De Certeau (1984) describes numerous ways that governments and powerful entities create those places strategically, draw spatial borders around them, attempt to surveil activities in those places, and discipline the meaning of those places (e.g. official descriptions of events on signs and placards, security forces, who is able to be there, etc.).

It was these explicit attempts to officially name, create a dominant meaning, and dictate what is acceptable in these places that motivated creators in this study to choose these public spaces (squares, parks) and private spaces (museums). Their augmented memorials aim to speak for the oppressed and remember events that are erased by strategies and institutions that manage place. Particularly in targeting public squares and places where governments and institutions often attempt to assign their own meaning and history through rigid and disciplinary forces (e.g. International Borders, Tiananmen Square), AR content work to recontextualize place by playing "on and with a terrain imposed on it and organized by the law of a foreign power" (De Certeau, 1984: 37). Utilizing the particular characteristics of mobile AR that require people to know that something is there and be in that physical location, these augmented objects exist in the strategic terrain but in a tactically invisible way that places it out of the panoptic eye of dominant authorities.

Participants also went beyond just changing the representation and began telling spatial stories, or narratives that transform and "organize the play of changing relationships between places and spaces" (De Certeau, 1984: 118). These mobile AR projects were attempts to change the narration of existing places and cut across the boundaries and limits of the place. Through these examples, we see people problematizing the dominant narratives crafted and maintained by strategic powers and utilizing mobile AR to create visual representations that reproduce, reappropriate, and displace those narratives. They actively used the objects in the physical space to bring stories to the forefront that were underrepresented, untold, or had disappeared. For example, using Border Memorial augmentations to "read" physical objects in that space such as old campsites and empty water bottles represents what De Certeau (1984) would describe as bringing out the stories and hidden knowledge of the world's debris, giving voice to invisible histories and memories of those places.

Finally, mobile AR also allows for unlimited reproductions of that space because augmented space is non-exclusive. De Certeau (1984) talks about stories surrounding space

as unlimited, numberless, fanning out in a spectrum, but the assumption has been that physical space is immobile and finite. Mobile AR broadens this framework with its ability to make visual representations in physical space which are non-exclusive—those unlimited stories can now be envisioned and embodied in the space itself without the authority to change the physical or the need to change the physical space. Unlike the assertion of power in physical space through exclusion, one person's augmentation of a physical object does not prohibit anyone else from being able to augment the space. These overcodings do not rely on collaborative authoring but instead are messages that can either encourage a collaborative dialogue with place (e.g. finding the parking areas, aiding in a sanctioned use) or a critical/combative dialogue (e.g. AR Tiananmen Square). Therefore, a multitude of stories can exist and be told in the same space through mobile AR.

As mobile AR becomes accessible for more people around the world, studying early adopters and emerging uses of Layar helps deepen our understanding of how changes in media may complicate the spatial landscape and our relationship with place. While this study only focuses on a unique set of early adopters of the technology whose experiences are specialized to their goals, their practices are still important to study because it is at these beginning stages of adoption when many norms and assumptions of usage are explicitly negotiated and articulated (Marvin, 1988; Rogers, 2003). As more people potentially adopt mobile AR and use it more regularly, these early practices can help shape their actions and contribute to broader uses of the technology.

Conclusion

Mobile technologies increasingly force us to confront issues of location as an influential factor for communication. Sheller (2012) uses the term "mobile medialities" to describe the various ways mobile technologies are mediating experiences, practices, and creating new and flexible mediated spatiality. While there are structural and pervasive power asymmetries in the creation of physical spaces, we see examples in this study where people are utilizing mobile AR technology to tactically exert their own power on these places. They did this by using the technology to heighten their connections with their surroundings, changing the augmented representation and meaning of places, and questioning people's authority to construct place. Future research would do well to further analyze users' perception of that relationship, using perhaps interpretive visual communication methods. As AR practices become more prevalent beyond early adopters, age and gender differences are also worthy of additional study.

It is also important to mention that these creative processes and possibilities for creation are fluid. AR is a growing industry comprising many powerful and strategic actors. As AR's potential for tactical reproduction and reinterpretation of space is realized, it is possible that strategic forces will seek to reclaim, limit, and possibly censor some of that tactical production. Similarly, the vision that powerful actors will deploy these tools to impose dominant narratives onto place, identify people through the medium, and make spatial practice transparent is a part of the discourse surrounding AR (Crang and Graham, 2007). The non-exclusivity that AR brings also raises concerns that people might utilize technologies to diminish their reality, or wall themselves off ideologically and politically (Liao, 2012; Spohrer, 1999).

For now, users are able to produce augmented space with minimal cost, produce layers in most physical locations, and augment what they wish outside of official control. Moving forward, researchers should continue to monitor the complexities of relationships, institutions, and organizations that host AR space, as well as the potential push back from dominant power structures to reassert control over AR space.

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