Urban User Interface

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INTRODUCTION

The January 2011 Egyptian uprising in Tahrir Square was called a "Facebook revolution," but its importance is not that it was solely digital, but rather that information and space were bound in an arena for social change. Some recent work analyzing the location of tweets within Cairo reveals a pattern that is directly tied to the location of mosques in tight alleyways during the insipient stages followed by surging crowds and tweets in Tahrir Square. Such technologically enabled social practices not only present challenges to policy officials concerned with the regulation and security of citizens in urban spaces, but are also giving rise to a plethora of new research opportunities for urban designers about the methods, effectiveness, and locations of their intervention.

Central to this discussion concerning the contemporary urban fabric is the rethinking of social life and urban places through highly integrated physical and virtual realms. As Robins and Hepworth urge, there is a need for a deeper understanding of the relation between technological developments and social and spatial processes (1988) to effectively plan for current and future urban environments.

In this paper, we begin with three specific urban situations from our research that require an understanding of these new issues; we then connect these situations to existing discourses from architecture, urban theory, and computer science. Our goal is to outline a theoretical position for urban discourse that combines an understanding of new technological forces with existing theoretical frameworks.

The examples from our work range in scale from urban spaces in specific locations to entire metropolitan regions, but they share a focus on public engagement with the built environment. While there has been a general move to transcend the distinction between urban design focused on form and space and urban planning based on policy, we will be using this distinction to precisely demonstrate their intersection.

One area of our research centers on issues of representation and mapping at an urban scale. How can we best present complex information to analysts and users, combining space and data in useful ways? Working with researchers in the area of visualization, we have developed representations of the city that are user-centered, based on both location and on the interests at hand. We have distinguished between spatial and semantic descriptions of the city, and have demonstrated how to translate knowledge between the two. This research relies on an understanding of **interactivity**, a perceptual concern for Human

Computer Interaction researchers. We find that the idea of a single map of the city is naïve; the digital flaneurs expect instant and continuous data about shopping, navigation, history, weather, and politics.

A second area of research is the emergence of Twitter-based food trucks in the San Francisco Bay Area. How are we to think about space when it refuses to remain in place? We have developed techniques to map and understand the relationship between mobilized services and location-based information via social media. The overlay of real-time information onto space reveals reconfigured social patterns of exchange and of movement. **Embedded interaction** refers to the transition in interface design from command line interfaces to graphical user interfaces and then to fully physically embedded systems. In this context, systems we use are embedded in our social practices and provide us with the ability to create and communicate meaning through our interaction with the system (Dourish, 2001).

Public spaces are increasingly being flooded with media, computing and interaction. What are the critical dimensions of design for these mixed places? Using anthropological ideas of place and perceptual concepts from computer vision, we have shown how to extract meaning from a complex public setting and use it as part of a public interface. **Affordance** is a term from psychology that studies cognition not as an internal state but as an interaction with a particular environment. We use this concept and its extended use within computer science as a means to propose a theory of computing in public.

URBAN VISUALIZATION & INTERACTIVITY

Numerous systems have been developed to display large collections of data for urban contexts (e.g GIS); however, most have focused on layering of single dimensions of data and manual calculations to understand relationships within the urban environment. Furthermore, these systems often limit the user's perspectives of the data, thereby diminishing the user's spatial understanding of the viewing region. In collaboration with computer scientists in the field of visualization, we developed UrbanVis, a highly interactive urban visualization tool that provides intuitive understanding of the urban data. This system utilizes an aggregation method that combines buildings and city blocks into legible clusters, thus providing continuous levels of abstraction while preserving the user's mental model of the city. In conjunction with a 3D view of the urban model, a separate but integrated information visualization view displays multiple disparate dimensions of the urban data, allowing the user to understand the urban environment both spatially and cognitively in one glance. This system allows for the active exploration of alternative scales, interests and locations.

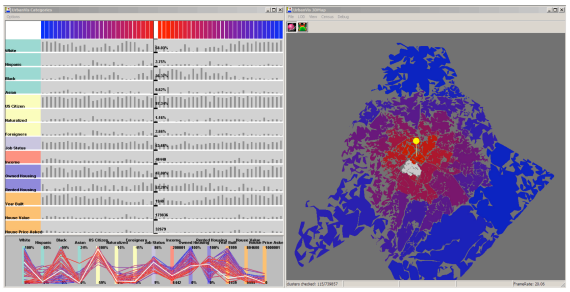

Figure 1: UrbanVis overview. The data view on the left shows demographic data of the areas around the focus point (focus in the middle). The model view on the right shows the clustered building models. The color gradient indicates the distance from the focus point, and provides a visual link between the two different data views (matrix view and parallel coordinates) and the model view.

The critical insight of this research is that the form of the city is variable. Within this program, the form of the city is organized as a hierarchy of single buildings combining into larger and larger aggregate forms. As we move our focus within the city, the rendered shape is altered, not as a function of the necessities of computer graphics, but in way that reflect meaningful assembly of shapes into larger units (based on Lynch (1960)). Our current work on this project deals with the addition of semantic information to this algorithm; particular interests of a user influence the hierarchical structure of the urban form. Urban form is variable based on user location and intent.

An understanding of this new representation requires an understanding of interactivity as it is understood within the computer science community. Although interactivity is sometimes associated exclusively with gaming, it has become increasingly important to the fields such as of information visualization, as the ability of users to interact with data allows them the opportunity to explore meaningful relationships. This increased ability to interact has been associated with human computing systems (Law & van Ahn, 2011) and with the foundation of human computer interaction through the work of Schneiderman (1987).

In our collaboration with computer scientist interested in interactivity within visual analytics, we have begun to understand the role of urban design as a spatial background that interacts with the data both in terms of its semantic meaning and in terms of the shifting position of the user. In both cases, space becomes not a fixed matrix but one that is based on the interests and position of the user. Urban form becomes a framework for the understanding of the city.

TWITTER-BASED FOOD TRUCKS & EMBODIED INTERACTION

The growing mobile food truck industry across major U.S. cities exemplifies the interrelation between information technology and social life in urban space. Central to the success of this enterprise are online social media platforms, which not only allow for vendors and customers to communicate various types of information, but also allow vendors to mobilize around a city and activate urban areas. Viewed as a trendy and hip activity, food trucks can rapidly generate droves of customers even before they park by using social media platforms. Some trucks cater to customers who enjoy the convenience and accessibility of the to-go style meal during lunch periods. Other trucks park outside nightclubs serving the masses offering food and a place to socialize in their long waiting lines. Street food events, such as the Bay Area's "Off the Grid" and Oakland's "Bites Off Broadway," are becoming permanent fixtures in the urban fabric with unprecedented attendance. Beginning in 2008 with one location, "Off the Grid" now hosts as many as 12 locations and has been visited by as many as 9,500 attendees in one evening. Despite the fact that food truck owners face a plethora of regulatory obstacles to operate and maintain service in cities, their demand promises incessant customers with no sign of diminishing. By examining food trucks in the San Francisco Bay Area, a region that has exploded with vending activity over the past decade, we reveal a heterogeneous network of relations among food, customers, vendors, mobility, time, urban space, and communication.

Figure 2: Food truck vending. San Francisco, CA.

Central to this study is the diminishing significance of traditional concepts of urban form and the emergence of place as an intersection of technology, human activity and space. As early as 1964, planner Melvin Webber proposed a "nonplace urban realm" framework for cities suggesting that accessibility through electronic channels of communication, rather than physical propinquity, would become the necessary condition of place and that territorial place is less important to maintaining social communities. Conversely, planner and sociologist William Whyte suggested the importance of place resides in its system of physical and social organization that should be empirically studied in order to understand the key determinates of its vitality (1980). The mobile food truck phenomenon is neither a distinctly virtual or physical condition; rather it is germane to the concept of embodied

interaction popularized by informatics scholar and professor Paul Dourish which suggests that the use of technology must be understood in relation to the environment in which it is situated; it might be defined according to a particular point in space and/or moment in time (2001, 91). By employing the notion of embodied interaction, how can we better understand the meaning of interactions between people and social media in relation to the social setting in which they unfold? Do these interactions reshape traditional notions of place?

To pinpoint food trucks in the San Francisco Bay Area and narrow the analysis, less affluent and often marginalized food trucks are set aside to expose the emerging type of vending distinguished by trucks with innovative designs, restaurant quality food prepping equipment, and vendors who use social media platforms on a daily basis to communicate with their patrons. Eight food trucks were chosen by analyzing the high frequency of tweet activity of vendors in the region. Information was collected on the time the tweets were posted by food vendors, as well as the content of the tweets, which included planned vending locations in the city and daily menu items. By interviewing food truck owners, information was also obtained about locations where vendors prepared their food before and between vending services (i.e. locations of certified prepping kitchens) and where they were located in the city when they sent out tweets to customers. In addition, vendors were asked where they parked their trucks overnight, which varied from parking lots at prepping kitchens to separate commissaries. This information was recorded and used to map vendors' starting points on their daily route, geographic locations of tweets when posting on Twitter, places of vending service, routes of travel between vending services, and finally ending locations. A series of maps were then generated for a single day at one-hour intervals to display the activity of the eight food trucks.

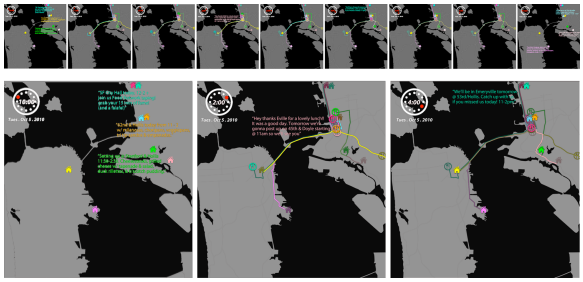

Figure 3: Food vendor and tweet activity in the San Francisco Bay Area. This information was documented for eight mobile food trucks every hour on Tuesday October 5th, 2010.

First, a macroscopic lens illustrates the spatial patterns of food vendors combined with social media communication as a field of sporadic activity expressing little predictability of function to the observer. Webber indicated that neither traditional city plans nor their underlying studies have successfully depicted the city's social processes or flows of information through space, and yet, city planners have traditionally sought to influence social processes (1964). Today planners understand the importance of visualizing social relationships, but representing the processes that operate virtually is often difficult. Those interested in the future development of urban environments must conceptualize and attempt to visualize social processes as both virtual and physical integrated networks that extend beyond self-contained spatial understandings.

The social processes and actions that unfold in this time-lapse visualization indicate a new form of urban meaning. Following Dourish's work, this new form of urbanism is based on events rather than on abstract and separate notions of space, social interaction or computing. The meaning of any human event is determined not by a universal measure, but rather by a specific context that includes who uses the space, when they use it and what they do while they are there. Dourish calls this embodied interaction to distinguish it from more abstract methods.

While urban space will continue to matter in a digitally connected world, this study shows the interweaving of social and information factors with space. As vendors determine locations for vending and disseminate this information via

social media, the traditional fixed notion of place diminishes as events are produced. This implies that acts of urbanism arise as particular behavior occurs in a particular place at a particular time for a particular reason. Backwater urban space such as alleyways, mall parking lots, and community parks become instantly and densely activated with social activity centered upon the food truck. Moreover, vendors are known to adjust their menu items and their music selection in relation to the locations they choose, in order to attract customers of the local demographic. Place in this context situates the process of the digital communication and acts as a fundamental and constitutive component of the activity that takes place.

The social, cultural, and technological practices occurring within and around food vending locations constructs a new spatial and temporal order where meaning is produced at specific moments in time that is embodied in digital communication. This specific case also suggests that digital communication and connectivity propagate physical real-world connections, and today, both can produce prosperous social life in cities.

COMPUTING-IN-PLACE & AFFORDANCE

Public spaces, from the Vatican to Times Square have embraced the use of digital displays as an important element of design. There is a significant body of research in social and ubiquitous computing that addresses how groups of people use computers or how computers are embedded in physical space; yet, there is no framework that deals with the design of combined virtual and physical spaces and the resulting interaction of large numbers of users as a social-computational system. Until such a framework exists, there will be no systematic method of designing or evaluating the use of computing in public places. As a result, many of these interactive public displays become merely expensive signage rather than enablers of interactive and engaging public spaces.

Figure 4: Digital Tunnel Installation. A public interactive installation connected two locations on the UNCC campus.

ComputingInPlace is an initiative involving researchers in anthropology, computer vision, and human computer interaction to define a theoretical and practical framework for the design and evaluation of interactive computing in public spaces. For such spaces to better engage people and take advantage of virtual and physical capabilities, they must be adaptive to the people in them, incorporating not just passive displays but also interactivity in a particular place as a form of socially-intelligent computing.

The immediate objectives for this research are two-fold. First, we are developing automated sensing techniques that are particularly suited to such public spaces, using insights from anthropology and architecture to guide tracking and action recognition toward higher-level concepts of meaning, place, and spatial affordance. We currently have a system deployed in a large public university building. The system is capable of tracking multiple users for position, vector and grouping information.

Second, these insights are being used to develop strategies to guide the design of responsive virtual and physical environments that can afford multiple channels of communication between members of the public. Anthropologists are studying user behavior within this public space using video, proposing meaningful behavior patterns that

can be applied automatically to huge and on-going video databases.

Camera-based sensing, when guided by a more sophisticated understanding of human behavior, is a general and inclusive method of capturing behavior in public spaces. Purely automated methods for video analysis are limited in their ability to extract meaning from object motion; thus, there is a need to incorporate human understanding into a mixed-initiative framework to guide interface and architectural responses.

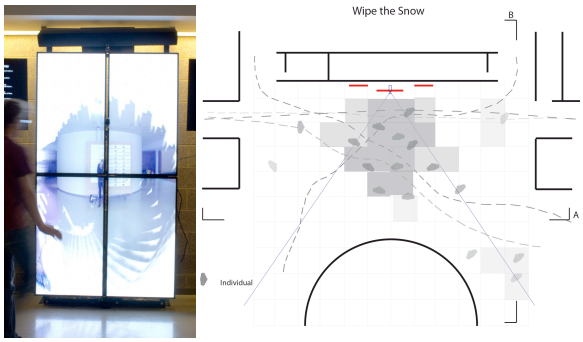

Figure 5: Digital Tunnel. Analysis of movement activity and affordance.

We have also studied the role of spatial analysis for these public computing systems. Two aspects have emerged as central to this understanding: the spatial extensions of the technological media and the analysis of the behaviors of users.

The spatial extensions of the technologies vary widely with the nature of the system. Speakers create dispersed spatial fields; cameras tightly constrained ones. We have developed a notation system that allows simple methods of calibrating space and technologies. This system is useful for both analysis and design. The analysis of the behavior of users has centered around analysis of movement and of the specific activities of the users. This is useful mostly in comparing different alternatives or settings.

The central insight of these studies has been the conditional importance of space and form. There are aspects that are vital to understanding a public display and others that have no effect. These effects are tied both to the spatial aspects of technologies and to the positions and activities of the users.

One theory that has dealt with both of these factors is affordance theory (Gibson 1979), which attempts to understand cognition and perception not as an internal state, but as an intersection of the physical world with the movement and intentions of humans with that ecology. Beginning as it did with understanding the role of cognition and perception in the training of pilots, it has always had a prominent role for the physical setting. The emphasis has been on those aspects of the physical design that are seen and acted directly, such as flat surfaces to walk on or walls that occlude vision. Within the HCI community, affordance has been adopted as a term that covers anticipating the likely desires of a user using text and graphics.

Our work with colleagues suggests a broader importance to the concept of affordance. We expect that following the idea of physical cognition (Card 1983), the constructed environment "stores" cognitive information in physical form. These physical forms organize possible sets of behaviors, and are often expressed with terms such as "way finding". Work on space syntax is one form for this idea (Hillier 1999) although the insularity of this approach is often not very useful.

At a practical level, we need to be able to evaluate space and form in a way that clearly indicates a set of possible actions within the space. Any abstract idea of spatial arrangement is of limited use; we need to provide a description that shows the intersection of human activity and built form.

CONCLUSION

The futuristic tenor of urban theorist Melvin Webber in "Order in Diversity: Community Without Propinquity" (1963) and "The Urban Place and the Nonplace Urban Realm" (1964) set the stage to rethink the dynamics of communication and urban spatial arrangements in cities. Webber's work challenged the traditional conceptual framework of cities as places in which physical

artifacts and social interactions are spatially distributed in the built environment by acknowledging the emergence of new social relations dependent on public communication and interaction that transcends place. While at the time revolutionary, Webber foresaw public communication channels, such as electronic transmission devices (i.e. telephones), mass communication (i.e. radio and television), and face-to-face communication, to be indicators of cultural development, which can be used as devices for evaluating the effectiveness of plans and programs for urban spatial structure. This prospective reading of the city focuses on social processes as webs of interaction dependent on accessibility rather than traditional, place-based conceptions of urban environments

Our work with ideas and colleagues on problems of urban form and representation has led us to consider concepts of interactivity, embodied interaction and affordance as specific instances of Webber's more general idea that frame the current changing nature of cities. We have used these studies to suggest how theories of urban design will need to adapt and respond to cities that are information saturated.

Undoubtedly, ideas of urban form and space are still relevant; indeed, space is one of the dominant metaphors for graphical user interfaces. But just as ideas of space invade computer science, ideas of procedure and interaction invade urban design. We have found that this adaption will include three practices of interactivity, embodiment and affordance.

1. The careful consideration of user-centered interactivity. This requires a specific set of expectations or demands for those who will be using the city and their cognitive reading that takes place in experiencing cities. Maps are still important, but the day of a single map of a city is gone.

2. An empiricist understanding of the full context that situates information will be vital. This means that descriptions of urban settings will of necessity include ethnographic approaches. This "thick" description of the interplay between humans, technology, and the built environment will substitute for reductive and singular ones.

3. Urban settings will be understood and perceived as a series of potentials continually fashioning and refashioning themselves, rather than acting as stable and permanent fixtures. This will require the construing of alternative scenarios of action that respond to the temporary rhythms of urban life based on immediacy and mobility enabled by technology.

Each of these practices requires that those concerned with the future of urban environments adapt to a wider range of analytical methods. Regardless of the historical tension between urban design and urban planning, both fields are now faced with a complex set of social, economic, and technological revolutions that demand immediate attention from both angles: the ways people and places, movement and urban forms, and nature and the built fabric form a connective system, as well as the technical, political, and implementation measures needed to manage land uses.

Since the emergence of the industrial city, we have moved from history as a source of unity for the city to principles and strategies of modernization focused on the social sphere. If an urban user interface were to emerge as a source of unity, it will likely be less focused on singular and stable representation of the city and more focused on individual and collective experience.

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