SOCIAL "CODING:" URBAN PROCESSES AND SOCIO-COMPUTATIONAL WORKFLOW

INTRODUCTION AND OBJECTIVE

The urban environment that surrounds us is not only built and formal; human and environmental phenomena inhabit built form to create a cohesive medium of urban experience. Some argue that the city may no longer be understood as a whole but rather a system of related processes [1]. As ubiquitous urban computing increasingly integrates the part physical and part phenomenal worlds, human and non-human interactions occur in two ways: 1) between humans and the urban environment via information interfaces such as Twitter, and 2) in the design and analysis workflows that increasingly connect architects, landscape architects, planners, ecologists and economists that make up the complex, interdisciplinary work of urban design today.

New research gaps and emerging opportunities exist of users and mobile computing interfaces as tools of computational urbanism. In particular, social relationships as distinctive as cultural background may now be incorporated into computational urban design work through the use of new multiplatform methodologies to collect, codify, analyze and begin to design for the processes of social phenomena in cities.

URBAN PHENOMENA AND SOCIO-COMPUTATIONAL WORKFLOWS

Urban designer William Whyte in his 1980 film *The Social Life of Small Urban Spaces* used on-site video to understand how the social behaviors of people interact with the built physical environment. [2] Theorists today such as Juhani Pallasmaa speak to architecture's ability to engage the senses [3]; and Bruno Latour's ideas of atmosphere and attachment in the context of digital social media allow us to think of an urban design approach not as one that yields petrified physical form but as one that adapts to the time-based phenomena of people and built environment [4]. From these theoretical understandings and the ubiquitous integration of urban computing and human experience, new fields of urban robotics and smart city design have emerged. Traditional urban design understandings of land use, urban form and transit have given way to the manner in which people and natural resources coexist [5] and metabolic understandings by biologist Salvador Rueda of the Barcelona Agency of Ecological Urbanism in his

Methodological Guide to Sustainable Planning that outlines: land use, public space and sustainability; mobility and services; urban complexity; green spaces and biodiversity; urban metabolism; social cohesion and management and governance [6].

The research presented here investigates both a methodological workflow to 1) "codify" twenty-two qualitative characteristics of cultural background, business access and architectural infrastructure data to geospatially quantify the nuanced differences of adaptive urbanism; and 2) develop an IronPython script within Grasshopper to automate social coding and geospatially visualize the urban data (figure 1). The word "coding" used here will describe the translation of qualitative, in person interview responses to numerical data using binary 0/1, rating, numerical count, typological and relative evaluations.

SOCIO-COMPUTATIONAL METHOD: CSV DATA TO GIS WORKFLOW

The research around the content of food carts and food trucks, respectively in Portland, Oregon and New York City, was initiated as a systematic way to collect and process in-person interview data of mobile cuisine owners between two teams of investigators working separately. Three features of mobile cuisine were studied: the food, the business, and the vehicle, including its use of space and time. Data was drawn from interviews conducted with 40 operators of mobile food trucks in New York and 42 operators of stationary carts and trucks in Portland, Oregon. The work continued an ongoing collaboration in the investigation of public space between one of the authors providing geospatial computational expertise and an urban sociologist located in New York. The methodology described here was used to geospatially understand the distinctive urban qualities of mobile cuisine for the book chapter "Food, Time and Space: Mobile Cuisine in New York and Portland" for *Ethno-Architecture and the Politics of Migration* (2015).

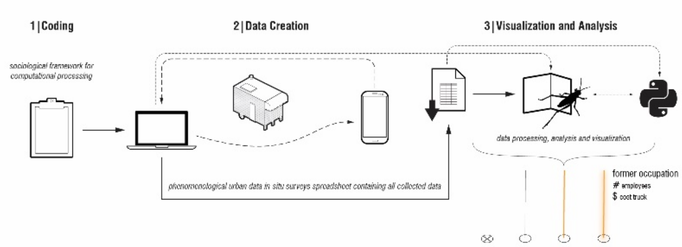


Figure 2, Left: Photo of Taste of Transylvania. Figure 3, Right: Diagram of Methodology Chart.

“Coding”
Objective: To establish sociological and human-scaled framework for computational processing.
Actions: Creation of researcher-conducted surveys to be deployed via online platform Formhub through mobile application ODK Collect.
[Product: Quantifiable survey.]
Data Creation
Objective: To collect phenomenological urban data through in-situ surveys of mobile cuisine owners.
Actions: On-site, researcher-conducted interviews; data uploaded to Formhub’s servers for later data processing.
[Product: Downloadable spreadsheet containing all collected data.]
Visualization and Analysis
Objective: To aggregate downloaded data for geospatial realization and analysis.
Actions: Data aggregation in Excel, data processing, analysis and visualization in Grasshopper and GHPython.
[Product: Geospatially-visualized urban data.]

Chart 1, Methodology chart.

Additionally, the work contributes to the idea of an IoT, or Internet of Things, specifically Mark Wieser’s prediction that computers and computation will become less and less visible, and more integrated into a complex web of relationships between people, space and behaviors [19]. The inclusion of characteristics of the business owners via the mobile survey workflow makes affective these qualities in an urban design process where designers are more and more comfortable finding data off-site. The computational coding, GIS work and use of mobile smart phone device with sensors described here empowers designers who do in-person interviews to systematically reach broader applications. It affords a human and non-human workflow when the individual parts of people, mobile devices, online interview software and the study of GIS already exist independently. These aspects of design process are no longer autonomous but are interconnected.

Sociology Workflow: Ideas, Research Questions, Survey Questions and “Coding”

The creation of new data from scratch [7] relies on a clear sociological protocol to data collection. The presented research ideas and survey questions were developed, led by the urban sociologist, to gather data via in-person interviews by the researchers of business owners of food carts and food trucks, respectively ‘pods’ in Portland, Oregon and ‘rallies’ in New York City. Early research questions focused on the ideas of the *food* (cuisine), *business* (entrepreneurship) and *architecture* (infrastructure). Questions were categorized and articulated to elicit systematically comparative answers such as years, yes/no, number of employees, rating (1-5) and ‘match expected answer,’ with each ‘coding’ step carefully framing and recording the protocols of the original survey questions. The method is very conscious to carefully not flatten any information at the point of researcher interviews.

Data Creation: Survey Interface Formhub, Mobile App ODK Collect and On-Site Smart Phone Collection

To systematize the data collection, all interviews were aggregated into one spreadsheet. Efficiently working across the United States, the research team used Formhub [21] online survey service hosted by Columbia University's MODI lab. Smartphone survey interface types using the Formhub syntax included specific ways, or widgets, to skip irrelevant questions, dropdowns of 'yes/no,' numerical answers, 24 hour and 60 minute scroll-downs for times, check boxes for days of the week, image capture, and GPS to record latitude and longitude data (figure 3). A variety of challenges and problems were faced including coding syntax in Formhub and the need to develop survey questions short hand for cell-size legibility in Excel. In-situ surveying with application ODK Collect provided other challenges such as calibrating the tedious scale of scroll down times, recording data before knowing the owner was available, GPS accuracy, and the aggregation of different survey uploads to one CSV file and the intermitted access to Formhub's MODI remote servers. Formhub's online map interface allowed manual adjustments of data points to manually correct any GPS accuracy within five to ten feet. Overall the Formhub and ODK applications provided a user interfaces to compare survey data, facilitate on-site interviews and access smartphone sensors such as GPS critical to geospatially measure urban phenomena.

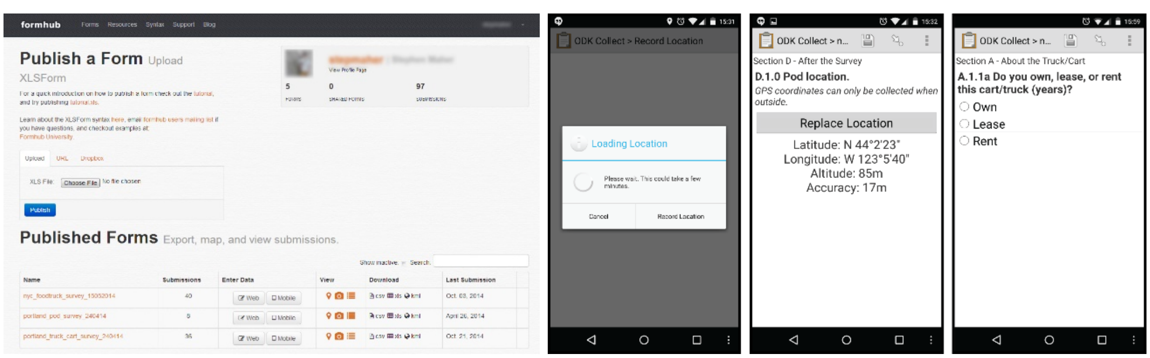


Figure 4, Formhub interface and ODK interface (GPS and multiple choice question).

Data Dictionary, Aggregate and Non-Spatial Analysis in Excel

An initial aggregate analysis of the answers to each question provided numerical averages and ranked occurrences, contextualizing the data between Portland and New York, and was used as numerical data to highlight observed trends in the aforementioned book chapter on ethnicity and architecture. This workflow step at the scale of cities was an important collaborative moment to bridge the qualitative social understanding and the quantitative computation. The answers to each question were organized using a 'data dictionary' including column headings for Variable/Quality, Indicator, Coding Type, Unit, Notes and Idea (Chart 2). The 'coding types' provided the most important understanding of coding translation, categorizing answers to formats such as 'does it match (ethnic/cultural),' 'match,' number, similar to (ethnic/cultural), specific reason (Ex. 2008 crisis), match (USA or not), or rating type. All of these answers were translated into numerical format units of 0/1, dollar amount or otherwise numbers. This step revealed that numerically aggregated, non-spatial data may be more effectively analyzed in spreadsheet format rather than in Grasshopper. Use of the two software together, finding thresholds to analyze data first in CSV formatted tables, allows greater efficiency for geospatial analysis in Grasshopper. The use of the data dictionary allowed the emergent pattern of categorization clearly into Cuisine, Business and Architecture/Infrastructure, used in subsequent test analysis for each food cart/food truck.

Category	**Variable/Quality**	**Indicator**	**Coding Type**	**Unit**	**Idea**
Cuisine	Type of Food	Food Description (ethnic/cultural)	does it match(ethnic/cultural)	0/1	Diversity
Cuisine	Is it ethnic/non-local	Food type	match	0/1	Diversity
Cuisine	cost_high	affordability	**number**	$	Access
Cuisine	cost_low	affordability	**number**	$	Access
Business	Entrepenuership	~their own business	similar to (ethnic/cultural)	0/1	Micro
Business	Entrepenuership	~their own business	specific reason (2008 crisis)	0/1	Micro
Business	Type of Business	Food Description (ethnic/cultural)	match	0/1	Unique
Business	recipe_origin	origin	match (ethnic/cultural)	0/1	Unique
Business	birthplace_owner	country	match (USA or not)	0/1	Unique
Business	birthplace_parent	country	match (USA or not)	0/1	Unique
Business	Business name	name	similar to (ethnic/cultural)	0/1	Unique
Business	Food Matches cultural background	analysis'	match	0/1	Unique
Business	Brick and Mortar	yes/no	match	0/1	Micro
Business	Brick and Mortar_desire	yes/no	match	0/1	Micro
Business	time of ownership	number	**number**	years	Access
Business	cost of truck	affordability	**number**	$	Access
Business	Staff	overhead / micro business (prefere	match	0/1	Micro
Business	Staff_how many	overhead / affordability	**number**	**number**	Access
Architecture / Infrastructure	Regulatory issue_city	grey	any	0/1	Ease
Architecture / Infrastructure	Regulatory issue_private owner	type	type	0/1	Ease
Architecture / Infrastructure	Virtual Presence	type	type	0/1	Access (know
Architecture / Infrastructure	cost of truck	affordability	**number**	$	Access

Chart 2, Data Dictionary.

Formulation and Visual Parameters

Traditionally, data is visualized as points at the scale of a city, district or neighborhood. However, the fine-grained data presented here is capable of being differentiated at the small-scale and shows vastly different qualities of information to the user, such as cuisine, business and infrastructure that is not conducive to traditional modes of urban representation. The sociological protocol would warn against mixing data, both numerically and visually, though formulation used various indicators for a single category. For example, aggregating business access data using 1) cart/truck cost, 2) number of employees and 3) job training via previous occupation, the three primary areas of cuisine, business and infrastructure would *not* be mixed. The work of Carlo Ratti's SENSEable Cities Lab and Manuel Lima provide some visual organization through order or coloration to create a single language that carefully shows varied information to the user. At a closer look, they maintain the distinctions of qualitatively unmixable information. A general unit for each cart or truck was visualized as a vertical line along the z axis with three parameters: 1) height; 2) color; and 3) weight. Unlike many GIS analysis across cities with evenly distributed data such as rental costs, building heights or demographics, this new phenomenological data was highly grouped in the pods or rallies and often spaced vastly apart. This new fine-grained and human-scaled data is therefore best understood at the scale of the urban room often centering around one to two blocks, an empty parking lot or on-street parking. The resulting visual analysis would provide clues to differences of urban design characteristics including building morphology, built fabric densities, street structures and regulatory support of private and public space that is otherwise not detectable at the traditionally larger urban planning scale of GIS visualization.

VISUALIZATION ANALYSIS AND *ELEPHANT*

Socio-computational workflows at the human and time-based scale of social phenomena required new scales to understand the city. When point-based z-line data was first viewed at the city scale, distinct lines and small visualization differences of height, color and line thickness, with various calibrations, could not be distinctively understood. The work of urban design suggests the valued ecological technique to "use a good helicopter" [10] to zoom far in and far out to understand cities. Visualizations of data at the scale of the city of Portland and of New York revealed certain differences of business access while not showing significant differences of cuisine qualities within each city (figure 4) (figure 5). However, clear differences between east and west Portland as well as Manhattan and Brooklyn New York are evident. Whether these are economic such as the cost of food trucks (figure 7), ethnic related to immigrant and first-generation status (figure 6) or morphologically different (figures 8a and 8b), they are understood upon viewing smaller scales of information. At the scale of the city, the locations of the pods and rallies reveal clues to situating these businesses, often gathering along major vs minor streets, easily differentiated as separate categories of OSM data introduced from the Grasshopper Elk plugin (figures 6 and 7).

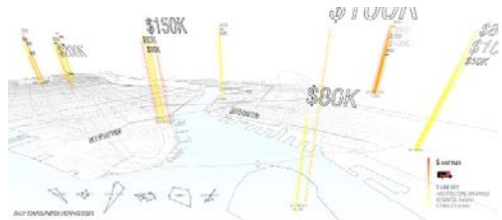
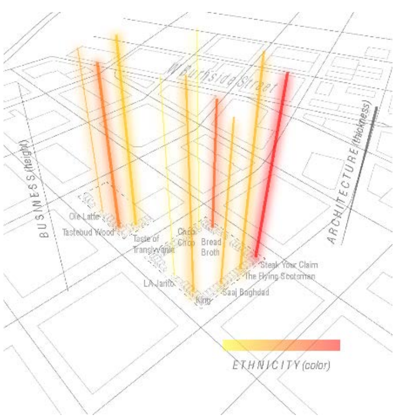


Figure 6, Portland, City Scale Visualization.   Figure 7, New York, City Scale Visualization.

The fine grained differences of data resulted in two approaches to clearly understand the information: 1) at larger city and district scales, showing either individual indicators such as the number of parking tickets received in New York or visualized combined information such as business access (cost of truck, number of employees, ‘yes or no’ of previously related occupation); and 2) at the urban room scale, the pod/rally was studied to understand the quality of that place. The latter can visualize block and street morphology differences via OSM data from Elk, including key clues to the location of pods and rallies in public or private spaces. In Portland for example, most food cart pods on the denser west side were located in parking lots, one as large as an entire block, with each cart facing outward along the street right-of-way, reinforcing normal sidewalk storefront economic relationships (figure 8a). Meanwhile, on the sparser east side of Portland, most pods were located near, but not directly, on major commercial streets of previously historic street-car lines, facing inward within the private parking lots, creating a more private experience that did not include the socio-economic life of streets (figure 8b) (figure 9). In New York, where the food trucks are far more transient than Portland’s food carts, owners predominantly use parking spaces often subverting the residential or park zoning use, but similarly activating the sidewalk with economic and social food services from the street side. The result is the ability to visualize any one or combination of twenty-two indicators of distinctive mobile cuisine establishments in the city, resulting in a careful urban computational understanding to control various 3D visualization possibilities in the Rhino/Grasshopper environment. In traditional planning interfaces, such as ESRI ArcGIS [11] there is less access to the user in a more closed, top-down workflow. The push and pull between traditional scales of urban design and the new scales for the users of urban ecological design interface of dynamic processes with this new information workflow became the critical and informative results of this last analytical phase of the computational design work. Existing Yelp, Google and other individual websites, Facebook and Twitter do not have these twenty-two indicators organized as metadata. A designer could choose any indicator. The research method encourages designers to meet the owners in-person which, for sociologists, is always important. Additionally, economic data is often not made public with the aforementioned social media but in person the design researcher was almost always provided such information.



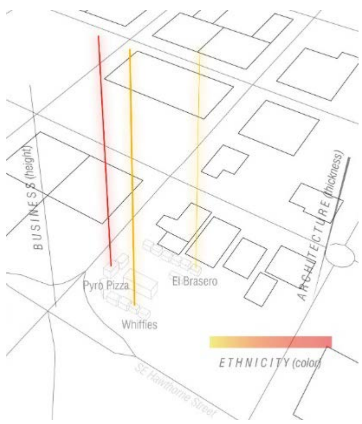


Figure 8a, Left: Urban room pod visualization, Portland, Oregon. *Alder Street Pod*.

Figure 8b, Right: Urban room pod visualization, Portland, Oregon. *Cartopia Pod*.

The visual analysis of “social coding” presented here involved an initial workflow of data inputs from both an OpenStreetMap OSM file for existing major streets, minor streets, buildings and waterways, along with the custom twenty-two cuisine, business access and infrastructure data in a separate CSV file. The workflow allowed certain non-spatial calculations such as overall indexes on a scale of 0 to 1 for each cuisine, business and infrastructure to occur in Excel. While this did not burden the Rhino/Grasshopper platform with complex calculations, twenty-two data types for approximately fifty mobile cuisine locations in each New York and Portland, enabled simple data visualization for these three categories for all of the pods/rallies (figure 3). Other challenges within the formulation included determining how to interpret null sets of information within the calculations. Determining the 0 to 1 domain for the cost of the carts/trucks for example required a standard deviation calculation using the maximum and average costs of trucks for that city. This would then provide a localized normalization in New York vs. Portland, but future research would benefit from greater statistical protocols.

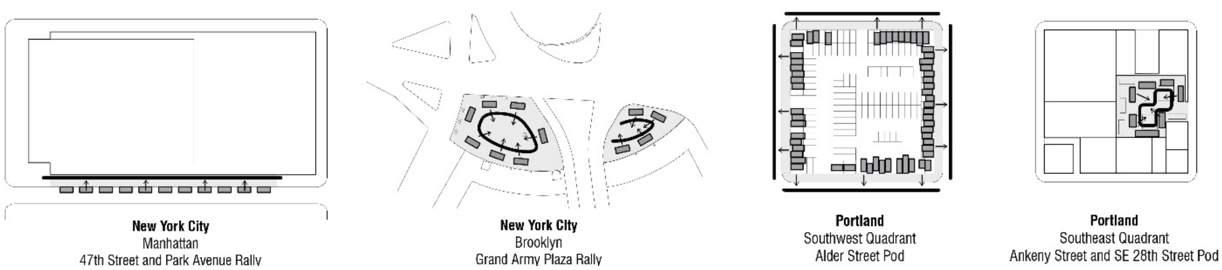


Figure 9, Food Truck Rally and Food Cart Pod geometries.

The resulting visualizations (figure 12) added greater resolution and careful differentiation of visual language, especially at the scale of the urban room. Cuisine, business and infrastructural information could be separated along the z-axis: 1) business access at the top including the cost of truck/cart, number of employees, previous occupation; 2) cuisine or ethnic identity of food at the bottom including as place of birth, parents place of birth and where they learned their recipes/name of the truck; and 3) infrastructure ease located at the middle including the number of parking violations. The newer New York visualizations still use the line height, color and line thickness for the overall indexes of each category.

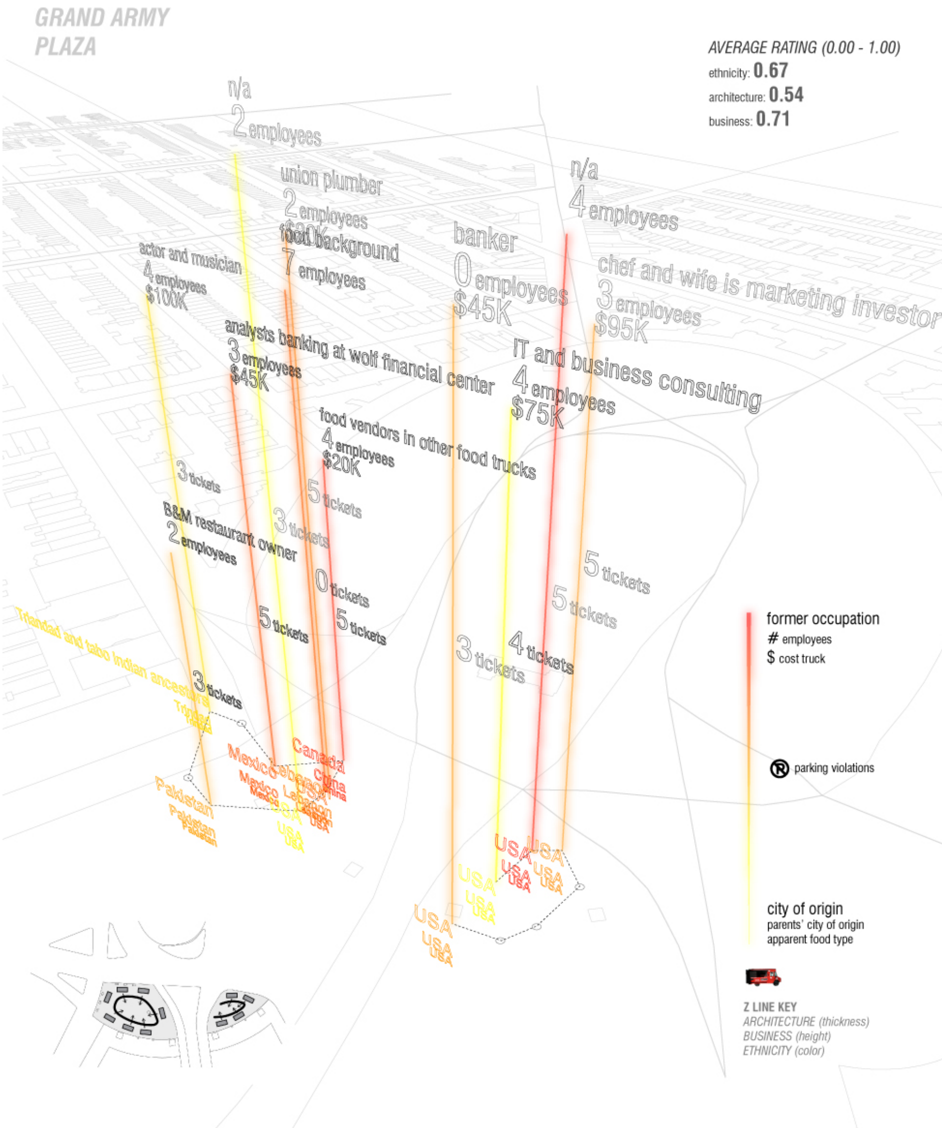


Figure 12, Rally at Grand Army Plaza, Brooklyn, New York.

OUTCOMES FOR URBAN DESIGNERS: INDIRECT, DIRECT AND REAL-TIME

The distinctive nuances of a city that accumulates processes to a greater whole, enable our design of the city as a living place. Economies of agglomeration [12] and the replacement theory of local goods by Jane Jacobs in *The Nature of Economies* [13] suggests the value of tools that affect users of human and non-human information. The socio-computational workflow presented here finds ways to efficiently connect urban ecological information across various software platforms using custom in-person, on-site surveys to visualize the diversity and ease of professional and economic access for food truck owners in New York and Portland. The careful protocols of this workflow create a systematically comparative tool to geospatially understand the subtle information of each business, across various existing and new scales of urban design, namely the city, the district, the neighborhood, and the urban room as the smallest spaces of human occupation between carts. The visualization tool provided an openly formulaic environment with its own opportunities and challenges within each step and between the various software environments.

The quantitative translation of qualitative information in the 'social coding' of this work offered that greatest challenges but also the most contribution. The sociological protocols were influenced by the advice and long-term collaboration with an urban sociologist, stressing the importance of in-person interviews on-site because they allow reflection of non-prescriptive data collection and iterative revisions of the data collection process. Moments of the greatest possibility to misunderstanding information occurred when combining dissimilar information, such as *Walkscore's* [14] numerical scoring versus its breakdown of various indicators, and when combining visual graphics, but learning from Manuel Lima's *Visual Complexity* [15] providing a basis with the combination of visual information. The intersection of the framework of cuisine, business and infrastructure combined with the computational workflow can best be understood as an investigation of these types of urban phenomena to observe the compatibility of qualities and numbers. Seen as a tool within an overall discipline of geospatial computational design, this tool attempts to contribute to the identification of visualizing agent-based [29] urban ecological phenomena.
The visualization of social phenomena affects urban design 1) indirectly via design strategies, 2) directly via value sets for parametric input and 3) in real-time feedback.

Indirect Design Integration

Indirectly the workflow, and yielded data, may be used to identify urban design strategies that respond to geospatial patterns of social use, such as immigration or business accessibility values. At scale of cities, research results included more immigrant owned food cart or food truck in Portland (58%) than in New York (44%), but more first-generation US citizens owned in New York (40%) than Portland (10%). The cost access of trucks versus brick and mortar restaurants $20,000 to $200,000 demonstrated access to ownership, the average vehicle in Portland costing only $26,500 and in New York $68,000. At the plaza scale in Grand Army Plaza in Brooklyn a strategy of new paving pedestrianized a location of food truck rallies and Saturday farmer's markets. More Portland operators desired to open brick and mortar restaurants (88%) than in New York (35%) with more owners with multiple food trucks in New York. These findings suggest indirect urban design strategies including: 1) Additional paving types to mark pedestrian food truck rally areas; 2) Eliminating or centralizing parking costs as done in Portland with Car2Go; 3) Adding nearby pedestrian areas with seating or tables for eating food. In Portland, owners responded more positively to regulatory support including designated parking areas from the city government as strategies to enhance cultural diversity for both food culture and business, becoming a top destination for tourists and locals. New York operators subvert the traditional planning use of parking spaces as commercial spaces and 86% report parking fines, some everyday, but still take advantage of truck mobility, with 85% changing locations during the day and on weekends to cater events such as weddings and corporate events. These phenomena and strategies of adaptive urbanism are closely related to the use of Twitter, Facebook and Instagram allowing customers to follow them over changing locations, menus and times of operation.

Direct Design Integration

Designers may use the integrated information to design the support of specific qualities of new food cart or food truck design, in the design of trucks themselves or the infrastructure for mobile cuisine. Directly translating parking ticket data in New York, for example, designers can create new regulatory support per neighborhoods or even physical environmental changes conducive to the city's mobile cuisine market. Strategies could also include 1) smart lighting responsive to truck proximity, 2) mobile application user data to affect behavioral change or 3) stepped parametric seating reorganized with different uses. In Grand Army Plaza for example immigrant owners seem to aggregate in one circle while US born owners in another. Perhaps parameters exist for each food truck design related to rear or side openings of the truck or integrated seating. Such direct urban design workflow directly connects analysis with design synthesis.

Real-time Design Integration

Real-time information about cuisine, business and infrastructure may be integrated into design using the social and economic data framework. Associated colors of light or text may be displayed in various aspects of public space design. An example of this may be seen in the Hult Public Plaza Design following a similar design protocol (figures 13 and 14) where white light across the plaza illustrates one set of values and colored light at each mound represents another. Values include owners' place of birth, origin of recipes, the number of other vehicles, previous occupation or highest and lowest cost of a meal (figure 14). This design illustrates all three data design integration approaches: 1) indirect strategies of sit, eat and play from similar data analysis and visualization (figure 13a); 2) direct design in the placement and data topography of values for stepped mounds for sitting, eating, playing and meeting near food trucks (figure 13b) ; and 3) real-time interaction design open to data using illuminated light and text for cuisine, business or architectural (figure 12), or natural phenomena such as air, water or heat/light (figure 14). Future research will develop an interactive circle diagram for public participation for the public to select desired program and location, using a mobile application or large touch screen.

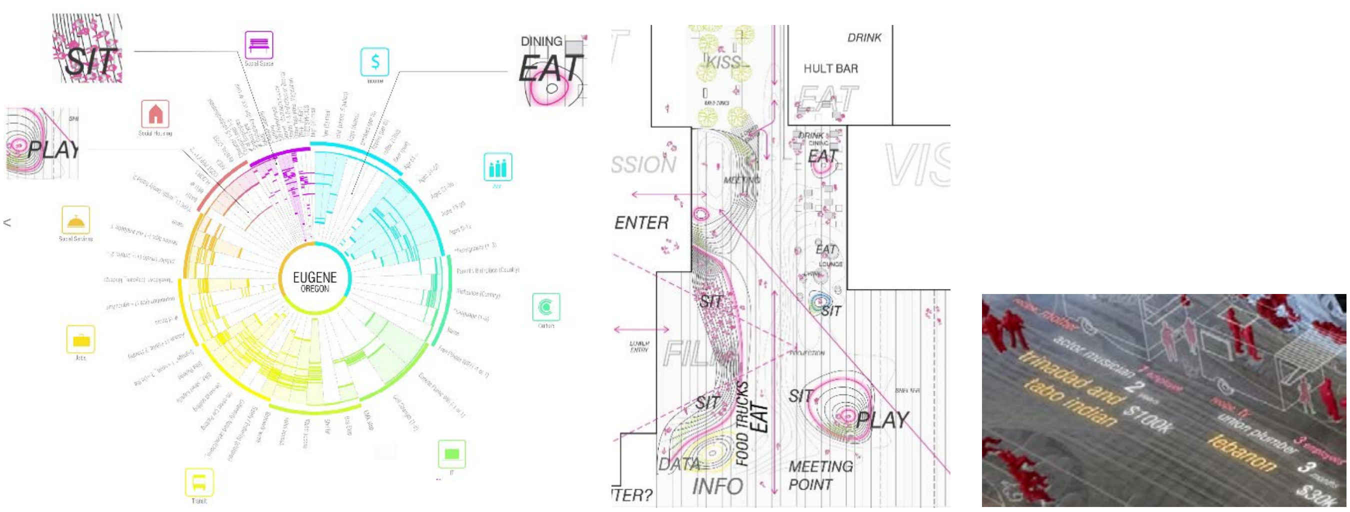


Figure 13, Hult Public Plaza

The data may also be made actionable to affect behaviors in public space by 1) using Human UI [16] to create a tool interface directed at non-Grasshopper users in design offices, 2) mobile applications and situated technologies such as kiosks for everyday users and 3) a website for business owners to plan or adjust their operations.

As cities change through the subversive and unplanned use of both public and private space, there is an increasing layer of urban design, namely sociological phenomena and resulting data that is conducive incorporating into already advancing methods of computational urbanism. The constant shifting of human and non-human information leaves us unsure of the relevancy of existing methods to understand our cities. Processes that break the barrier between sociological and computational workflows offer hope of a new discipline of urban design that may support a greater connectivity between people and place.

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