

## **'Attachment' as Agency in Off-Site and On-Site Indicators of Phenomena in Geospatial Urban Analysis Tools**

### **ABSTRACT**

'Attachment' is a term used by social media philosopher Bruno Latour to describe the use of data to understand the 'thingly' quality that connects a system to its place over time (Latour 2008). Using data to connect people and place in urban design, this paper describes an approach to creating custom urban analysis tools to gather data geospatial off-site and on-site. Unlike traditional planning software with such as ArcGIS, this approach uses open urban design scale software, plugins and custom scripts to individually formulate and understand new relationships and new dataset of ephemeral *phenomena* gathered on-site and off-site. This integration of human design and simulation intelligence increased agency in urban design and planning. These tools for agency empower and connective not only government agencies but also business owners and everyday citizens. Project tools for the post-industrial "22@" district in Barcelona are used to demonstrate these ideas.

City agencies, urban planners and everyday citizens have always worked to find ways to better design the built environment to support people and place over time. The understanding of 'attachment' was first used as applied to the virtual communities by social theorist Bruno Latour but later used to describe how architects may strive to create designs but measure people and place over time (Latour 2005). This paper describes an approach to urban design and parametric design to design focused analysis tools with existing and new geospatial data gathered off-site and on-site. The very nature of creating these custom tools creates an agency to measure temporal phenomena, or the everyday experiences (Norberg-Schulz). As the tools generative new possibilities from analysis to simulation, the agency of new understandings is created (De Landa).

#### **Tools to Measure the Urban Environment, Social Cohesion in 22@ Barcelona**

Rather than using the 'big data' of predefined relationships and existing data of urban planning software from the top down, this approach creates custom tools to formulate new relationships measuring phenomena gathered on-site and off-site. The research question asks if these new types of urban design tools may serve city planners, urban designers and everyday citizens of tomorrow. Urban design guidelines of the future may be driven by combinations of ever increasing computational and cognitive models, merging hybrid agency of artificial intelligence and human agency of both design and user feedback (Latour 2005). This is particularly evident in the study area of Barcelona's post-industrial "22@" information activities district. The 22@ district, initiated in the year 2000 to be unlike the top-down traditional planning of the nearby Olympic Village that destroyed much of the historic fabric, uses open-ended parameters. Guidelines for individual block units augment social cohesion between workers and resident including 10% minimums for social housing, social services and public space as well as protecting culturally significant built fabric.

#### **Qualitative Information in Parametric and Urban Design**

The approach described here supports understand the urban site first as existing data and secondly as newly collected *indicators* of qualitative urban design characteristic in-situ phenomena. An initial qualitatively understand urban experience defines the over arching goal of the tool. Design characteristics, or criteria, are determined (at the city block scale) to formulate information. The criteria are then measured through data collection using measurable indicators both quantitative (ex. rooftop area and height) and qualitative (ex. roofing material type and building structure type). Output parameters provide qualitative and quantitative understanding including color optimized to measure urban relationships from the neighborhood to the block scale.

### **Background of Attachment in Urban Design: Form, Program and Phenomenon**

Early parametric design that included parameters of phenomena of time and people has been credited to Ildefons Cerda's modular Barcelona *Eixample plan*, Frei Otto's (Spuybroek 2002) time-based material machines and Christopher Alexander's Pattern Language urban taxonomy. Patrik Schumacher's "Parametricism – A New Global Style for Architecture and Urban Design" (Schumacher) contributed to formal understandings of urban design. Bernard Tschumi's idea of *event architecture* contributed to the measurement of program over time and Ian McHarg and James Corner's contributed to the idea of indexing to measure adaptability of people and place over time. Artists such as Ned Kahn and Janet Echelman have used parametric design to make visible real-time environmental phenomena to understand identity (Echelman, et al). A recent generation of urban designers is exemplified by Carlo Ratti's SENSEable Cities Lab including the recent contribution of three types of differentiated datasets from: 1) single system; 2) aggregate data from multiple authors and multiple purposes; and 3) scratch about specific phenomenon (Nabien). This last example describes a recent effort also argued in this paper to include phenomena through a customized understanding of data workflow. Project tools become agents of understand.

### **Significance: Empowerment through the inclusion of qualitative phenomena**

Why is the inclusion of everyday phenomena important in urban design tools today? Design processes today that use data to include phenomena of both human and environmental data generate new understandings of forces that shape human interaction in urban space over time. Measuring indicator urban design criteria makes information accessible at a variety of scales previously unavailable to traditional top-down urban design and planning. In Barcelona this may provide for new small-scale variations of pedestrian distances, transportation systems and emergent, democratic and shifting hierarchy across the otherwise homogenous unit based system of the "Eixample" grid. The phenomenal parametric variables at the parcel unit within the block become Latour's 'thingly' qualities including the characteristics of sound and human behaviors (Latour 2005) with traditional geographic information systems measured here in projects. The objective is to empower current generations of urban citizens with urban design and planning tools that are informed from the smallest and most actualized scale upward to the larger city (author 2012) (Franck).

### **Existing GI and Quantitative Municipal Data**

The design process to integrate qualitative and quantitative information is integrated with geospatial latitude and longitude data in tabular format using plugins and custom scripts with architectural scale software Rhino/Grasshopper (Rutten 2007) rather than fixed parameters and existing datasets from planning scale software such as ESRI ArcGIS and City Engine first pioneered by Roger Tomlinson in 1968 paper "A Geographic Information System for Regional Planning" (ESRI ArcGIS 1999 and ESRI City Engine). Examples of municipal data collection include parcel area, building areas, tax assessment, property owner, owner address, zoning use, transit, etc. Sensors and measurement on-site has led to more recent approaches to urban computing inclusive of everyday phenomena in the project to be described here.

### **New Tools with Indicators**

This paper describes a new approach where data may be measured and compared with a constant assessment of qualitative to quantitative transformation, through the lens of on-site and off-site data collection with the purpose to understand people and place. Projects

for the post-industrial “22@” district in Barcelona measured off-site and on-site are used to demonstrate these ideas.

## 2 CLASSIFICATION: METHOD, OFF-SITE, ON-SITE, EXISTING GI DATA

In regard to the generation of new data project will be categorized in those that primarily gather data off-site and those that gather data on-site. In both cases a general method of formulating these project tools follows:

### STEP

- 01. Purpose:** Define an unmeasured **urban experience problem** in the 22@ district.
  - What, Why significant, Who does it affect?
- 02. Research:** Explore the **parameters to measure** this quality of attachment.
  - Identify parameters.
  - Comparative statistic in Barcelona with other cities.
  - Develop a visual language for parameter.
- 03. Criteria:** Explore urban design **characteristics** for parametric inputs.
  - Criteria to **indicators**: Identify indicators of these characteristics.
  - Map indicators for a 3 x 3 block set area (on-site only)
  - Analyze relationships individually
  - Repeat in other locations such as Granada, Spain (on-site only)
- 04. Formulate:** Develop relationships as analysis tool including weighting parameters
  - Model parameters at **abstract unit parcel**
  - Model parameters at parcels across **abstract unit block**
  - Identify existing Grasshopper plugins (HUMAN, ELK, Galapagos)
  - Model **real-world case-study block** in 22@, build 3D model
- 05. Model as Agent:** Repurpose urban analysis tool for synthesis
  - Expand the real-work block to **3 x 3 test area** with case-study at center
  - Develop parametric tool in Grasshopper including **output**
  - **Diagram** final formula from grasshopper
- 06. Findings:** Look for **emergent patterns** and

However the approach gathering data off-site versus on-site is important to understand the different type of agency of each approach and the urban design conditions in which they were gathered. The projects described here as case studies demonstrate always one of two related but different approaches to data collection and analysis.

### Off-Site, Virtual Data Collection and Formula Development

Work off-site forces a critical examination of the origin of existing data and the creative gathering of ‘first-hand’ data via online tools. Existing data is provided by the 22@ planning office in form of PDF and GIS shape files. New data is gathering using Google maps, Google StreetView, Bing, Yelp and other online databases.

### On-Site, The Addition of In-Situ Data

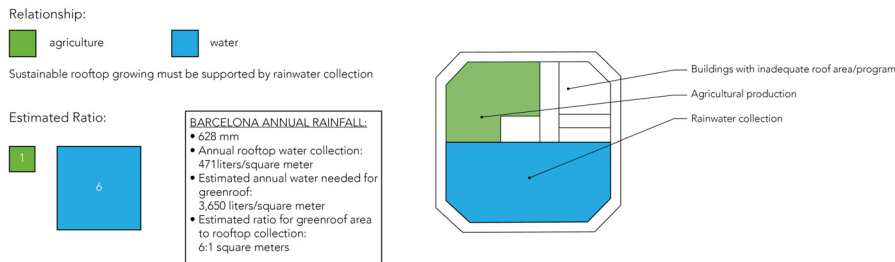
Work on-site in Barcelona made accessible new input data that is measurable in-person over time. Early work with mapping phenomena was done measuring indicators of these criteria at 33 meters intervals along the 100meter Barcelona blocks, totaling 108 points over a grid of three by three blocks. This first indicator set in Barcelona was refined and repeated in a different urban morphology in Granada, Spain with smaller *plazetas* and

larger formal spaces. Returning to Barcelona an individual test area to best study the phenomena was selected along with continued refinement of the urban design criteria and subsequent indicator sets. A minimum 3 x 3 test area was selected and data gathering was done on-site, off-site and compared with existing GIS shape files.

## 2.1 Farm City (On-Site)

The urban analysis tool Farm City identifies the optimal use of existing rooftops for urban agriculture and water retention for a single city block (see Figure 1). While such a tool uses the measurement of quantifiable data from online geometric data, it also uses off-site identification of roof type and building structural type as two qualitative criteria that are translated via a quantifiable rating system for a combined analysis tool.

Barcelona annual rainfall is 628mm with annual rooftop water collection of 471 liters/square meter. Estimated annual water needed for a green roof is 3,650 liters/square meter with an estimated ratio for green roof area to rooftop water collection is 6:1. Water is costly in Barcelona for residents and agricultural space is ever decreasing. Urban farming has become a valuable component for both reduction of transportation cost as well as a place for social interaction. A key component to the 22@ plan is the protection of many historic buildings. The tools use the existing form and height of building mass for any given test block- it does not simulate form but suggests qualities of use for agriculture or water retention.



**Fig 1.** Farm City, Unit of rooftop agriculture or water retention, ratio 6:1 and block prototype, students Erica Thompson and Wes Thompson

To measure these rooftop uses four parametric criteria of rooftops were identified and used as inputs: area, structural capacity, material and height.

**Surface Area:** A minimum surface area was determined for any rooftop/parcel size.

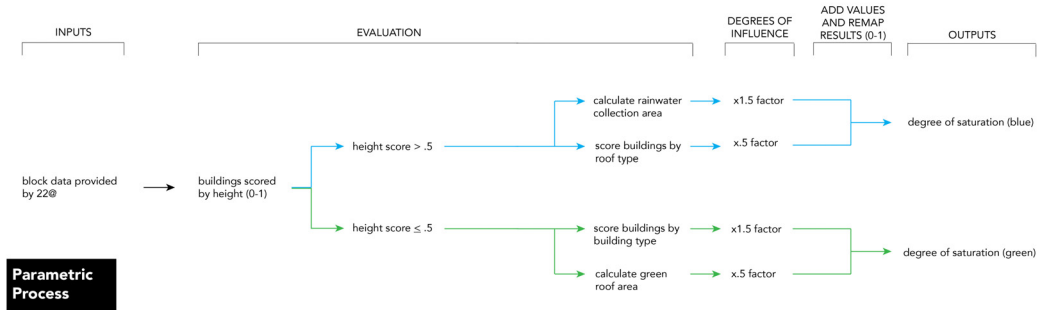
**Building Height:** Relative height to adjacent existing buildings was measured for passive water catchment to or from adjacent rooftops.

**Building Type:** Each rooftop was assigned a rating 0 to 1 based on building's structural and morphological type to support water and earth roof loads.

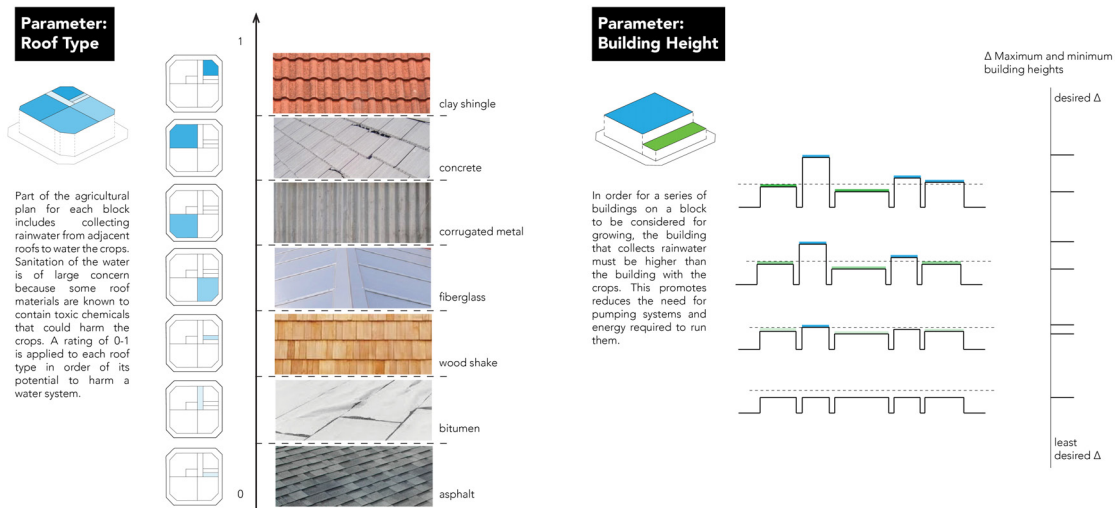
**Material Type:** Each rooftop was assigned a rating 0 to 1 based on the toxicity of the rooftop material from clay tiles to asphalt.

The criteria from one existing block in 22@ were inputted into a formula (see Figure 2) (inputs, evaluation scores, degrees of influence, add values and remap results 0-1, outputs) using Rhinoceros Grasshopper (GH). Qualitative criteria such as the roof type (see left side of Figure 3) and building structural type are converted through the rating system. Geometry

data such as the roof area and relative height in the z-axis (see the right side of Figure 4) are already in calculable format using a tabular assessment for geographic analysis. The Grasshopper plugin Human (Heumann) was used to input and output color for visualization. Data comes from 22@ planning department maps, Google Aerial View and Google Street View. A fifth parametric criterion of sun/shading on the rooftops for agriculture was not included with variation in plant types was instead assumed.



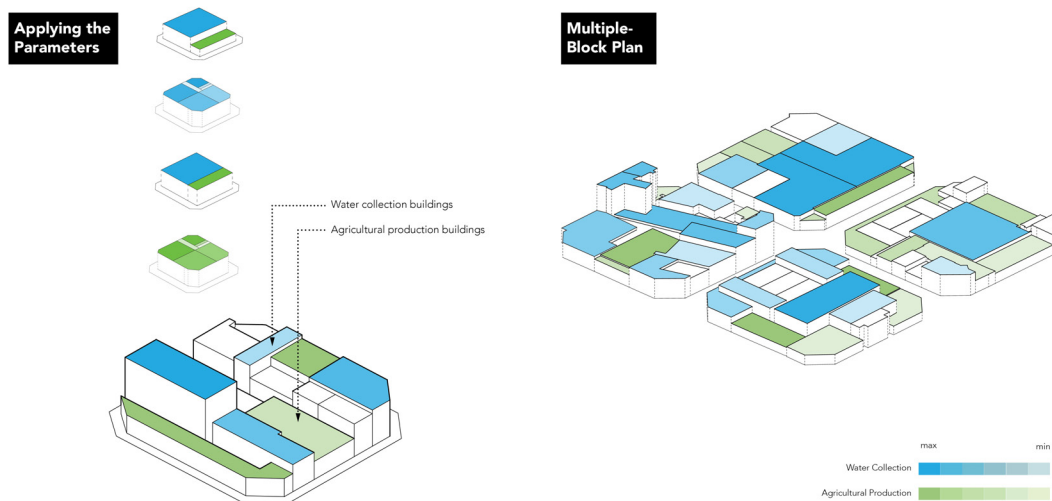
**Fig 2.** Farm City, Formula of Parametric Process, students Erica Thompson and Wes Thompson



**Fig 3.** Example criteria, Roof Material Type Rating and Relative Roof Height, students Erica Thompson and Wes Thompson

Output data of the analysis and assessment uses Human to visualize 1) the simulated suggestion for agriculture (green), water retention (blue) or neither (white) and 2) the degree of intensity via color saturation (see Figure 4). The final output is a suggestion of the optimized use of rooftops based on the criteria. The scale of the urban block suggests a new self-sufficiency and coordination at the block scale (Guallart), traditional urban scales often consider more the neighborhood or district scale. The tool may also be used to evaluate the criteria for future building proposals for the block. It is important to recognize limits of the tool such as accuracy of the input data (heights, material types, etc), the

accuracy of the formula and that it is not comprehensive as neither an urban design tool nor an architectural design tool.



**Fig 4.** Parametric analysis of one block and multiple blocks, students Erica Thompson and Wes Thompson

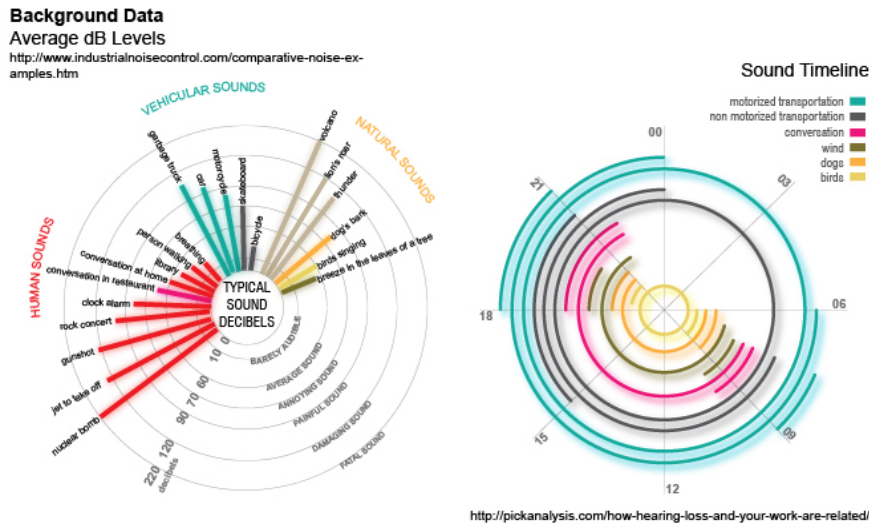
This tool developed off-site is important because it demonstrates the ability to measure data remotely, identifying types and using the described method to carefully translate qualitative types to quantifiable rating systems. This allows the custom developed tool to formulate and combine different types of data with specific use of the HUMAN plugin. It is important that this data is generated from ‘scratch,’ even if done so remotely, to make datasets clear and filtered for use in Grasshopper.

## 2.2 Sound Pollution Tool (On-Site)

A second urban analysis “Sound Pollution Tool” will demonstrate the additional use of on-site information and geographic information. The sensory phenomenon of sound is combined with other urban criteria to provide a tool for citizens to understand scenarios of sound in real-time and location based, extending the use of urban design tools into the realm of sensory qualities.

Like the previous project example this urban design tool identifies criteria and a formula to generate an analysis. The following initial criterion were located using a custom scripted geographic information tool in the form of CSV tables: zoning use, sensitivity to noise (rated 1-5), fenestration operability (open/closed), density of people, construction (yes/no), noise source (emitter) and decibel level. All criteria were observed first hand including verification of zoning use existing data and with the use of mobile phone apps for the example of decibel levels. Data was recorded and mapped with 108 points over a 3 x 3 grid of Blocks first in the Poblenou area of the 22@ district in Barcelona and later comparatively in small plaçetas in the Albaicin and other areas in Granada, Spain. Data mapping was done iterative over 24 hours a day. Again the Human plugin to Grasshopper was used to visualize data using colors. An important differentiation of data occurred when it was noticed that sound data was not only quantitative but also qualitative as types such as

human sounds, vehicular sounds, and natural sounds against an abstract scale of human tolerance of sound (see Figure 5).



**Fig 5.** Sound Pollution, Data Analysis, students Alexandra Lambrechts, Pedro Peralta and Eleazar Racoma

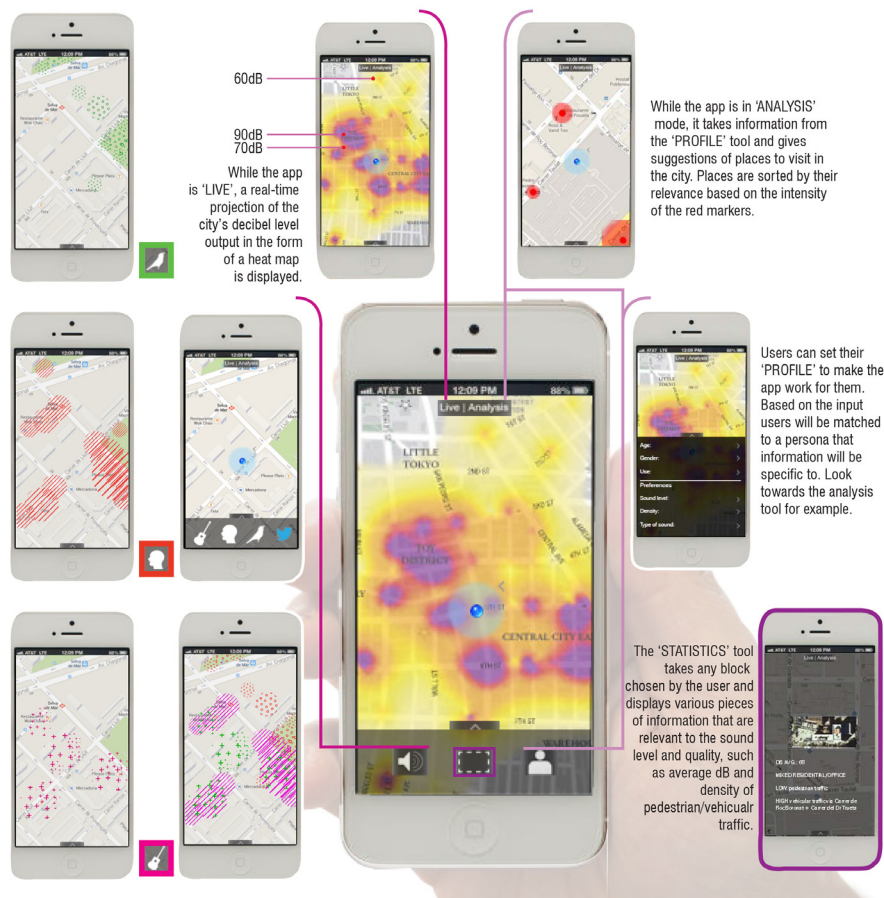
A final iteration of the tool utilizes the following criteria (see Figure 6):

- Zoning Use: in particular measuring residential and ground floor commercial activities
- Noise Source: type of noise source
- Decibel Level: measurement of decibels at location and time
- Sound Output: type of sound
- User Persona: tool user persona (Ex. couple with infant looking to rent or purchase an apartment, or people looking for indicators of urban activity on a weekend evening.)

Sound quality types are cataloged and differentiated for use by a 0 to 5 rating system for use as inputs in GH and Human.

The input data in quantitatively converted with the rating system and, somewhat different that the Farm City project from the Eugene based work, compiled in a spreadsheet format and imported into GH in the CSV format. Like ESRI ArcGIS latitude and longitude are converted into column entries. A custom scripted was used to calculated column and row information into an assessment and visualization of the information. The limitations of time and expertise prevented the further development of a working app interface to test the tool.





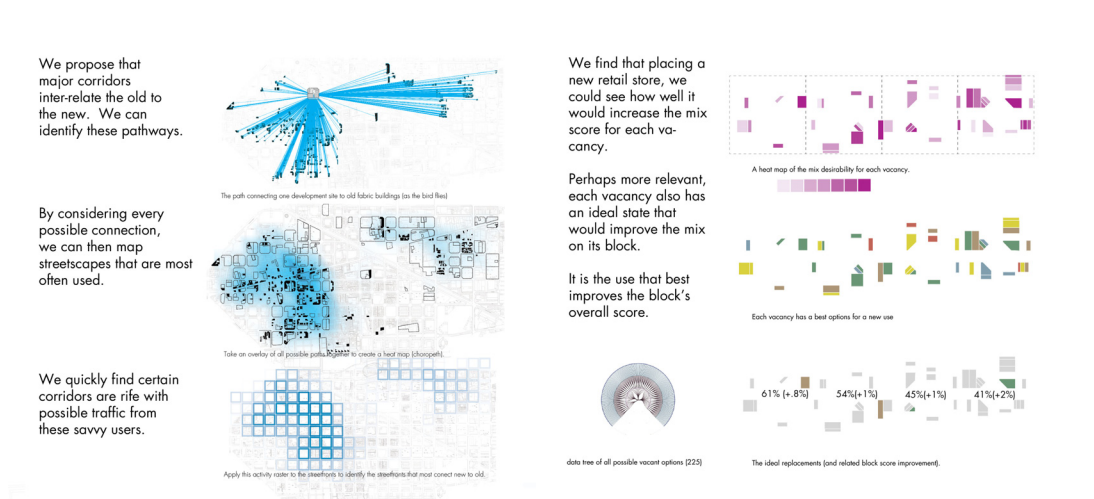
**Fig 7.** Sound Pollution, Mobile App Interface, students Alexandra Lambrechts, Pedro Peralta and Eleazar Racoma

The output for this tool in an interactive visualization (see Figure 7) of sound quality and type for a given neighborhood and urban room location. The interface as a mobile app or situated technology such as a kiosk would provide a feedback loop with users. The question this raises is whether such a tool without a physical intervention in public space and without fixed, traditional guide to urban information is urban design. It also suggests that user behavior as changed by the tool might also affect the synergies of qualitative and location based information.

The importance of this tool is the value being on-site to first identify the significance of the sensory human experience of sound in urban space. Phenomena such as sound are important indicators of various types of human behavior including recreational, dining, business delivery and children at play on-site in how we measure place in urban space (Lynch) (Vitello). Such observations even if measured off-site would be difficult to differentiate and unlikely to existing in predefined parametric urban analysis software.

### 2.3 Complete Streets Fronts (Off-Site) and Street Vitality (On-Site)

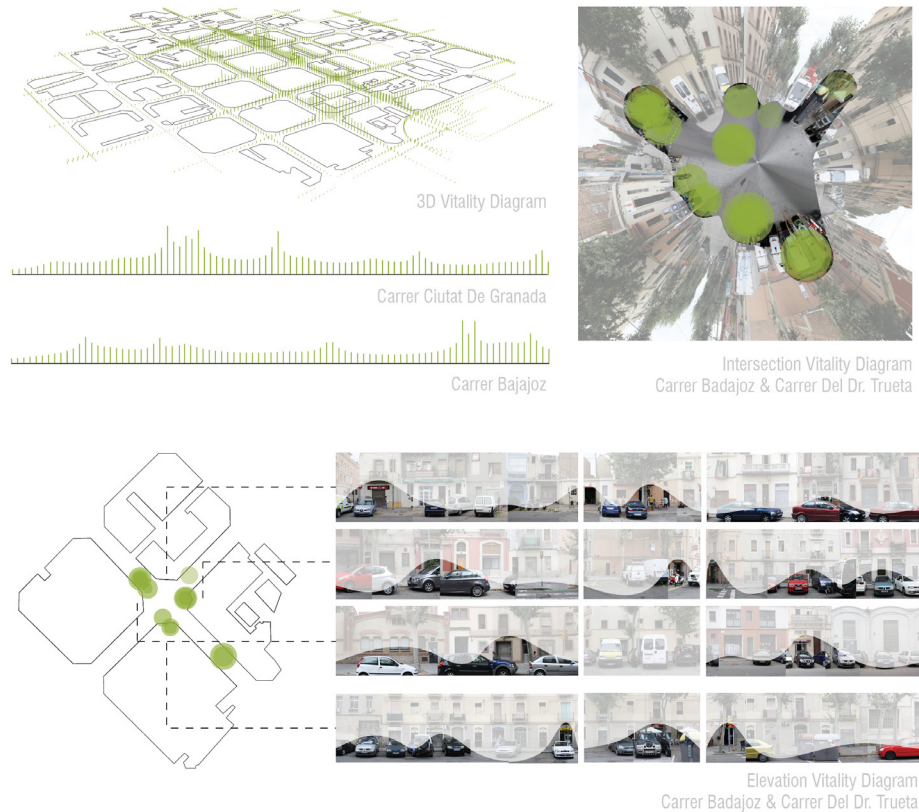
The continued project participation for one project in spring and summer of 2013 allowed a progressive development from existing data to new on-site data for the assessment of ground floor storefronts and urban design. These projects will be described briefly to demonstrate the variations of scale and purpose of qualitative indicators and geographic information for urban design tools to attach to site (see the left side of Figure 8).



**Fig 8.** “Complete Streets Fronts,” by students Andres Utting and Dan Anthony

The project “Complete Street Fronts” was first done off-site and relied on existing data from the 22@ planning office and other open source data found online. Input data as criteria included primarily indicators of public and private uses of ground floor spaces such as retail, service and leisure and lobbies to residential, office and institutional uses above. Data was sourced Google Maps and search engine from various interfaces. The tool provides an aggregate analysis of block uses of street corridors (see right side of Figure 8). The challenge of this tool was to evaluate the business difference for potential business owner and users by hours, prices, name and business type without an extensive, existing database (Yelp.com database in Barcelona is less subscribed than in the United States). The next tool “Street Vitality” in IcaBCN on-site in Barcelona will include this data and architectural characteristics of storefronts. Importantly, both datasets did not already exist in the larger scaled data of city shape files used in planning GIS software.

“Street Vitality” was grounded in the criteria and scale of the initial “Complete Street Fronts” tool. “Street Vitality” expands on the purpose to include the place branding identity of the site. The unit block in both cases is defined not by center of the built fabric but on the center of street right-of-ways or intersections, with the street corridor as the primary geographic unit. The space of street rooms is key, not built form. Measurement aimed to capture indicators of street appeal, identity, gathering, local patronage and projection into the street.



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**Fig 9.** “Street Vitality,” by students Dan Anthony, Jose Cornejo, Danielle Hoet, and Jenna Pairolero

Final indicators of this criterion included primary data for appeal, projection and percentage of open façade and existing data for building use and typology. Data processing used FormHub survey software and Rhinoceros Grasshopper. The resulting output data utilizes the z-axis for individual uses and creates a unique diagram (see upper right of Figure 9) to communicate street vitality type, returning the data to a qualitative geographic visualization of the architectural scale. The tool would be used for storefront enhancements, organization for business promotion, and search results for patrons and connectivity between neighboring business owners. The use of indicators and geographic information synthesized at the architectural scale in tabular format makes this possible.

The inclusion of these two tools here point out the complementary nature of off-site dataset analysis to focus the economy of tool develop on criteria **formulation** and on-site dataset analysis to focus on the use of **indicators** to measure specific phenomena. Dividing attention between formulation and applicable dataset generation allows for an efficient workflow. This in turn allows clarity in analysis, visualization and reported findings of the tool.

## **6 CONCLUSION**

### **EMPOWERED PARTICIPATION**

What is important about this method and the tools shared here is the empowerment of participation, that open software allows for the inclusion of specific measurement of people and place over time. This is far more challenging with planning software such as ArcGIS with prescriptive parameters and government managed datasets in the form of shape files. One may argue that the agency of open tools is the very specificity of their design intent, rather than the importance of holistic design in any one tool. The specific connection to place between the software and especially on-site data gathering sensors implies an agency that may be set forth by the human design but given its 'attachment' to site generate an agency that is not purely from the human designer (Latour 2008).

### **OFF-SITE ON-SITE**

While the on-site measurement of phenomena in real-space was very important to the agency of connectivity to site, the off-site limitation of datasets focuses an economy of effort on the custom formulation of project. In this case the consciousness of data as originating from one source, multiple sources or from scratch (Ratti) was far more focused. The difference of off-site and on-site data collection suggests further investigation into custom scripts that augment plugins such as ELK to input even more data than the available roads, bikes, rail and buildings currently available. Future research will focus on writing such custom scripts to include newly data gathered on-site and off-site.

### **FUTURE TOOLS FOR EVERYDAY USE**

Future and current urban analysis tools will continue to investigate challenging indicator datasets such as indicators of qualities of social behaviors (Kolarevic). Current work with Salvador Rueda of the Agency of Urban Ecology of Barcelona focuses on the creation of a 'social simulator' to measure social cohesion within the 22@ and larger St. Marti district in Barcelona. The method described above and the careful evaluation of qualitative criteria via quantitative codification will be further scrutinized with stricter dataset generation protocol.

Additional tools in development include a small scale PM air pollution tool using similar methods mentioned above and a sensory interface for public bike share tool that uses user feedback to drive community connectivity.

### **THE AGENCY OF URBAN ANALYSIS TOOLS**

Will open design tools in the hands of urban designer in combination with social media datasets and ever increasing accessibility of low cost sensors replace the authority of traditional city planning? When everyday users rely on real-time tools such as Google Maps, open street maps, Yelp and third-party transit tools, the agency of easily developable urban analysis tools may soon be at hand.

The research of these new types of urban design tools opens the question if urban design guidelines of the future may be driven by combinations of ever increasing computational and cognitive models, merging the agency of phenomenological connection to site and the human agency of both designer and user feedback. If the purpose of urban design is to seek a more efficient and connective social environment in cities then the real-time measurement of changes in behavioral phenomena in physical public space is ever more valuable. We need urban analysis tools that attach. We need tool development that is open.

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