Social Interaction and Cohesion Tool: Integrating Socio-Computational Design in Urban Ecology for Barcelona's *Superilles*

Social Computing and Urban Ecology

The way urban inhabitants experience the processes of the city has changed. Each day more devices from the Internet of Things, IoT, (Weiser 1991) pervade the way we perceive the city as an assembly of related urban processes (DeLanda 2006) rather than solely as a collection of fixed physical infrastructure. How and what designers identify as urban problems, create new datasets, understand and integrate measurements of the urban environment with design has changed given the everyday non-human and human interaction of a next generation of designers. Smartphones provide portals to record in-situ perception of the site and the subsequent integration of that information is now possible via parametric geospatial information systems, GIS. Pins are dropped in Google Maps and datasets may be interacted with, quickly entering workflows to 3D spatial analysis tools. The selection and creation of new 'data from scratch' (Nabien, Ratti, et al 2013), integration and analysis of information may then indirectly or directly inform design processes and how design proposals may 'attach' themselves to the site (Latour et al 2005), entering into the new urban assembly that is experienced by the public over time. The question of 'how' is thus closely related to 'what' types of urban processes define each designers perception of urban condition including the relevance of the relationships of small-scale social phenomena.

This paper will first describe the use of a new geospatial methodology within the rubric of architecture and planning to measure conditions of social interaction and cohesion for new pedestrianized three-by-three block units within Barcelona's *Eixample* grid called *Superilles*. The methodology was tested first by student projects and later developed in a group project to collect new data and analyze the new datasets for downtown and waterfront *Superilles* compared for the first time with model streets and blocks in Barcelona. Work began from an initial theoretical basis and in-person collaboration with Barcelona Agency of Urban Ecology director Salvador Rueda. The paper describes how this urban design method empowers design students to create individual tools within the larger social interaction framework to understand their own perception of problems of social interaction in Barcelona, using a workflow that is more open to including custom indicators and formulation of designer chosen qualities than traditional planning GIS software and methods.

Superilles and the Social Interaction and Cohesion Tool

Since Barcelona's *Eixample Plan* expanded the city ten-fold in 1859, the 100m chamfered block system has shaped the way people experience urban life. The 22-meter wide right-of-way has served a variety of purposes including walking areas for pedestrians, dedicated paths for private and public bicycles, space for dining, planting and lanes for private vehicles as well as public transit. The dense urban fabric of Barcelona, geographically bound by the Mediterranean Sea and mountain and the Llobregat and Besos rivers, has contributed toward its rich and focused urban spaces but has also led to recent problems of automobile congestion and air pollution. Today Barcelona has an annual particulate matter, PM, index greater than Los Angeles (WHO). Meanwhile the strong neighborhood identity of previously autonomous pueblos, or villages, (author) provides an expected perception of the city as one of human-scaled social connectivity, public space and interaction, and healthy ecological living.

Current work by Barcelona urban ecologist Salvador Rueda includes a methodological guide to sustainable urban design, new orthogonal bus-network reorganization and an associated strategy for three-by-three block *Superilles*. Similar principles for *22@ innovation district* guidelines for block minimums of open space, social housing and social services (Rueda 2014) and Vicente Guallart's ideas of block self-sufficiency (2010), have focused on new cross-disciplinary urban ecological understandings and models of bottom-up driven interconnectivity of urban life. The objective of *Superilles* is to create spaces of "placer," or pleasure and peacefulness, by limiting vehicular access within the two interior streets. Model plazas such as the Plaza de Sol and Plaza de la Vila de Gracia in the previously autonomous

Gracia neighborhood, and streets such as Enric de Granados, have been cited as models for the new pedestrianized interior streets and plazas created at the four intersections of each Superilla (Rueda 2014). The studio objective was to design how new streets of these Superilles could support dynamic urban processes today including ideas about ecology, health and economic activities.

The Social Interaction and Cohesion Tool emerged from research work with Salvador Rueda to create a 'social simulator' to measure social cohesion as one of eight primary criteria, for his Methodological Guide to Sustainable Urban Design (2012). An important theoretical basis is the affordance of diverse accessibility to options of social interaction, for example, transit options of bus, metro or bike share, indicating the support of a diversity of experiences of social interaction. Rueda's theoretical framework was revised by the author to includes public and private indicators for each category, new categories of job access and broader social inclusion. The tool, or methodology, follows others using parametric methods in urban ecological design(Holzman and Cantrell). A custom built parametric GIS uses the Rhino, Grasshopper platform and plugins Elk for OpenStreetMap data, Human plugin for object attributes and custom tabular scripting to process newly collected data. Forty-eight total indicators measure the following taxonomy of urban qualities: *use* including social space, social services, social housing and job access; *demographics* including age, income and cultural background; and *infrastructure* including information technology and transit. Each of these indicators is measured at individual street addresses in a study area. For example, the ability to secure a bike is given a rating of 1 to 5 at every street address. Income is measured at shops through the numerical cost of a cup of coffee, 330ml beer and food index of cost of two specific vegetables, milk and eggs.

The workflow has evolved through inquiry in an urban media elective course, lab environment research and part of a summer Barcelona urban design program. Previously published research about off-site vs on-site data collection (author) and contribution toward 'systematic, experiential and open" urban design pedagogy (author) describe the methodology. For each of the qualities of the framework, measurable indicators, mostly of physical attributes, are used to measure the ability to support urban experiences. The direct measurement of natural and anthropological phenomena was limited because data collection could not be reasonably reproduced across varying ambient conditions and times of the day, week and year. Indicators of these qualities were chosen by each student and tested first at 33m sidewalk locations within the three-by-three block area, totaling 108 points per *Superilla area.* These indicators were then tested in various urban morphological spaces in Granada, Spain and later again in Barcelona. A final group data collection was performed for the overall framework project and analysis was done via a lab at the University of Oregon to analyze and visualize this data for each of two *Superilles*. The result is one diagramming syntax that: 1) carefully codes data by quantity, rating 1 to 5, binary yes/no as 0/1, typological diversity, text match and other qualitative to quantitative translation; 2) does not combine nor flatten different data; and 3) provides general relationship understandings within the primary and secondary dataset types (figure 1). A plannometric diagramming method was also developed to show qualities in geospatial location within the streets of each block.

The ability to measure social interaction is an important gap in the specific study of this new *Superilla* model in Barcelona and a key contribution to make urban ecology more inclusive of social understandings (Carmona, Franck, Hou et al., Mostavi et al, Seamon). Specifically, the methodology makes a significant contribution because: a) social interaction plays an important role in relationships of urban space in the culture of urban life in Barcelona and b) no current method is used by the Ajuntament of Barcelona nor Barcelona Agency of Ecological Urbanism to measure qualities of social interaction. Coding was undertaken with contributing expertise in both sociology and in computation. However, the key element that makes this assembly of knowledge possible is the phenomena of a current generation of design students who are inherently adept at the ubiquity of mobile interface and the open processing of parametric workflows in both their everyday lives and as architectural students. The Social Interaction and Cohesion Tool has been used especially in the last three years of a graduate level Barcelona urban design program to test analysis and design proposals to problems of social interaction at the *Superilla* scale in Barcelona.

Figure 1, Social Interaction and Cohesion Tool v1.0.

Tools and Designs

From the previous summer Barcelona urban design program, research work and collaboration with the City of Barcelona and Barcelona Agency of Urban Ecology, a variety of problem spaces were identified by groups of graduate and undergraduate architecture, landscape architecture, business and planning students. In addition to new understandings to measure urban phenomena and the challenges to provide fundamental principles of urban design solutions, a common thread throughout the work was the ability to identity how the physical city would support the non-physical relationships of natural and human phenomena. Students identified problems, chose and created new data-collection techniques and integrated analysis to design solutions. Specifically, the effects of natural phenomena such as air quality and natural habitats were studied by two of the three projects. The third project investigated a more anthropological phenomenon of local versus non-local activities that define the tourist influenced urban flows of Barcelona. All three projects directly responded to the challenges to consistently measure the ability to support aspects of social interaction by urban conditions and how they could systematically measure physical qualities as indicators of the urban phenomena and processes at the heart of their focused understanding. This was evident both in the measurement of existing condition and in how they designed physical properties of their proposals to support the intended behaviors of "the urban" within the city. All three projects from the 2015 Barcelona Urban Design Program, including students from the University of Oregon, New Jersey Institute of Technology and Reed College, were selected to demonstrate the methodology. New this year was comparative measurement of model streets and plazas used as baselines for student proposed *superilla* street and plaza designs.

Urban Fitness

A challenge for many of the projects was the need to measure a quality that was not a fixed physical characteristic of the city but rather a quality of urban experience. The project *Urban Fitness* focused on two complimentary problems for social interaction in Barcelona: air quality and respiratory health. The ability for the city to support air quality was considered from both natural and human sources, and cardiovascular health related to the ability to do running exercise. Initial research pointed to sources of particulate matter PM including pollen, smog, and automobile brake and combustion particulates, leading to high levels of allergies and asthma both in Barcelona and comparison city of Portland, Oregon, used to statistically contextualize city-scaled data. From this research the design team chose specific indicators in both public and private space to measure urban fitness: pollen counts and wind velocity, pavement type for running, pedestrian safety via buffers from traffic, and proximity to industrial air pollution sources including factories and recreational facilities such as gyms (see figure 2). Data was collected within a three-by-three block study area and relationships were observed both at the overall *superilla* scale and within the scale of streets and sidewalk spaces of the area. The resulting street design proposal featured pedestrian running and bike paths with smooth pavement patterns, and street buffers for pedestrian safety with selected species European Hackberry for shading and enhanced soil drainage. Importantly, the final design solution integrated analysis and design solutions to simultaneously support running activities and reduce air borne pollution. Trees were selected with both criteria in mind affecting their species and placement location within the right-of-way. The project provides an overall enhancement of targeted deficiencies from analysis diagrams to support running and limit the impact of air pollution, while allowing flexibility and variety of other aspects of social interaction within spaces such as sidewalks adjacent to building edges.

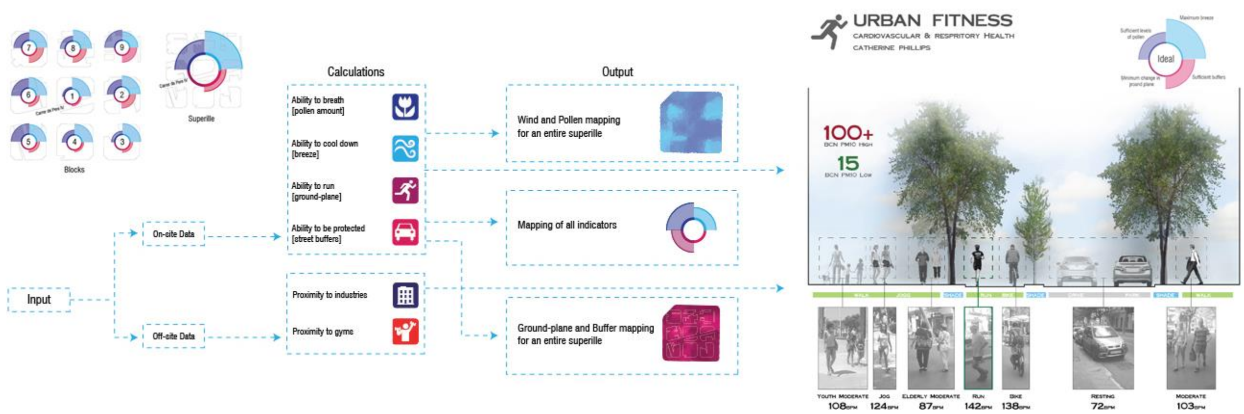

Figure 2. Urban Fitness analysis diagrams and design drawings including workflow.

Livable Ecology

The designers of Livable Ecology like the designers for Urban Fitness measured qualities of urban experience affected by both natural and human phenomena. Similarly this group measured qualities within the primary use categories of social space and social services. Contextual research showed a lack of green space and open space in Barcelona when compared with Portland, Oregon, 16 million acres versus 53 acres, resulting in 1.2 open spaces per 10,000 inhabitants in Barcelona versus 4.0 open spaces in Portland. The statistical contextualized in both projects helped direct the group to qualities of urban experience and how to measure them quantitatively. The resulting design proposal focused on the quality and location of green spaces within the street and intersection plaza for streets within *superilles*. Nine indicators were used to understand existing conditions included three qualities. *Ecology* indicators included vegetation height, private vegetation such as plants on balconies and planters in front of business to enhance evidence of cultivation and pride, and proximity to moderate to large open spaces to share fauna lead to more complete and diverse ecologies. *Vitality* indicators included the number and type of active storefronts to draw people to experience open spaces, and residential density to activate space at different times of the day. A *deterrent* indicator of excessive building height was chosen that would isolate pedestrians and habitats from light and visual access to the sky and lanes of traffic. The group responded to specific existing *Superilla* objectives (Rueda 2014) to increase fauna diversity beyond the current inventory of mostly birds to include lizards, frogs, hedgehogs and other animals.

Features of design proposals included a bio-swale and planted habitat with a careful study of hydrology to measure and design for increased water retention in soil, plant and paving design. Analysis diagrams pointed to existing deficiencies of proximity to open spaces and specific locations of high traffic and low eco-diversity. The analysis tool was directly used to inform the parametric variation of proposed habitat open space sizes and water retention to support life. Similar to *Urban Fitness*, solutions required an indirect urban characteristic to support both human and natural phenomena. Each of these indicator datasets provided a way to address related assembly not of isolated conditions but of a related urban ecological condition relating use activities, hydrology, fowl and fauna, and transit. While the analysis data was not always directly related to the design solution it did inform qualities of the design solution to achieve the desired complex ecological solution.

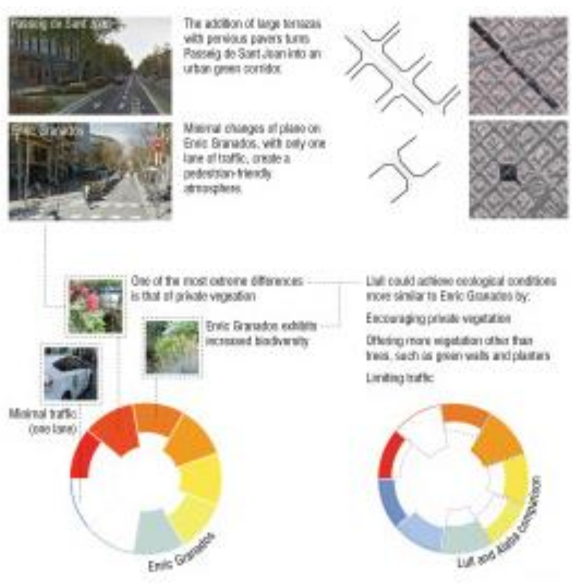

Figure 3. Livable Ecology comparison to street Enric de Granados for given indicators using photographic, drawing and analysis diagrams. Findings are described with each diagram.

Locally Grown Interaction

The city of Barcelona is distinctive as a place of converging forces of local community interaction and international tourism. The project *Locally Grown Interaction,* designed by students from both the University of Oregon and the New Jersey Institute of Technology, unlike the first two groups, engaged a mostly anthropological challenge without directly measuring people's actions, rather measuring urban characteristics that would support an urban interactive experience relating social space and job types. Accordingly, their objective suggested that social spaces in Barcelona lack the fundamental properties to attract and retain a range of local and non-local users, including workers, residents and visitors. Social space indicators included: the ability to *sit*, the *presence of nature*, the ability to support *diverse numbers of people*, the *scale of space* and the *noise levels*. Job type indicators included *business activity types*, *building use,* and transit access of *mass transit* and *lanes of private vehicle access.* Research to contextualize their qualities was done between Barcelona and New York City. Barcelona has slightly more than $1/6^{th}$ the population of New York but is similar in the numbers of hotels at 394,000 versus 534,000 hotels in New York, and about a third of the number of air passengers and professional visitors. Per capita urban green space is similar for both cities. In Barcelona other indicators were studied across the seasons of the year including habitation, traffic, rain, temperature, shade and sun hours. Similar to the other projects this research was used to then create a prototype geospatial point unit at each sidewalk street address.

The resulting Rhino/Grasshopper analysis generated circle diagrams identifying indicator deficiencies as the whole of the *superilla* but also at the individual streets. The ability to sit and variations in type of human inhabitation showed the greatest deficiencies to support diverse types of social interaction. This resulted in the design investigation first organizing street buffers, lanes of traffic and then remaining sidewalk areas to support a diversity of activities such as seated face-to-face interaction, relaxed seating configurations, green spaces for shading and noise filtration, and place for recreation across age groups (see Figure 4). Similar to the other projects, the resulting design work was not an isolated increase in elements that support these urban qualities but rather a clear understanding of the individual needs and the investigation of elements that serve multiple and integrated needs for the space. The parametric environment likewise facilitates an design result that integrates and processes multiple inputs of existing conditions and design criteria. For example, a long bench element in the design proposal of *Locally Grown Interaction* integrates design conditions of seating, resting, recreating and covered green space. It integrated projected information. It does not necessary directly align that design variation with existing physical conditions of the site, as this would potentially not include processes of the city that were not currently at the specific physical site.

Figure 4. Locally Grown Interaction design proposal with data and various seating, resting, recreation and interaction configurations.

Group Data Collection and Comparative Analysis

Following the student design projects, the class worked together as a whole for two weeks to create a high resolution diagram for two *superilles*, one downtown in the Eixample neighborhood and one in the previously autonomous waterfront neighborhood of Poblenou where they lived. The detailed and comparative data used the full forty-eight indicator dataset from the Social Interaction and Cohesion Tool framework. Additionally for the 2015 program, the group measured the full forty-eight indicators for comparative model plazas in Gracia and along three blocks of Enric de Granados street in high resolution using data points for each street address and in some datasets additional upper level businesses and residents. Data collection was done for all five areas using knowledge and expertise in techniques gained by each student in their own experienced design projects. These techniques were applied to gather, clean and process the new data. The second week was used to analyze the data with the GIS analysis tools to combine the data, further trouble shoot data entries, formulate equations for coding the data to create useable information, and further development of the analysis and visualization components via the Rhino/Grasshopper parametric environment. The work was then discussed and shared with stakeholders.

The comparative information between the two primary Superilles and the comparative model Gracia plazas and Enric de Granados street provided new knowledge about why people may point to these spaces as places of intensive social interaction in Barcelona (see Figure 5). Income accessibility and social space showed the greatest variation. As expected the model plazas and streets showed a greater ability to support social interaction with key areas including diversity of transit and social space.

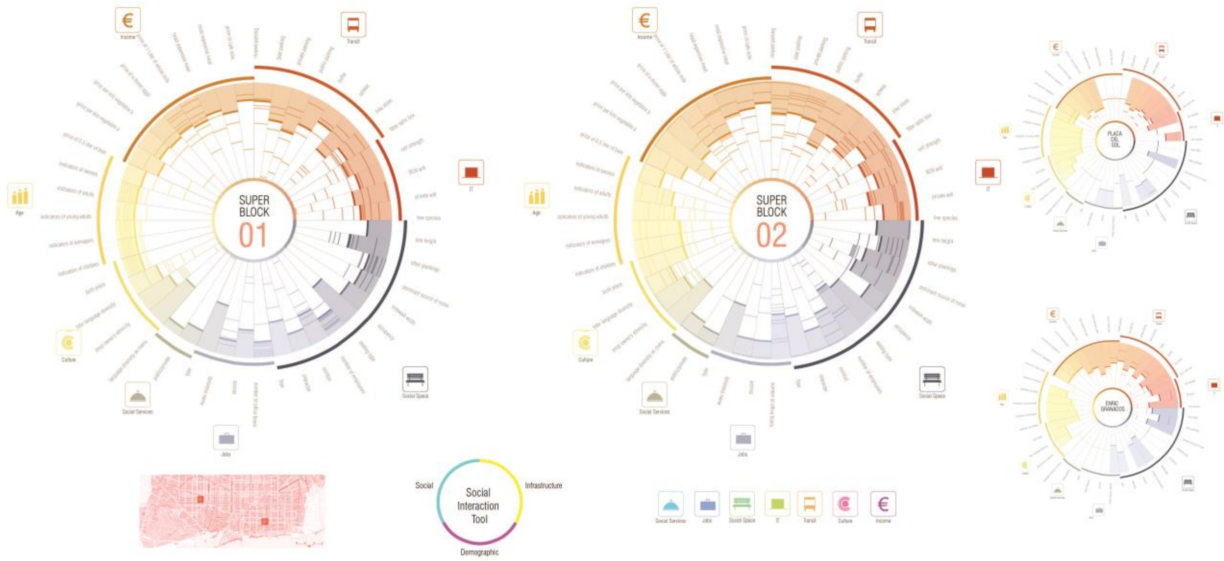

Figure 5. Comparative Diagram of Superilla 01 in the Eixample Dreta, Superilla 02 in Poblenou, Plaza de Sol in Gracia and street Enric de Granados.

Challenges and Future Work

The three student projects and the group project describe how to better understand specific problems of urban processes, namely the focused objective of each student project and the overall theory of diverse accessibility for the group application of the Social Interaction and Cohesion Tool. Within each project and the realm of social interaction students used individual qualities via indicators and an assembly of their relationships as a new understanding of these spaces. This is done through a new visualization technique thatgroups and associates color spectrum of related qualities shown in figures 1 and 5, carefully trying not to flatten or combine unlike information. Likewise the instinct to measure urban phenomena directly was done with great caution and while most design groups used the measurement of one to two phenomena directly at three or more times of data collection, the direct measurement of phenomena was looked as very critically. Physical characteristics that would support the phenomena were preferred.

Another challenge to the effectiveness of these tools to collect and analyze new data is the consistency of built morphology. In Barcelona all of the projects were done within the same urban form of the Eixample blocks. The Gracia squares and Enric de Granados street were used to understand the overall quality of those places. However important it is to acknowledge processes of non-fixed phenomena of the urban within the city, this study did not attempt to create comparative understandings between different morphological neighborhoods. Urban structure of street lengths, widths and geometry as well as formal zoning consequences of built city form would also effect differences between social interaction information visualized in the diagrams. Future studies could try to reveal differences of built form including forthcoming data collection and analysis in Portland, Oregon and Eugene, Oregon with block dimensions of 200 feet square and 335 feet square, respectively. A radically different morphology such as Barcelona's *Gotico* neighborhood or Berlin's Prenzlauerberg neighborhoods may also be studied in the future.

A different type of challenge is how understandings of the analysis tool inform design. In the methodology above the selection of qualities and subsequent indicators after problem selection, as well as city wide statistical contextualization, all provided design criteria direction to students. The analysis directed students where to act to compensate for deficiencies or what qualities to support at the street level streetscape. In rare cases such as the *Urban Fitness* project, direct data was used in place to locate varying output parameters of design specific to specific point locations. While students were limited to analysis work for direct use of datasets, the identification of indicators and the prototype unit measurement in space provided a clear study of parameters for design strategies. This led to investigation of how student's research at the human scale can lead to design strategies that move between phenomena and design of the physical environment, between urban processes and the built city.

Measuring Social Interaction and Cohesion at the Scale of Blocks and Superblocks

The integrated analytical and parametric design for Barcelona's *superilles* acknowledges new ways to measure and understand non-fixed urban conditions within the framework to measure social interaction. These projects revealed how students began the analytical process by measuring the ability of a place to support an urban quality of human experience. The teacher built the pedagogical framework by eliciting iterations of urban qualities and measured indicators on-site and the careful coding of qualitative information to visual information. Students learned to begin design through systematic observations and analysis using iterations, visualization and exploration of a quality. They then used the new knowledge to make director or indirect design from that actionable knowledge, for example, the lack of seating, shelter or and qualities of shading.

The work demonstrates how the content of this urban design knowledge is understood by a current generation of architecture students to perceive the built urban environment as a place that supports the inert constituent of the site. Methods such as the Social Interaction and Cohesion Tool describe a methodology to understand the relationships between phenomena using visualization language to associate, but not flatten, qualitatively similar but typologically different data. The integrated analytical and design method provides students with a geospatial means to choose urban qualities to measure urban content and a medium to relate complex and broad urban ecological forces, to understand and communicate new knowledge of urban forces in the city.

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