Atmosphere InFormed: Design Awareness of Small-scale Differences of Atmosphere in Architecture and Urban Design

ABSTRACT

Architects and other environmental designers often admire an environment for the first on-site atmospheric experience of its air, light, heat and humidity (Rahm 2014). We later measure the success of designed environments by the way people and animals use them. Thusly how can we begin a project by including atmosphere at the human-scale and can such a method of atmospheric awareness and testing affect design? Emerging tools of data collection including remote sensing, the accuracy of mobile phone based GPS within 1m, local weather data, and the widespread use of parametric design in practice, allow us to rethink the way environmental designers integrate accepted methods of site observation (Whyte 1980) (Appleyard 1982) in design. These emerging tools affect the way a new generation of designers measure atmospheric phenomena at a site, testing small-scale differences across short times, allowing important iterations of understand and new knowledge about place.

This paper will describe the investigation of design that measures atmospheric phenomena at the human scale in professional practice and education of architecture and landscape architecture students. Underpinning architectural and urban ecological theories of thermodynamics (Abalos et al 2015)) (Moe 2010) and Barcelona's *Superilla* pedestrian friendly urban units (Rueda) will be explained. This paper will then explain the series of site analysis techniques done off-site and on-site, iteratively revising the designer's knowledge of atmosphere in scales of both space and time. Case studies will include a professional residential project and subsequent educational urban design projects in Barcelona *Superilles*. Challenges related to times of visit, communication of phenomena over time, and sensor technology will be discussed. Conclusions will focus primarily on learning outcomes for the architect and the awareness by students designs measuring atmosphere at the human-scale.

INTRODUCTION

Architects and other environmental designers often admire an environment for the first on-site atmospheric experience of its air, light, heat and humidity (Rahm). We later measure the success of designed environments by the way people and animals use them. Thusly how can we begin a project by including atmosphere at the human-scale and can such a method of atmospheric awareness and testing affect design? Emerging tools of data collection including remote sensing, the accuracy of mobile phone based GPS within 1m, local weather data, and the widespread use of parametric design in practice, allow us to rethink the way environmental designers integrate accepted methods of site observation (Whyte 1980) (Appleyard 1982) in design. These emerging tools affect the way a new generation of designers measure atmospheric phenomena at a site, testing small-scale differences across short times, allowing important iterations of understand and new knowledge about place.

This paper will describe the investigation of design that measures atmospheric phenomena at the human scale in professional practice and education of architecture and landscape architecture students. Underpinning architectural and urban ecological theories of thermodynamics (Abalos et al 2015)) (Moe 2010) and Barcelona's *Superilla* pedestrian friendly urban units (Rueda 2016) will be explained. This paper will then explain the series of site analysis techniques done off-site and on-site, iteratively revising the designer's knowledge of atmosphere in scales of both space and time. Case studies will include a professional residential project and subsequent educational urban design projects in Barcelona *Superilles*. Challenges related to times of visit, communication of phenomena over time, and sensor technology will be discussed. Conclusions will focus primarily on learning outcomes for the architect and the awareness of new design approaches by students to design measuring atmosphere at the human-scale.

THEORETICAL CONTEXT

Design and educational design traditionally begins with the importance of understanding phenomena and observation of a place, including the ideas of place phenomenology (Norberg Schulz 1980), attachment (Latour 2005), attention to walkable scale (Gehl 2006) and place attachment (Manzo and Perkins 2006) (Seamon 2013). This view has been closely followed by research techniques measuring human scale time-based social phenomena including human and automobile patterns (Appleyard 1980), on-site video recording (Whyte 1980), numerical rating to measure walkability (Ewing and Clemente 2013), different of behavioral types (Gehl and Svarre 2013) and the non-physical qualities of atmosphere (Stefansdottir 2016). The theory to include phenomena and specifically atmospheric design (Böhme 2016) is currently emerging alongside a technological capability using mobile smartphones and affordable sensor based platforms to affect how designers interpret observation techniques theorized over thirty years ago in a digitally integrated design process.

Meanwhile in urban design and architecture the importance of atmosphere as a time-based phenomenology alongside ecological urbanism (Mostafavi 2010) and architecture responsive to atmospheric elements (Rahm 2006). Atmospheric theory of heat, air and light has driven recent architecture theory of thermodynamics (Moe 2010) and its application to design (Abalos et al 2015). Urbanism and planning has shifted from long-term fixed infrastructures of open space, uses and transit to also include ideas about water, energy, materials and urban metabolism (Guallart). The student projects discussed here are located in Barcelona's three-by-three Superilles, primarily informed by Salvador Rueda's Barcelona Agency of Ecological Urbanism to create a place of refuge and human pleasure amidst the problems of automobile congestion and air pollution (Agencia 2015). This paper in fact is underpinned by the authors published work measuring comparative social interaction of *Superilles* (author 2017) and particulate matter air pollution measured, both measured at the small-scale of street addresses within three-by-three block areas.

Professional design practices have followed with atmospheric responsive works and writings including Tadao Ando's abstract of nature via light, Steven Holl's ideas of anchoring (1989) and Enric Miralles and Carme Pinos's design that does not resist the decay of materials over time (author 2016), Diller Scofidio's misting Blur project and recent work by Pritzker Prize winning RCR Arquitectes designs in Olot and Ripoll that respond to the misting and snowing conditions near the Catalan Pyrenes. Current work by Kieran Timberlake and others measure human scale data of moisture, light and air using Arduino-based sensor platforms to visualize green roofs and other projects. A consciousness of time and the non-physical world is afforded to these designers. This may be measured over a year, a week or a day. Temperature, light, and air movement often change significantly over these periods.

METHOD: MEASURING SMALL-SCALE PHENOMENA, PRACTICE AND TEACHING

The approach to including atmospheric experience in design work using emerging tools of observation and recording will be compared between a professional six-acre rural residential project along the Hudson River in New York State and student street and plaza design work on-site in Barcelona's Superilla areas. Both projects use the same small-scale approach to observe, measure and shape design with existing and new atmospheric qualities.

I. Hudson House - Hyde Park, New York

The professional design project was located in Hyde Park, New York. The first site visit in April by the architect revealed a view from atop a rocky knoll, located two hours from New York City. The client desired primarily a one story design for aging in place and her stepmother. Setbacks informed the location of the house. The following observations were made:

- Winter visit - no leaves and view west through trees to the partially frozen Hudson River
- Spring visit - wet lowlands, taller grasses and an active waterfall to the east.
- Autumn knowledge from personal memory of foliage along Hudson River valley.
- Summer knowledge from personal memory and testimony from the Town building official of hot and humid summers with few breezes.

The results of the observations, memories and testimony informed siting and the need to induce passive air cooling.

A variety of ways to collect data, create information and build knowledge about the non-physical atmospheric conditions included

Wiki Weather / Climate data - comparative study of nearby Eugene, OR to nearby Poughkeepsie, NY, respective to Veneta (location of architects previous work) and Hyde Park.

- *Humidity* peaked in summer at 30% in Eugene and almost 90% in Poughkeepsie with NOAA data characterized as "miserable" and "muggy."
- *Rainfall* (Daily chance of precipitation) in the summer was almost zero in Eugene and relatively steady but peaking at 40% in the summer in Poughkeepsie.
- Temperature average annual peaks were 106-108 degrees in July and August in Eugene, and 103-100 in July and August in Poughkeepsie.
- Temperature average high to low in July and August were 82.2 to 51.7 degrees F in Eugene and 85 to 61 degrees F in Poughkeepsie, differences of 30.5 and 24.0 F.

Results show that the summer in Poughkeepsie is far more humid, greater rainfall, slightly lower peak temperatures and slightly lower ranges of daily temperatures.

Rhino Grasshopper Ladybug plugin - Wind-Roses and Sun-Path tools were visualized for both sites.

- *Wind*
    - Summertime - from the north and calm for 8.83% of the time in Eugene and southwest and calm 33.20% of the time in Poughkeepsie
    - Wintertime - from the south and calm 8.15% of the time in Eugene and north and 33.01% of the time in Poughkeepsie
- *Sun-Path*
    - Latitude - 44.05 in Eugene and 41.63 in Poughkeepsie
    - Azimuth - 177.33 in Eugene and 181.53 in Poughkeepsie

Results show far lesser summertime breezes in Poughkeepsie than Eugene.

Site Visits On-site - Reveal three seasonal phenomena of river, waterfall, SW hills.

- Winter - open visibility through trees to Hudson River to the west; low grasses
- Spring - wet/soggy lowlands and high creek, loud waterfall to east; high grasses

Design Strategies tested - considered solar chimney, porches, and evaporative cooling.

- *Solar chimney* strategy was chosen to enhance passive cooling
- *Removeable fabric canopy* over a courtyard was designed, covered in summer and removed in winter.

Results were a series of massing strategies tested in Ladybug radiance simulation: 1) assembly of squares; 2) bar building; and 3) compact volume with subtractive voids, each with four variations with courtyard voids to the: a) northeast; b) southwest; c) center and d) perimeter wraparound porch, with the latter two showing the most opportunity to syphon cool air in summer.

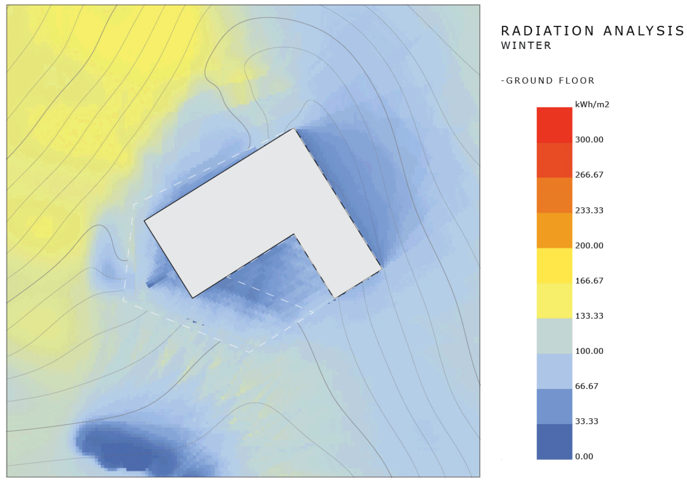

Figure 1. Rhino Grasshopper Radiance cooling of adjacent landscape, final design.

3d parti and Air flow - Diagram was developed to integrate three primary orientations, sun and moon paths, and general massing.
Results was information to inform the *locations of door and window* openings between the solar chimney and adjacent exterior cooling locations.

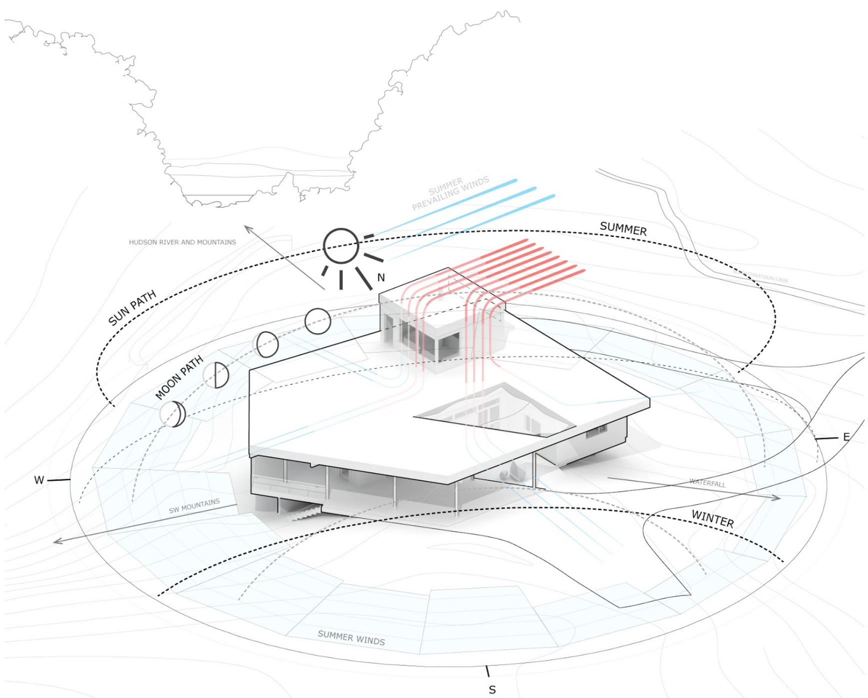

Figure 2. 3D Parti with Sun-Path and moon paths, prevailing summer winds and orientations.

Interior Perspectives - Show specific times of snow or sun, and the respective locations of human comfort. Examples include outdoor snow, steam rising from a cup of tea, the glow of a fireplace, waterfall view and warm colored leaves. Speculative temperature and relative humidity quantities are overprinted on the rendering.
Results was design exploration of future user atmospheric comfort. The client subsequently requested more of such drawings, highlighting a steam shower and songbirds in spring.

Figure 3. Left, Reading niche; Right, Living room.

Ecology Collage - A collage timeline was developed to relate atmosphere and animal species. Again speculations on temperature and humidity are overprinted. Meteorological conditions such as sun, rain, snow and fog are shown.
Result was the warm shelter of the Living room in snowy winter, exterior Breakfast nook view to the spring waterfall and barbequing at the cantilevered wrap around deck in autumn.

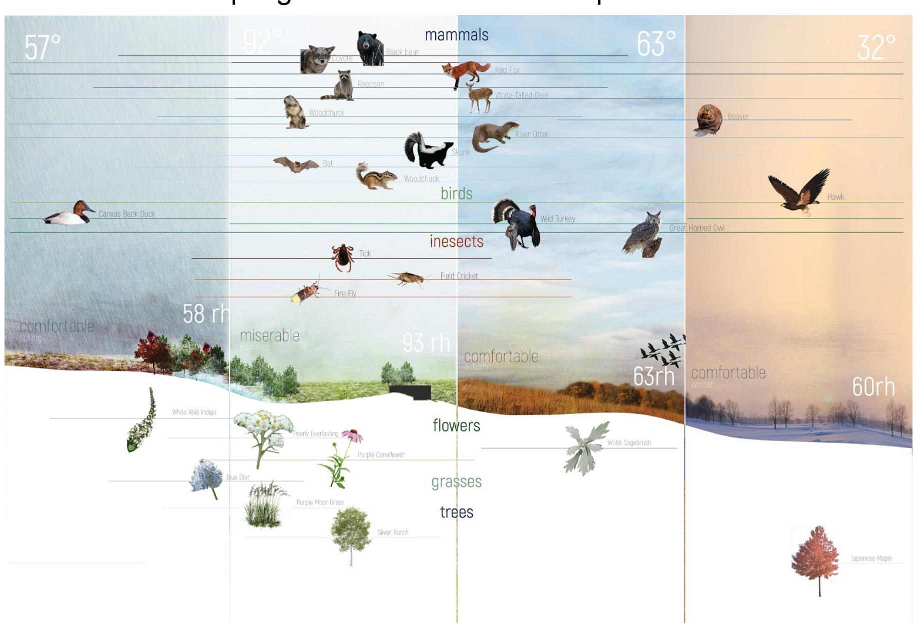

Figure 4. Ecology Collage.

Arduino Sensor deployment - Seven Arduino sensor prototypes for temperature, humidity, pressure, light and NOX were deployed fifty feet apart around the hilltop in August.
Results failed to compute because of challenges to synchronized startups.

Final Analysis of atmosphere and design impact
The resulting design and budget decision was allocated to radiant, passive design solar chimney / moon room, social space of deck, individual cozy spaces of wood niches and nooks, steam shower and future infrared sauna. Value was not placed on fixed expensive materials, appliances, fixtures, formal design or symbolic design features.

II. Barcelona Urban Design Program / Atmosphere + Design
Students of architecture and landscape architecture from two universities spent ten weeks, primarily in Barcelona designing human-scale street and plaza design for Barcelona's new Superilles. Comparison visits and data acquisitions were done in both Granada, Spain and Berlin, Germany. Students worked first in groups of three and then all nine students together. The objective of each group was to design around relevant urban problems using methods of measuring small-scale data including fixed and non-fixed phenomena in collection, visualization, analysis and design.

Neighborhood Studies - On-site visits are made with students to neighborhoods of varied types 1) previously autonomous villages and maritime oriented neighborhoods; 2) 19th Century Eixample 100m blocks and 3) contemporary pluralistic areas. Observation diagrams are done of various street and plaza spaces by hand including both fixed and non-fixed phenomena. Categorization methods are used (author 2016) of rating, binary, types and other ways to measure qualities in a place, including phenomena of atmosphere.

Urban Problem Identification - Local problems are identified through urban design theory, local news articles, scientific journals and observation studies. The initial problem is them understood as urban qualities and subsequently indicators are identified and tested, eliminated and added. Off-site weather and climate data is gathered for baseline and quantitative comparison.
Resulting projects address problems of 1) Urban Air Flow, 2) Equitable Urbanism: Aging in Place and 3) Urban Sound Santuary.

Data Acquisition On-Site and Off-Site testing -
Each project is studied through its qualities and indicators. A series of primary site visits are done. Pilot sensors on phones are first used them sensors platforms with Arduino micropressors were used by each ground. Three-by-three block areas are mapped at low resolution with data points every 33m, for a total of 108 points. Additional baseline data collections occur at accepted and identified areas of each urban problem in Barcelona.

Results are maps and GIFs of data comparing various times of data. Data maps are not collapse or flattened. This process of data collection and visualization of the data is repeated. Design is begun at the scale of newly designed streets and plazas.

Cultural Comparison visit in Granada - Maps of each indicator of atmospheric qualities such as light, air, humidity, wind and temperature complement fixed indicators of supported urban phenomena. Eight placetas were measured in Granada, each at various times, with GIFs created. A visit to the Alhambra and Generalife provides a spiritual baseline of healthy and pleasant, spiritual spaces of air quality, sound quality and inclusive design.

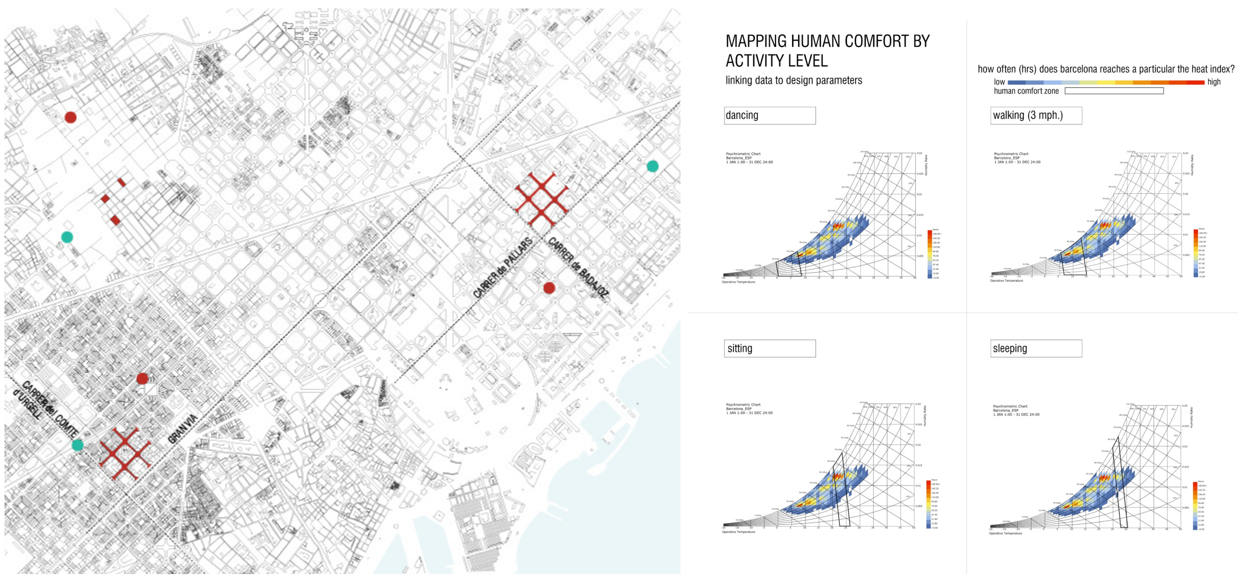

Figure 5, Barcelona map of Superilles with baseline areas in Gracia, Paseo de San Joan and Carrerr de Enric de Granados. Psychometric charts for dancing, walking, sitting and shopping.

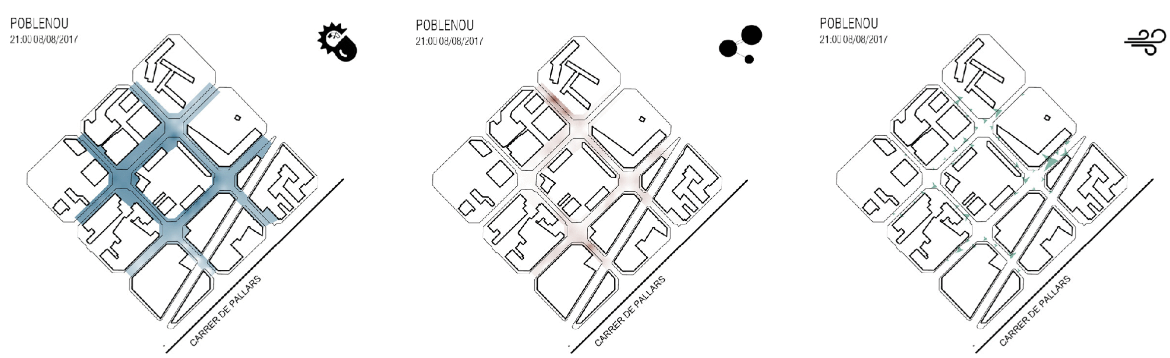

Figure 6, Poblenou Superilla data at 9:00, 12:00, 16:00 and 21:00 for temperature, humidity and wind.

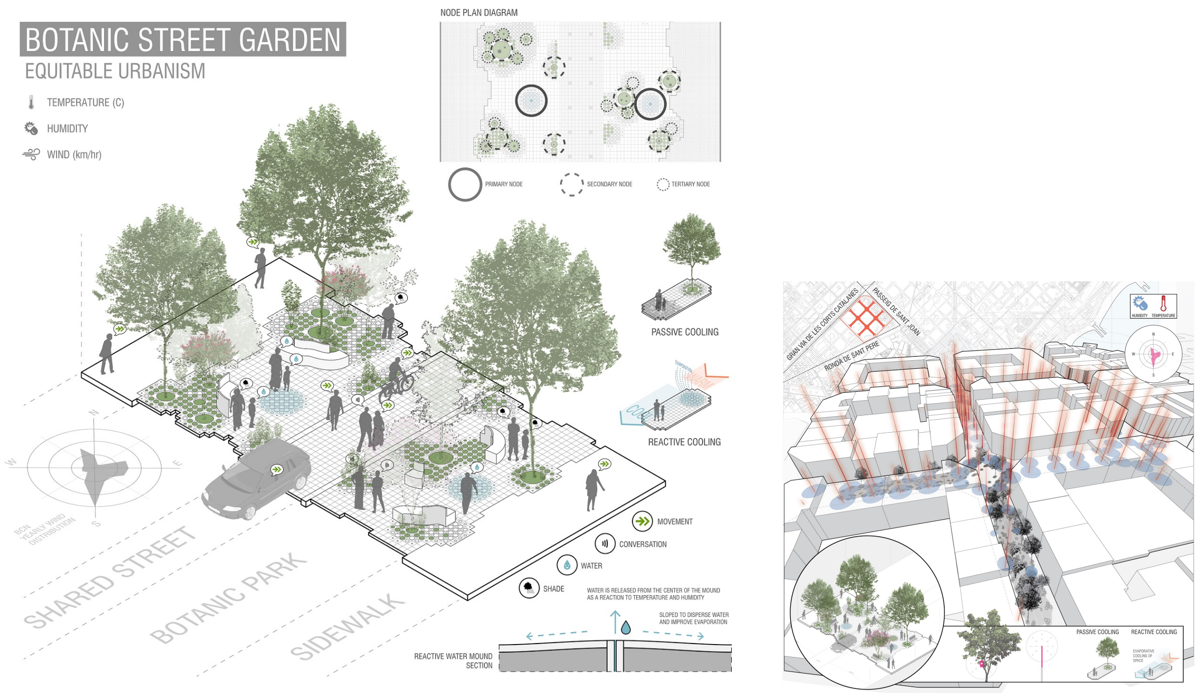

Figure 7, Design of misting nodes to cool and clean air quality. Superilla visualization of data and design.

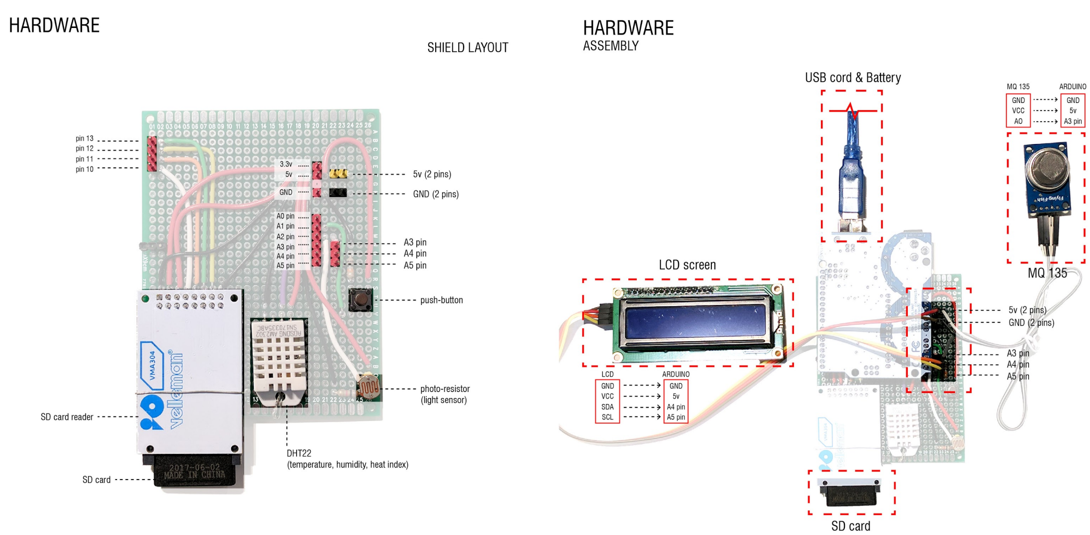

Figure 8, one of eight prototype boards with Arduino, LED, SD card, and sensors for temperature, humidity, light and NOx.

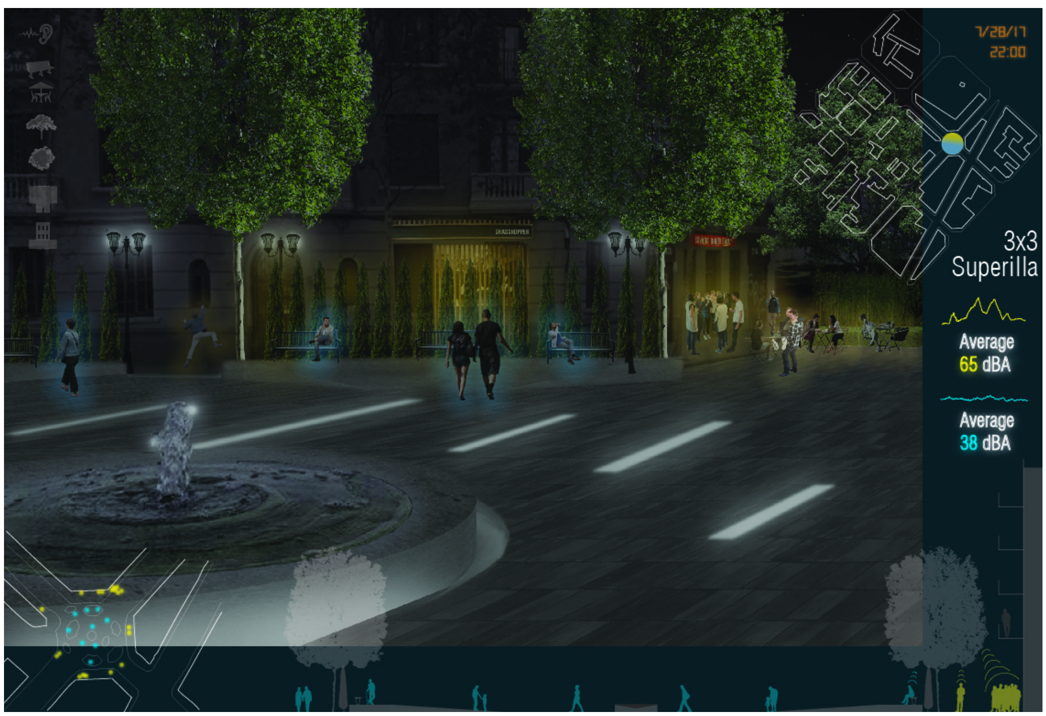

Figure 9, "Urban Sound Sanctuary" decibel measurements over images; Drawing of data and design. Important to show students the problem of a place are many times induced by social and natural phenomena - that fixed infrastructure such as the Eixample may be adapted to scale three-by-three heirarchy.

STUDENT EDUCATIONAL EXPERIENCE

Focus was given to understand a new local problem from new research and observations on-site. It was observed that in some limited cases students are eager to begin formal design solutions before analysis, observations and identification of how human experience may be supported at a place. The design method explained here made an overall impression to delay design of the actual architecture or urbanism, while drawings were done and conclusions made.

A key part of the student process is the theoretical organization of the project problem, the qualities that support that problem and the indicators as way to measure those problem. The ongoing and iterative critical assessment of that process by each student allows multiple opportunities to measure the impact and success of this design process. New understandings are revealed through the study of a very specific quality, resulting in a broader spectrum of conditions of that quality, of diversity and user experience.

Comparison locations provided reflection on variations of climate, culture and physical morphology. Such comparisons in both Granada and the Prenzlauer Berg neighborhood visited the last week of the program in Berlin allowed not only 1) in person observations, 2) reflections on differences with Barcelona spaces but also 3) the latest operating hardware to test fully operative sets of sensor platforms. The results in Prenzlauer Berg in Berlin for example focused on less attention to heat, less density of ground level storefronts as sources of terrace noises and greater public access to interior block courtyards.

Design and Design Communication

Design seen in the student work was more qualitative and human experience centric than witnessed in the same students' work prior to the program. Students learned to assess both fixed urban features that support qualities but also phenomena, social and natural, atmosphere only being some examples of phenomena that was measured. Problems change quickly with new store types such as bars, new terrace seating, new businesses in 22@ leading to new workers and congestion and food demands. This scale of urbanism in planning is traditionally not understood at the geospatial scale of streets and plazas.

Survey

An understanding of how students learned to related atmosphere and design was informed by the following survey provided to the students. A summary of their responses is provided below.

I) How did your design approach differ before and after this program and the instructor's methods, including the measurement of small-scale social and natural phenomena?
How do your observations differ? Do you see site analysis as fixed and or non-fixed phenomena?
How is your design communication different?
How is the result different?

II) How do you see a place now?
How do you understand a place differently, how do approach measuring, understanding and integrating that information into your design process?
How do you see the life of a design proposal after the taking this course?
What else did you learn?

Multiple students referred to the new attention to human scale. They also pointed out how they now look to not only fixed aspects of a site but "non fixed phenomena, such as user experience, weather impact, and human involvement." They also point out how to now "capture the attributes of a place to host a specific phenomena."

Other responses focus on new ways to design and draw "systems" and to diagram a critical reflection of their design "process."

CHALLENGES / LIMITATIONS AND NEXT STEPS

Challenges were often related to data recording at same time to ensure differences of values were due to atmospheric differences in the urbanism and not time. Most three-by-three block data collections occurred in 17 minutes, far less than the three hours of previously used techniques used in prior years. Baselines data was sometimes not accessible or in an accessible form to import. Sensor accuracy, for example of sound and particulate matter and NOx was limited with cheap sensors. Some sensor integration with Arduino was a problem for the ananometer (wind sensor) and an accurate sound sensor (microphone). The limited times on-site limited to the summer visit and often not able to be left overnight, were challenged. Students' user skillsets in coding, sensors and parametric design, and facility with mobile data recording was augmented with pre-departure meetings but was an issue with some students. However it is observed from teaching this method for various years that students are become more native within the digital environment and mobile data collection with Google Sheets for example.

Some next steps and improvement could occur with the professional design approach focused around time access to the site and various seasons. A next project may afford more time as the client contemplates purchase of the property but does not yet own it. A different project that is owner design build offers control and access to the site but still must coincide with the construction schedule.

An ongoing media course called Atmosphere + Design is already benefitting from a premade kit of sensor platform and visualization tools from the Barcelona program. Eight sensors are available to begin the term and same students with background. It is otherwise challenging to build custom sensor platforms for each project and would be efficient to have an existing platform that could be enhanced but already has sensors to measure temperature, relative humidity, pressure, particulate matter, sound and rain.

CONCLUSIONS

Human Experience Over Time
Phenomena centric design process supports design methods for students and professional designers experience a place in ways that are: 1) not fixed and 2) understood over time. These methods of design are inherently human engaging, acknowledge a changing atmosphere and adaptive architecture, and support the urban processes in urban design that are most accessible to change and supporting local needs..

Design Communication
Students engage with time in their design communication but it is challenging. Gifs, series, databases, sensors with LCD and SD cards, geospatial visualizations tools in grasshopper using OpenStreetMap and CSV based data are just some of the ways designers can communicate over time. Axonomentric and perspectival drawings with phenomena are important. The inclusion of ways to communicate design that embrace differences and diversities is important but implies methods that are more than formal. This often requires a balance of simulation from existing data and more integration of chose design qualities to observe and record from sketch. This empowers the designer with their own way to create specific to their interest and not relying solely on pre-existing data.

Speed of Social Phenomena Change
Social phenomena can change more quickly from a planning perspective than natural elements of atmosphere alone. Rain, heat and humidity is relatively predictable by season. But the problems observed and published in Barcelona for example around sound pollution, congestion and air pollution are mostly based on human behaviors such as automobiles and shop types including noisy restaurant terraces that could easily be changed with policy alone, not to mention simple changes to the built environment. These seem to be the low hanging fruit to improve urban environments that small-scale measure of phenomena may address and may inform elements of street and plaza design by designers and citizens together to make healthy and inclusives spaces today.

REFERENCES

Agencia d'Ecologia Urbana de Barcelona (2016) *Supermanzana: Una nova cèl·lula urbana per a un nou model funcional i urbanístic de la ciutat,* powerpoint presentation online, last accessed 8/23/2016 (http://imagenes.w3.racc.es/uploads/file/68094_Jornada_*Superilles*_Rueda.pdf)

Appleyard, D. (1980) "Livable Streets: Protected Neighborhoods?" *The ANNALS of the American Academy of Political and Social Science*, vol 451 (1) Challenging Cities: A Challenge to Planning, September 1980, pp.106-117, Sage Publications.

author (2017) "A human-scaled GIS: measuring and visualizing social interaction in Barcelona's *Superilles*", *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, Vol. 0, Iss. 0,0, Pages 1-22, Published online: 14 Jul 2017.

author (2015) "Using parametric methods to understand place in urban design courses." *Journal of Urban Design*, Special Issue on Emerging Pedagogy, London: Routledge.

Böhme, G. (2016) *The Aesthetics of Atmospheres*. London: Routledge.

Gehl, J. (2006) *The Life Between Buildings,* Washington DC: Island Press.

Gehl, J. and Svarre, B. (2013) *How to Study Public Life*, Washington, D.C.: Island Press.

Guallart, V. (2010) *Self-Sufficient City*. Barcelona: Actar.

Jacobs, J (1961) *The Death and Life of Great American Cities,* New York: Random House

Latour, B. & Yaneva, A. (2008) "Give Me a Gun and I Will Make All Buildings Move: An Ant's View of Architecture." In R. Geiser (ed.), *Explorations in Architecture*, Basel: Birkhäuser. 80.

Manzo, L., Perkins C. & Douglas D. (2006) "Finding Common Ground: The Importance of Place Attachment to Community Participation and Planning," *Journal of Planning Literature* 20 (4).

Mostafavi, M. and Doherty, G.. (2010) *Ecological Urbanism*. New York: Lars Müller Publishers.

Rahm, Philippe (2006) *Environ(ne)ment : approaches for tomorrow*, Gilles Clément, Philippe Rahm, Skira, Milan: Italie.

Rahm, Philippe (2014) *Constructed Atmospheres*, Postmediabooks, Paris: France.

Rueda, S. (2012) *Guia Metodológica Para los Sistemas de Auditoría Certificación o Acreditación de la Calidad y Sostenibilidad del Medio Ambiente Urban.* Centro de Publicaciones Secretaría General Técnica Ministerio de Fomento, Madrid, Spain.

Seamon, D. (2013) "Place Attachment and Phenomenology: The Synergistic Dynamism of Place" *Place Attachment: Advances in Theory, Methods and Applications*, edited by Manzo, L. and Devine-Wright, P. Routledge.

Stefansdottir, H. (2017) "The role of urban atmosphere for non-work activity locations", *Journal of Urban Design*, London: Routledge.