Studio Education for Sustainable Urban Spaces

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Why?

"Sustainable" architecture is a vague concept. This lack of specificity helps to create a fertile basis of discussion and discovery, and also leads to confusing, contradictory claims. The growth in green materials, products and projects is partially a function of serious application and investigation into forces that affect these artifacts, and partially the opportunist seeking to expand market share and manipulate an image. Some suggest that sustainability in all forms requires an established standard. Attempts have been made at this (such as LEED®) and they have certainly not been free of criticism. But as educators of architects it does imply important pedagogical questions, such as how does one know, teach and learn sustainable architecture? At the very least, sustainable design education will benefit from the establishment of a rigor towards analyzing and evaluating sustainable architecture. A challenge for future architects is their social responsibility in maintaining public safety through their designs, since this obligation may be perceived to include efficient resource consumption, pollution prevention and ethical material specification. Architects are uniquely poised to be leaders here, because they have a tremendous potential impact on resource efficiency through design decisions that reduce energy demand, specify materials and how far they travel, and how much it will take to heat, cool and light spaces. As has been discussed elsewhere[1], the portion of current carbon emissions that fall under the architect's control is the largest of all contributing factors. Design has contributed to our current situation, and design can help resolve it.

The School of Architecture has incorporated into its architecture program several techniques to analyze and evaluate design proposals and the existing urban tissue. Integrated among other coursework requirements, the third and fifth year studios incorporate notions of performance and form (*performative*). Performance requires the maintenance of human comfort (determined by environmental conditions, metabolism, clothing, perception) while minimizing (or zero-ing) consumption of fossil fuels and carbon emissions. Form is determined by an in-depth study of program, site and culture. As part of the studio requirements, an extensive investigation of the urban site characteristics is undertaken using several techniques. The most radical of these techniques is a method of data collection whose intent is to make the student aware that the building can be seen to perform as an "organism" that continually interacts with and regulates the surrounding environment, whether intended or not.

What?

Students begin their coursework by studying and then measuring the characteristics of urban sites, program requirements, community and urban tissue. The climate of a general geographic area, such as Philadelphia, provides general data that is limited in its applicability to urban projects. The geometry, materials and density of the city require a more focused investigation into the microclimate of the site. Climatic conditions within a city are notoriously unpredictable and change rapidly. Students investigate these characteristics using hand-held measuring devices. Specifically, these inquiries include air flow (speed and direction), material properties, solar access, sky view, shading, pollution, water & vegetation, air temperature and relative humidity. This data is then presented through rigorous diagramming exercises, where analysis also takes place. By layering and presenting mapped characteristics simultaneously, the student is able to suggest and question correlations between their data (see Figures 1, 2).

The program is analyzed with similar rigor. Adjacency, volume and circulation routes are mapped alongside other criteria such as recommended lighting levels, air exchange rates, acoustical needs, air temperatures and relative humidity. These are considered with occupancy patterns to establish strategies towards incorporating natural systems. For example, some schools are used for nine months of the year, thus permitting the design proposal to consider the other three months as beyond the scope of the comfort regime, and allowing the design of the envelope and systems to focus on the heating season rather than the peak cooling demand at what can be the hottest time of the year in some locations. The program investigation sets performance targets that provide the information with which one may interrogate the climate and microclimate for possible solutions. In a sense, the program creates the shopping list to visit the climatic market.

Issues that affect community and the urban fabric are also analyzed. Locations of transport hubs, pedestrian paths (direction, rate and

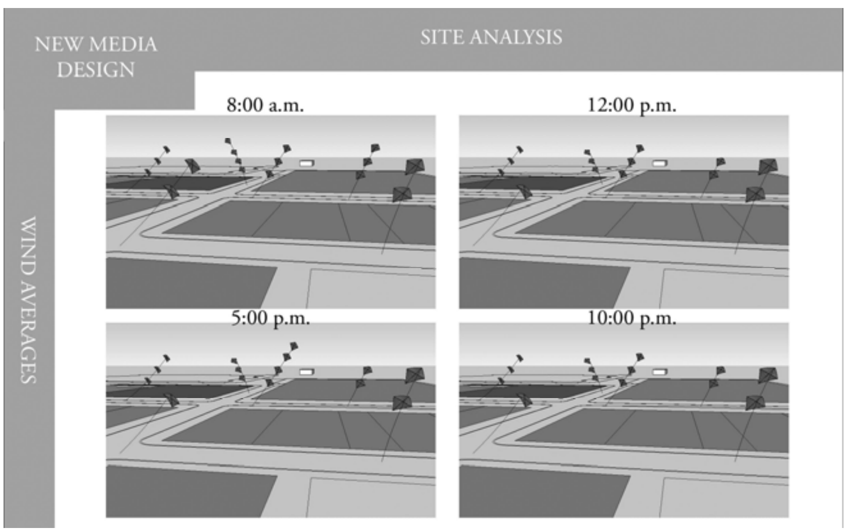

Figure 1: Wind Analysis Diagram[2]

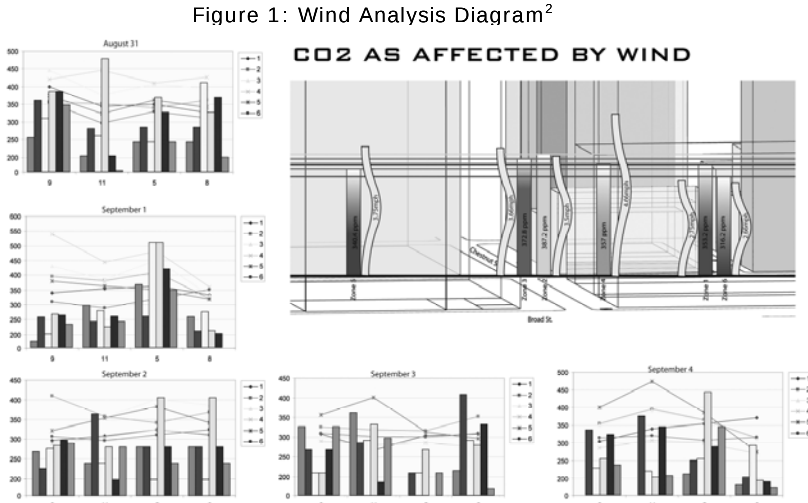

Figure 2: Correlation of CO_2 and Wind Site Measurements [3]

density), and location of community spaces are mapped and investigated. The students look for critical adjacencies, distances and paths between infrastructure that are traditionally used to provide community spaces and access to them. The students use this information as the basis to make design interventions to strengthen or provide additional resources for the community.

How?

For the past two years, the School of Architecture has incorporated two new techniques into their studio classes to evaluate urban space. First is on-site measuring equipment. The equipment consists of an acoustics meter, a wind meter, a light meter, a CO2 monitor and digital thermometers and relative humidity monitors. Studio work has found these devices to be essential in establishing a concrete and, literally, hands-on assimilation of climate data and its characteristics. Invariably students' a priori knowledge and assumptions are shown to lack the complexity of real situations. In nearly all circumstances the students are surprised with what they discover. This tends to fuel their interest. The students measure wind speed and direction, air temperature, relative humidity, CO_2 levels, daylight levels and acoustics with provided instruments. Additionally, students use their own corporeal sensing devices to detect other data such as smells, traffic volume and direction. The students visit the site three times daily for at least one week. This study provides the students with a wealth of data with which they are able to begin to understand the urban space and its temporal characteristics. With this data they are able to compare their recordings with that of the city as a whole for the same week over the past 30 years of weather data (ie climate) to see how microclimates differ from the weather data collected for the city as a whole (which usually occurs outside of the center city district)(see Figure 3).

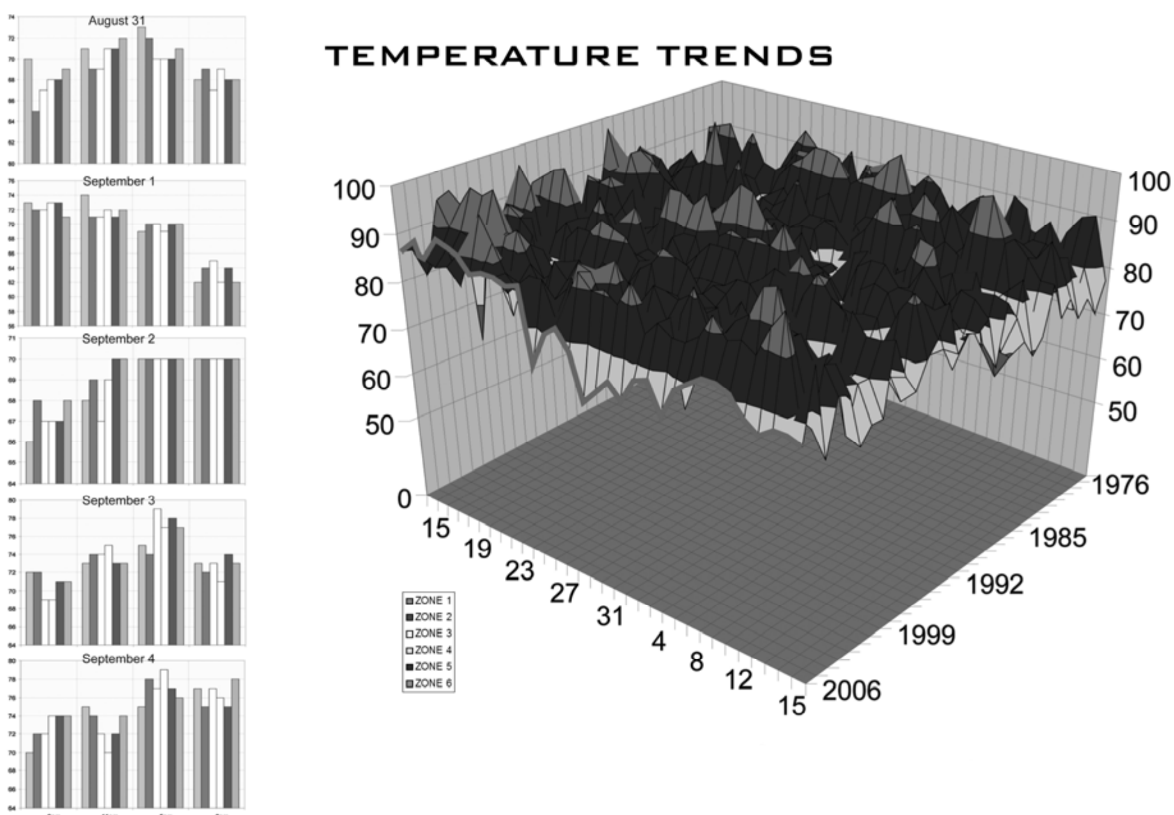

Figure 3: Comparison of Measured Site Temperatures to Recorded Temperatures of Philadelphia [3]

Secondly, software simulations are used to predict behavior of urban buildings. In some cases, students have modeled existing structures and compared their simulations to measurements taken on-site in the same buildings. Simulations are also used to predict how one's proposed building design may perform. Students have also created a weather data file from their own on-site data collection to examine how their proposed building may have performed during that specific week on their particular site. The studio has found that students are eager to use software and are very adept in quickly customizing it to their own purposes. This provides another opportunity to engage the student. The simulations in general provide a reasonable means to evaluate their own design decisions, but more importantly they provide an interactive and graphical basis to discuss issues of sustainability and the built environment, especially the unique characteristics of the urban tissue. Although sustainable design strategies share common physics, site and cultural issues, a design approach for the city differs considerably from that of other sites. The combination of on-site measurements and simulations provide a rich opportunity for discussion and instruction of these issues.

Another technique that students use to explore issues of urban space are precedents. The studio requires the students to keep a process book over the course of the semester, during which they continually add to their library of investigated precedents. Initially the students are provided with a list of buildings/projects to research in order to familiarize themselves with the general scope of sustainable projects. These buildings span the time frame from antiquity to today. As the semester progresses and each team encounters different building systems, natural strategies, structure, circulation, fire egress, community space, etc the team is required to investigate a precedent for the topic. Here, the research is more focused. The students may look only at a particular system or component of a building, but they are required to research it in much greater depth. Their precedent research must also include a description of how they believe the system or component may be applied to their project and how it may be advanced or improved. This method is slightly different from the approach used before in the studio, as it extends precedent research throughout the semester. The process emphasizes using precedents as a means of justification of systems application and is researched simultaneously with the design of the particular system, rather than at the beginning of the term.

Criticism

Every semester begins with a healthy dose of student criticism of the described approach to sustainable design for urban spaces. A common concern is that the data is irrelevant to the design of the building, or that architects do not need to be concerned with data sets. The process is designed to shine light on the interaction between artifact and environment. This is accomplished by highlighting the role of building skin as the exchange boundary and active filter, that the choice of material has tremendous impact on embodied energy and occupant health, that absorptivity and air flow (regulating characteristics of urban heat island effect) affect demand for air conditioning, that buildings effectively act as radiators to the urban fabric, etc. Ultimately, the student becomes aware that the building is one large "organism" that continually interacts with and regulates the surrounding environment, whether intended or not. The designer is presented with the choice, however, of the nature of that interaction. Will it be positive, or destructive? The process introduces them to what was unknown to them.

By the end of the semester, most of the students' opinions have shifted. They tend to become engaged with the process through the opportunity for hands-on learning via the measuring devices. They are fueled by the opportunity to predict the performance of their buildings. They feel satisfied by their research into existing systems and strategies and their creative application of the systems to their designs. In short, they feel empowered.

Endnotes

1 Mazria, E 2003. "It's the Architecture, Stupid!" *Solar Today,* May/June 2003, pp. 48-51

2 Korejko, K, J Thomas, J Velazquez 2006. Wind Analysis Diagram, Student Work

3 Baaden, J, M Martini, A Musante 2006. Temperature Trends, Student Work