This case study is intended to serve as a reference example for educational purposes and for further research investigations. The specific results of this work can be applied to cases featuring similar conditions in terms of latitude, climate, surrounding context, building proportions, etc. The design process presented in this work is generalizable and applicable to any case.

Further investigations will regard more complex, shaded sites in urban contexts where, in addition to directionality and dynamics, the volumetric distribution of solar radiation plays an important role.

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WORK IN PROGRESS

SYNCHRONOUS HORIZONS:

REDEFINING SPATIAL DESIGN IN LANDSCAPE ARCHITECTURE THROUGH AMBIENT DATA COLLECTION AND VOLUMETRIC MANIPULATION

ABSTRACT

This paper addresses the limited shared vocabulary of landscape architecture and architectural design, evident in the application of terms such as "spatial design" and "spatial planning." In their current usage, such terms emphasize the visible, terrestrial, pedestrian-perspective level, often to the absolute exclusion of a spatial, i.e., volumetric comprehension of the environment. This deficit is acutely evident in the teaching of landscape architecture and architecture and discussion of these fields' shared ground. The dominant document type for mapping such analysis and design is the plan, or three-dimensional representations of the same, restricted to an extrusion or height map. GIS techniques in spatial design tend to be weighted toward visual, surface-based data (slope analysis, exposure, viewshed, etc.). Within this domain, our goal is to transform aspects of the intangible—the characteristics of open space itself—into a form that is legible, quantifiable, and malleable.

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1 INTRODUCTION

This paper addresses the limited shared vocabulary of landscape architecture and architectural design, evident in the application of terms such as "spatial design" and "spatial planning." In their current usage, such terms emphasize the visible, terrestrial, pedestrian-perspective level, often to the absolute exclusion of a spatial, i.e., volumetric comprehension of the environment. This deficit is acutely evident in the teaching of landscape architecture and architecture and discussion of these fields' shared ground. The dominant document type for mapping such analysis and design is the plan, or three-dimensional representations of the same, restricted to an extrusion or height map. GIS techniques in spatial design tend to be weighted toward visual, surface-based data (slope analysis, exposure, viewshed, etc.). Within this domain, our goal is to transform aspects of the intangible—the characteristics of open space itself—into a form that is legible, quantifiable, and malleable.

A deliberate emphasis is placed on the invention of novel methods for understanding the site through sensor-based data collection. This emphasis on data collection, interpretation, and manipulation is a direct reaction to the perceived risk posed by a "limited" understanding of site, in which designers react predominantly to existing physical features and culturally based design goals. This common issue in spatial design potentially fails to acknowledge specific site conditions that would remain undetected by our senses alone. The conceptual depth of the "conventional" site visit is called into question. Alternative methods for site recognition form the context of this exercise, as well as a didactic landscape design teaching process. A general, long-term aim is an increased critical understanding of local spatial characteristics and design implications for students of landscape architecture and architecture.

The question of what other data exists beyond our visible spectrum is one which we can begin to answer, due in part to the increased accessibility of low cost and simple-to-use electronic components. The range of available electronics includes a wide variety of sensors capable of translating environmental phenomena, via electronic signals and calibration, to result in common metrics of site, such as temperature, humidity, radiation, lux, decibels, pressure, etc. These developments have influenced several key goals within the research project, such as for students to create their own rough data rather than relying on third parties, and the development of teaching tools to broaden perspectives on landscape architecture and understanding by a process that combines human movement with data capture and subsequent data manipulation.

The fundamental organization set for data collection is termed a horizon. The dominant set is that which is created as a function of moving as a participant through the site—the format of the systematic data capture process negotiating with terrain, structures, accessibility, and visual cues. The concept of horizons is borrowed from an aeronautical comprehension of space, providing a

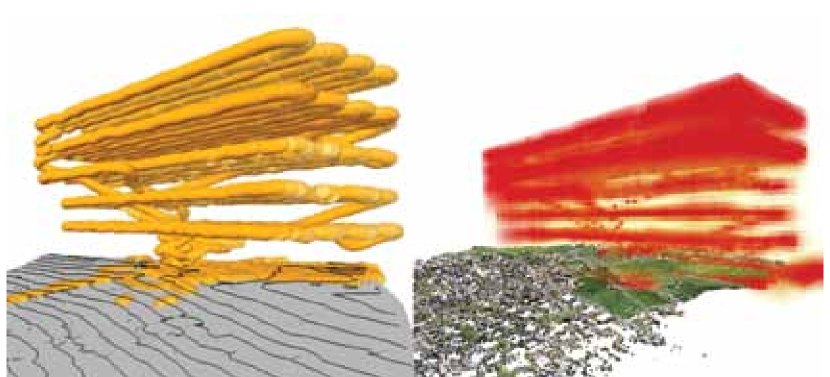

figure 1

figure 1

Data horizons are combined and evaluated for density and representative nature of values.

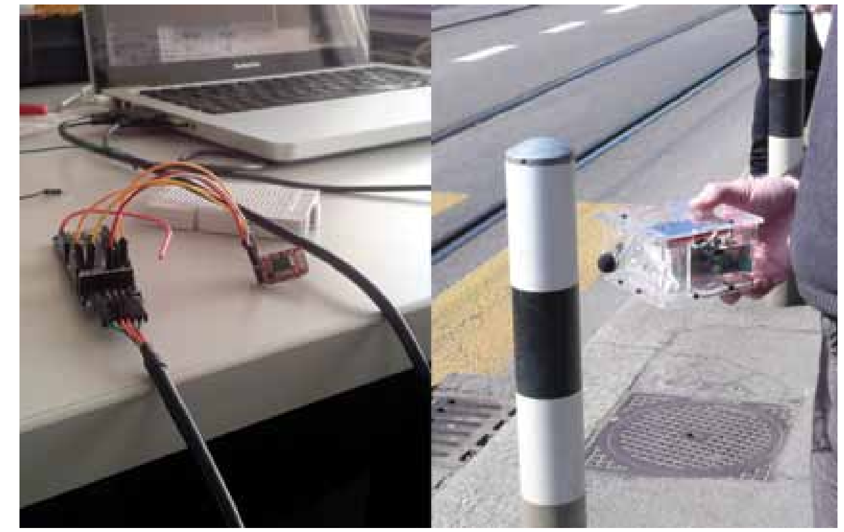

figure 2

figure 2

Ground data individual kits; preparation and programming of sensors (e.g., intervals), to be mounted on the UAV.

more balanced view and shifting emphasis to the vertical dimension. This view of landscape is supported through the introduction of unmanned aerial vehicle (UAV) drones within our own landscape architecture research and practice. By the end of the collection process (which we shall now elaborate), a UAV enables the generation of a set of these data horizons in order to form a spatial scan of the site. The horizon-based strategy is conducted in a synchronous manner, as it is derived directly on-site, to ensure that overall timing of the data matches as closely as possible, and to ensure both the flexibility and applicability of the dataset (Figure 1).

The premise of this paper is demonstrated through a case study carried out with a group of postgraduate landscape architecture students within a discrete teaching module. This case study frames the data collection experiment within the context of a given site, where the students apply techniques to appraise the site through iterative data collection. The paper presentation shall demonstrate various results of spatial site data review and manipulation, as well as key examples of site transformation within student research projects.

2 DATA CREATION / DATA INVENTION

Our process begins not with a methodology for data collection, but rather an acknowledgment that a given site can be rendered by potentially a much larger data set than what we can actually see. The visible spectrum is often privileged in its importance within the design field. The very premise of the collection of site data within the context of a design project needs to be carefully considered in order to clarify the objectives of the experiment. In that respect, the data collection is subject to its own nuances, which must be taken into account.

For the purpose of this research, we have considered our eventual data objectives in three categories: the individual, the instrument, and the site/problematic.

The individual: The inclusion of data collection for the purpose of addressing design problems adds a compelling bias to the collection process, in the same manner that site photography tends to generate individually differentiated results. It is also acknowledged that the very act of data collection and interpretation might lead to the redefinition of preconceived objectives, especially where an iterative data collection process is taken. We propose that the connection of the individual to the resulting set is both rational and personal, as the results are literally tethered to the body, figure 3

UAV-based data collection paths are updated iteratively in-flight to match ground data collection patterns.

figure 3

movements, and choices of the data creator. In light of this, a conceptual bias was quickly adopted, as the tendencies recognized in the relationship between the entire set of data points seemed more important than the absolute value attributed to one data point. From now on, we shall refer to the resulting, overall data tendencies as soft data, and maintain the link between the data and the individual who generated it.

The instrument: In both data collection methods utilized in the case study, the main instrument is comprised of a microcontroller and the attached sensors (temperature, humidity, dew point, ambient noise, and light), which are polled periodically (Figure 2). Each polling of the sensors is time stamped and geolocated for the purpose of compatibility with CAD and GIS applications during data manipulation. The data stream can be tracked and evaluated in real time, or it can be recorded to a file to be retrieved later in the process. The instrument is small enough to be handheld, and light enough to be considered a reasonable payload for different types of flight-capable vehicles. In the generation of soft data, data fidelity is balanced with the lowering of size, complexity, and cost.

The site and problematic: The relationship of designer and site is rarely objective; rather, it is often weighted with knowledge of existing and future influences. Data collection, based on individual choice, and with the aforementioned instrumentation, is intended to broaden the available metrics on a site by which an individual defines and redefines project objectives.

2.1 Methods of Data Collection

As already established, initial site data collection takes place by two synchronous methods:

Method 1: Humans and sensors: The primary method of data collection involved individuals engaging with the site—on foot as well as by other forms of transport—with the aforementioned data collection instruments. This phase of the case study sets up the initial control horizon as students collect data directly influenced by the physical elements of the site. This initial strategy and data density are reviewed to iteratively improve the control horizon.

Method 2: UAV and sensors: The pattern of the UAV method is developed synchronously from the base or control horizon, and extrapolated into aerial scanning horizons. These additional horizons are planned and scaled for density of readings to complement as closely as possible the approach taken with the control horizon. Once launched, the UAV remains under radio contact; at any time during each flight of up to 30 minutes, the flight route can be adjusted and updated, based on live data feedback results or additional input from the students returning from data capture (Figure 3).

figure 4

Filtered and interpolated representation of entire data set and nonlinear filtration of values.

figure 5

Combined filtered soft data with rough visual data (point clouds generated from site photographs).

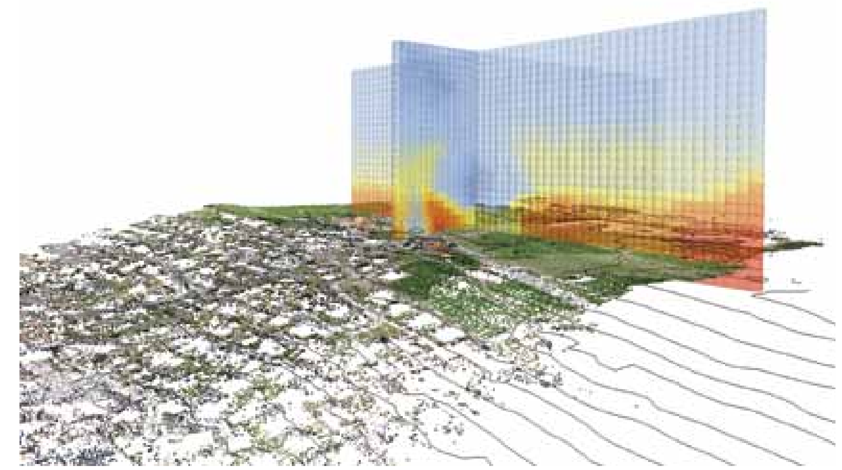

figure 4

figure 5

The scalability of a synchronous horizon data capture technique depends on the site. Both methods mentioned offer immediate feedback based on the data being captured, which means the collection of data can be continuously revised and retried in order to engage the site and project objectives in an iterative manner.

2.2 Data Relevance, Interpretation, and Manipulation

The fidelity of the resulting soft data is a product of various subjective factors including variable data density, low-cost components, uncalibrated sensors, constrained capture timeframe, and loosely systematic capture procedures. These apparently mitigating data quality factors define the specific quality and opportunity of soft data: its nonspecific nature, facilitating a loose approach in visualization, analysis, and manipulation. The resulting soft data can be viewed as an internally relative dataset—exhibiting compelling relationships within the connected data, but perhaps of little relevance to other data collected at other locations or times.

With an emphasis placed on understanding the volumetric dynamics of the site, we must not underestimate the challenge and the importance of developing adequate modes of visualization and manipulation of the collected data. This is an important aspect of the work in progress.

Various parallel disciplines have inspired the generation of hybrid visualization techniques. Of particular interest are the techniques used in geological and medical imaging and modeling. These disciplines share the need to represent data that is extrasensory, whether literally obscured from view, or of a volumetric nature, in a combination of fluid and solid states.

The potential of soft data to be manipulated lies in its vague characteristics; rather than being definite, as are surface- or line-based data, soft data is rendered suggestive and malleable through the application of voxel-type representation. Such voxel representations are easily compatible with constructive and destructive workflows, as well as threshold and logarithmic manipulation (Figure 4).

3 Conclusions

This research work in progress has thus far successfully integrated students into a process of site data immersion, data capture, and various forms of manipulation, whether raw data, site, or the reconfiguration of design issues. One key area to be developed is the didactic manner in which the project is introduced to the students and the approach to soft data collection explained.

The direct application to landscape projects and fundamental spatial understanding remains to be proven, though initial discussions are encouraging, as demonstrated by the voluntary adoption of the techniques into several of the ongoing student thesis projects.

The next steps include the development of deployment strategies, maximizing the efficiency of the site scan, and creating further synergies between group (individuals), instruments, and site. This shall require refinement of process, instruments, and manipulation methods.

As necessitated by the nature of this initial research, the project initiates a shift from the dominance of visible site analysis to an exaggeration and focus on the invisible aspects of place. Ongoing work would seek a balance of the visible and the intangible, in order to synthesize the sensory and extrasensory into compatible data models.

The presentation of this work in progress shall incorporate examples of the students' site-based work and its applications within varied scales and contexts. The implications for landscape design education and student comprehension of site shall be made clear. The results of current experiments in this field involve the integration of the extrasensory data with full-color point clouds—a possible visual analogy for soft data—generated on-site through photogrammetric techniques (Figure 5). Merging of the results with site photographs (panoramas) serves to localize the results, relinking them to the individual data capture exercises carried out by the students.

4 OUTLOOK

What follows is also a period of critical evaluation. As with any new set of tools, their nature and use will strongly influence any outcomes. ("We shape our tools and thereafter our tools shape us."—Marshall McLuhan.) As we review the first results of the approach, the refinement of the techniques begins. A key area of development is the representation of three- and four-dimensional soft data sets for the purpose of practical applications. This shall require new methods of data collection, data representation, data exchange, and data application, in order to combine the data sets through various visualization and modeling techniques.

We predict an acceleration and further ease in the generation of soft data—with increasing accessibility of components, vehicles (whether kite, balloon, UUV, etc.), and extrasensory awareness—within academic and public circles. The effects of this accessibility worldwide are already becoming apparent, with online sources of data spreading rapidly.

The implications of these collection, visualization, and manipulation techniques are significant—especially for increasingly abstract site parameters of a cultural nature, such as economic and historical influences, or waveform (mobile and electricity)—while maintaining the link between data and individual experience and perception. The approach shall address a perceived general dependency on the visible spectrum in spatial design culture, and promote awareness of—and curiosity about—the intangible environment.

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