ABSTRACT

The research presented in this paper seeks to examine how architecture and computational tools can be used to communicate on multiple levels by incorporating a series of qualitative and quantitative measures as criteria for a spatial and architectural design.

Air is taken as a material that has the capacity to create boundaries, yet unless under extreme conditions often remains invisible. Varying in qualities such as temperature, humidity and pollution, the status of air is highly local to a particular context. The research explores how rendering air visible through an architectural intervention made of networked sentient prototypes can be used in the creation of a responsive outdoor public space. Although humans’ ability to perceive and respond to stimuli is highly advanced, it is nevertheless limited in its spectrum. Within the urban context specifically, the information, material and flux being produced is becoming ever more complex and incomprehensible. While computational tools, sensors and data are increasingly accessible, advancements in the fields of cognitive sciences and biometrics are unraveling how the mind and body works. These developments are explored in tandem and applied through a proposed methodology.

The project aims to negotiate the similarities and differences between humans and machines with respect to the urban environment. The hypothesis is that doing so will create a rich output, irreducible to a singular reading while heightening user experience and emphasizing a sense of place.
INTRODUCTION

(Di)vision

Architecture has become an equally mediated experience as it continues to be a lived one, both at the stage of design as well as the final output.

The computer saw architectural practice shift from the handmade and drawn to the digitally modeled and CNC fabricated. While to some extent this has been seen as the liberation of design, some have attributed the loss of human sensibilities to such techniques, turning the process of design into a passive visual manipulation and a retinal journey (Pallasmaa 2005). On the other hand, physical forces and their transformational effects have sought to enrich the vacuum space in which architecture is conceived by instilling it with simulated parameters (Lynn 1995). Though various simulation tools have since continued to surface, a void remains in the creation of an experience and sense of place.

The evolution in modes of representation and mediation have also had an increasing effect on the ways in which humans view and consume architecture. Beginning with photography, buildings were often designed with a particular vantage point in mind so as to have maximum effect on the viewer in the form of a print or screen. Today, 3D visualization modes such as augmented realities and virtual worlds are effectively adding to the ways in which architecture is experienced. Spatial qualities often studied through scaled models can now be experienced in full-scale virtual environments. Similarly, with AR, virtual content can be integrated with the actual environment, thus animating and enriching it (Picon 2015). Nevertheless, there is an inherent quality in the physical space—in its form, materiality, and context—that impacts our reading, behavior, and sense of the built environment, which can be integrated as part of an embodied experience.

It can be said that on the one hand there is a parametric approach to design, which uses data and a series of logical/procedural steps to explain and generate a design, while on the other, there is a phenomenological one that generally relies on the sense of the subjective, and is therefore more difficult to argue. The fissure between these two schools of thought can otherwise be understood as the difference between quantitative and qualitative evaluation; the former being measurable empirically by units, while the other is based on the perception and subjective interpretation through one’s senses, including both mental and physical stimuli. While it has been noted that qualitative measurements are more difficult to evaluate than quantitative ones, there is an emerging trend across a series of industries and research projects that have continued to unravel how seemingly subjective experiences can be understood at a greater level.

The research presented here uses a hybridized methodology of computational tools synthesized with human sensibilities, an environmental context, and a local activity in the creation of what is referred to here as a Computed Immersive Environment (Figure 1). Through a networked field of architectural prototypes, a semi-enclosed space can be created and defined as a function of the evolving environmental conditions in which it is situated; in this case, through the removal of undesirable airborne particles as a byproduct of the enhancement of specific exterior qualities. The hypothesis is that such an approach can update antiquated perceptions of space as defined under such opposing terms as artificial/natural, interior/exterior, precise/uncontrollable, measurable/sensual. The research was materialized in a virtual model and partially tested in a pavilion (Figure 2).

BACKGROUND

Subjects

Humans are imbued with a particular set of embodied cognitive capabilities that in many ways can still be considered unique. Intuitions such as feeling “good” or sensing that something doesn’t “look right” are inherent in what can be referred to as acquired knowledge, which can be trained and refined over time through perceptual learning (Collins and Kaas 2005). On a corporeal level, humans are extremely sensitive to particular changes in stimuli, such as detecting changes in temperature as low as 0.02 degrees Celsius (Jones 2016). Conversely, computers and machines are able to detect a far wider range of otherwise invisible elements that surround us and are able to process the information at an unparalleled rate. While humans sort in order to organize and make sense of large amounts of information, computers operate on an iterative level through search, where knowledge is replaced with the ability to tirelessly run operations and check for solutions (Carpo 2016). With a base of differences between humans and machines, the research sought to examine how the two could be integrated as part of a hybrid design strategy and prompted investigation into a range of precedents.

Environment and Perception

In the context of uncontrolled outdoor environments, dust can often be seen as an undesirable condition. However, because of its ubiquity, it can also be used to clad the exterior of a building (Roche 2002). Conversely, within enclosed spaces the physical phenomenon of convection can be designed and used to suggest spaces through zones of intensities, rather than to define them (Bernik and Assaad 2008). While humans generally rely on the clarity of vision to engage with one another, a cloud-like exterior space can redefine the conventions of social engagement while...
taking advantage of readily available resources and computational methods to deal with the fluctuating exterior conditions (Diller Scofidio + Renfro 2002).

Yet, beyond the spectrum of human perceivability, there are constant changes at both the macro and micro level that can only be understood through computational tools. At the urban scale, air quality can fluctuate between high and low pollution levels too subtle for human detection, but that can be read through real-time sensors and visualized as an urban map (Calvillo 2008), or communicated via a user scaled interface (Ratti 2005). At the micro scale, subtle vibrations of plant leaves can be read and extracted to recreate the sound waves that caused them, using enhanced video processing techniques (Davis et al. 2014).

Research was also conducted in behavioral sciences, cognitive sciences, as well as other existing architectural precedents, in order to explore ways of integrating human sensibilities and perceptual phenomena. This research has found that the reason people forget what they were doing when entering a new room is due to a psychological phenomenon known as the event boundary, whereby the act of changing physical settings, as well as entering through the door as a signifier, treats the new space as a new event, therefore causing the mind to store what was happening previously as a separate event (Radvansky, Tamplin, and Krawietz, 2010). Labyrinths, on the other hand, were designed as pathways to follow, where one could experience gradual forgetfulness through a meditative walk (Kern 2000).

With regards to visual perception, peripheral vision—from both an experiential and medical standpoint—integrates us with space, while focused vision pushes us out of the space, making us mere spectators (Pallasmaa 2005). Finally, imbuing sensitively scaled objects with dynamic behavior through input and output feedback can catalyze opportunities for collective and shared experiences mediated by their presence (T. Spyropoulos and S. Spyropoulos 2013). These cognitive effects are also taken into account as part of the design methodology.

**Precedent Methodologies**

Historically, the potential for integrating the worlds of computation, interaction, and architecture reached its peak in the 1970s (Wright and Scharmen, 2011). Groups such as Archigram, MIT’s Architecture Machine Group (now Media Lab), as well as individuals such as Cedric Price and Reyner Banham all experimented and speculated with the ways in which architecture could integrate emerging and future technologies, centering their projects on augmenting the human experience while actively questioning their roles. Notable projects, such as the “Fun Palace,” envisioned a gridded framework that could adapt and interact endlessly according to people’s desires and needs (Mathews 2006). Banham’s “A Home is Not a House” used the technological infrastructures embedded in the modern house as the primary structure, thus opening new possibilities in engaging the environment (Jacobs et al. 2015). Yves Klein’s Air Architecture sought to do away with the spatial boundaries of solid objects through the use of pressurized air, which would consequently remove bodily boundaries and elevate the senses (Noever and Perrin 2004).

Existing methodologies were also examined as part of the research. While constraints can often be seen as limitations in design, they inherently possess the potential to catalyze new design solutions through bidirectional modeling (Killian 2006). Similarly, understanding the complex network of different design stages, and the number of individuals and industries intertwined in the process, can in itself become a design tool to inform the conception and materialization of projects (Marble 2012). On a lighter note, Peter Cook (2014) recently acknowledged that a strange and common tendency is that one might design something as simple as a gas station without ever going to see what it is that people actually do there. Finally, Sean Lally (2014) points out that one of architecture’s primary acts is to define spatial boundaries that organize and hold specified activities within them; therefore, boundaries can be defined so long as humans can detect the difference in spatial qualities.

This research synthesizes these multiple foci, with the aim of...
generating a highly localized response that integrates the differences and similarities among human sensibilities, technology, and environment through a polyvalent output that heightens the overall experience.

METHODS

Preface to the Case Study

Tokyo is taken as a modern-day case study for the creation of an exterior immersive environment. Spring is met with the highly popularized cherry blossom viewing known as hanami, an activity that has been argued to be both the creation of the only public space in Japan as well as the embodiment of its national identity (Ohnuki-Tierney 2015). The outdoor festivity overlaps with severe amounts of cedar pollen, which cause hay fever among 30% of the population, thus disrupting the outdoor activity and provoking a conflict of desire.

Design Methodology

Having identified the activity and the conflict in the case study, a diagram served as a navigational tool to the multifaceted approach and is outlined below (Figure 3):

- Identify the activity and extrapolate both general and specific values to take into account: what people do, what is significant about where it happens, and what is an invaluable part of the experience. In the context of hanami, this can be understood as the cherry blossom viewing, which takes place outdoors. Ideally, the activity remains outdoors without obstructing the view of the trees, especially in the areas beneath and around where people gather for viewing. The natural setting as a whole consists of sound, air, and smells.
- Identify the conflict: what disrupts or causes the activity to not be performed favorably. Here, the releasing of large quantities of airborne cedar pollen creates an undesirable condition during the activity.
- Understand the parameters that influence the conflicting element: with pollen, it was found that wind is the primary factor in airborne particle dispersal, followed by heat, which can cause the pollen to burst.
- Survey existing methods: with respect to airborne particles, specific types of mesh of varying porosities are implemented for both commercial and industrial use, while construction sites often deploy mist to collide with and/or suppress dust caused by construction, keeping them grounded.

Constraints and qualities of each of the points are weighed against the initial activity and evaluated so as to be used not only to respond to the conditions efficiently, but to also incorporate elements from behavioral sciences in order to augment the experience with respect to human perceptions. (Table 1).

Table 1: Evaluating quantitative and qualitative constraints.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanami</td>
<td>Tokyo’s hanami takes place from early to mid-April with a daily max/min temperature of 19.9°C and 10.2°C in 2017.</td>
<td>Physiological thermal neutrality is between 28°–30°C.</td>
</tr>
<tr>
<td>Wind</td>
<td>Wind is the primary form of pollen transportation. Bursting causes pollen grains to combine with airborne pollutants.</td>
<td>Wind chill is often only considered for temperatures at or below 10°C. and with wind speeds above 1.33 m/s.</td>
</tr>
<tr>
<td>Mesh</td>
<td>Mesh can be designed in order to perform a variety of filtration functions. Cryptomeria Japonica pollen is ~30 um. Different mesh densities also create particular effects with different degrees of visual transparency, patterns, and physical porosities.</td>
<td></td>
</tr>
<tr>
<td>Mist</td>
<td>Water droplet sizes can vary in order to minimize the slip-stream effect and increase chances for particle collision. Mist can lower ambient temperatures by 2–6°C. Humans can detect a change as little as 0.2°C.</td>
<td></td>
</tr>
</tbody>
</table>

Sentient Urban Artifact (Artificial Tree)

An architectural response appropriate for the manipulation and enhancement of exterior spaces was formalized by integrating the seemingly disparate parts uncovered in the previous section, referred to in this research as Artificial Trees. At the individual level, the trees are materialized as component-based tensegrity structures derived from the two-dimensional models developed by Kenneth Snelson in 1948 (Hearney and Snelson), which were later reinterpreted three dimensionally (Frumar et al, 2009). Here, each structure undergoes an algorithmic optimization process developed through Rhinoceros, Grasshopper, and Galapagos, whereby their exact locations determine the amount of wind loading they can endure, thus effecting the rotation of each...
4. **Sentient Urban Artifact (Artificial Tree).** (A) Differential transformations. (B) Mesh coloration over time.

5. **Sentient Urban Artifact (Artificial Tree).** Sentient system and artificial tree.

6. **Decoding Urban Air:** (A) Wind Shaped Tree. (B) Wireframe of a 3D-scanned tree and deformation diagram. (C) Render view of all 3D-scanned trees.

7. **Decoding Urban Air: Reverse Algorithmic Thigmomorphogenesis diagram.**

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**Sentient Urban Artifact (Artificial Tree).** (A) Differential transformations. (B) Mesh coloration over time.

**Decoding Urban Air:** (A) Wind Shaped Tree. (B) Wireframe of a 3D-scanned tree and deformation diagram. (C) Render view of all 3D-scanned trees.

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**In(d)visible** Charbel, López
component as well as its scale (Figure 4A). The structures are then mounted with the mesh, a sentient system made up of different environmental sensors, and an actuating system in the form of misting nozzles and solenoid valves (Figure 5).

The following describes the sequence of how the above-mentioned elements are networked: 1) Wind blows airborne particles onto the site. 2) The particle sensors detect the quantity of particles present relative to their locations, while the flex sensors are able to measure the wind speed as well as the wind direction. 3) The wind and particle information is then combined with the humidity and temperature levels measured by the weather shield, which are all used to decide which misters to activate and how much mist to spray. 4) The mist collides with the airborne particles, causing them to either stick to the mesh, or to eventually be weighted down to the ground. 5) As time goes by and the process continues, the mesh is gradually colored, revealing the differences of the pollen levels over time, while the mist cloud being produced is indicative of the real-time condition (Figure 4B).

Decoding Urban Air

As airborne particles are primarily influenced by wind flow, it is necessary to retrieve wind data from a given site. It was found that real trees actively respond and shape themselves according to wind over time in a process known as thigmomorphogenesis, whereby plants respond to wind and other mechanical perturbations in a way that is favorable to the plant for continued survival in windy environments (Telewski 1999) (Figures 6A and 6B). In most instances the differences are not visible to the naked and untrained eye, therefore a system of hybrid computer/human vision, referred to here as Reverse Algorithmic Thigmomorphogenesis, was developed using Rhinoceros and Grasshopper (Figure 7).

The first step is to scan the existing trees through iSense 3D Scanner (Figure 6C), thereby making them three-dimensional. Next, the tree types must be identified to understand their phenotypical properties and tendencies. The third step is to check for anomalies that risk distorting the data, such as buttress rotting. If no anomalies are detected, the measuring proceeds as normal. If anomalies are detected, however, the areas to evaluate are adjusted and calculations proceed to data extraction. The prevailing wind directions are then used in Computational Fluid Dynamics software in order to generate the full wind data on the site.

Case Study: Computing an Immersive Environment Virtual Model

In order to determine the overall arrangement and placement of Artificial Trees as an integrated part of the existing site, a logic was devised with respect to the context of pre-existing trees and wind patterns. The extent of the physical boundary was defined by overlaying the wind simulations from the 5 predominant directions retrieved from the site, and removing the vectors that were below a certain threshold deemed insignificant for particle

[Images: Spatial logic, Plan section on site]
transport. The wind vectors that conflicted, within a buffer zone proportional to the tree crown size, were also removed, thus creating an intimate semi-enclosed space with respect to the nature of the activity outlined in Part I (Figure 8).

The rigidity of the grid was broken by an attraction of the artificial trees to the cherry blossoms, introducing looseness to the space while creating a denser enclosure around the main attractions. This also creates emergent thoroughfares in the plan, which in turn serve as networked pathways into the spaces while enhancing the effects on one’s peripheral vision. The height of each artificial tree also varies and is determined by its proximity to a real tree; they are smaller and thinner when closer, starting at 0.6 m high, and taller and thicker when farther away, reaching up to 3.6 m. The height gradations relate closer to the human scale when entering the site, gradually immersing the viewer through the walk, and regress to allow for the viewing experience (Figure 9). The intention of the play in scale and spacing sought to combine the meditative effects of a labyrinth-like walk, while extending the duration of the event boundary.

**Physical Model**

A 1:1 physical model at the scale of a small pavilion, made up of 52 artificial trees in a bounding box of 2.4 x 2.4 x 2.4 m, was created following a similar logic (Figure 10). The four artificial trees (Figure 11A) at each corner of the square footprint were specially designed to incorporate four misting nozzles (Figure 11B), each connected to a solenoid valve that was controlled by an Arduino connected to a computer (Figure 11C). The valves were activated by reading recorded wind data from an Excel spreadsheet. The result is an orchestration of mist in response to wind speed and direction (Figure 11D), which while performed to capture pollen, enhances the perception of the space, earlier referred to as a computed immersive environment (Figures 12–14).

**Computing Immersion in Context**

A diagram produced by the interactive company Qualcomm Cognitive Technologies (Qualcomm 2015) is used as a basis for substituting the variables of their virtual immersive environments within the context of the case study (Figure 15). Furthermore, because the research hypothesized integrating both qualitative and quantitative criteria, tests were conducted on both fronts to measure performance efficiency; as such, biometrics and a self-administered survey are used to measure the human responses to the project.

**Wind Flow and Mesh Particle Capture**

A wind chamber was constructed with a section area of 60 x 60 cm. The exit of the chamber was divided into a 4 x 5 grid and a
Four artificial trees with misting nozzles, with directional spraying controlled by Arduino.

Close up of mist actuation controlled by Arduino.

Final prototype of the Computed Immersive Environment. View from front elevation.

Diagram of immersion through human and machine perception.

Mesh orientation in wind chamber (above). Wind tunnel exit grid with wind speed values in m/s (middle). Mesh in chamber below.

25 cm diameter fan was placed at the entrance. One of the mesh geometries from the proposal was tested in three different rotations: perpendicular to the wind, parallel to the wind, and angled with the wind (Figure 16). A digital anemometer was placed over each of the grid cells to determine the spectrum of most obstruction to least obstruction.

Next, a test was conducted to determine which orientation was the most effective in particle capture, and whether the addition of mist would make any observable difference. Pigment was used as a pollen substitute because of its similar particle size, as well as its ability to register color easily. Four mesh orientation options were tested with 1 gram of airborne pigment, which was weighed on a digital scale with a 0.001 g precision: perpendicular, parallel, angled, and angled with mist. A notable difference in local coloration was easily observable with the human eye in all cases. To determine a numerical value, a computer vision definition was developed in Grasshopper, which compared high-resolution photo pixels of each colored mesh against a plain white mesh through an RGB value percentage formula (Figures 17 and 18).
The orientation that performed the best in capturing particles was angled with mist, which had a global match ratio of 90.58% when compared against the plain white mesh. The mesh oriented parallel to wind flow performed the least effectively, with a global match ratio of 94.34%.

**Biometric Analysis**

Biometric devices were used to measure the emotional responses of four subjects, two male and two female; a Grove Studio GSR Sensor and a Grove Ear-clip Heart Rate Sensor. Research shows that alone or in tandem, such devices can be used to detect changes in levels of arousal and differentiate between emotional states (Piccard and Scheirer 2001; Wen et al. 2010). The subjects were sat in a partial enclosure made up of the artificial trees, four of which were mounted with the misting nozzles (Figure 19). Each person’s biometric data was measured twice for three minutes at twenty second intervals. The first measurements were taken during the static state of the experience (without mist), and the second set of measurements were taken during the dynamic state (with mist). The same wind data simulation was used on each subject so as to reproduce the same conditions each time. At the conclusion of the experiment, each subject was also given a self-administered survey relating to their experience according to guidelines published by Whitney (1972).

**RESULTS**

**Decoding Urban Air**

Using the beta version of the Reverse Algorithmic Thigmomorphogenesis proved to be a possible way of gathering wind data from a local site. Although at this stage it was only testing the stem cross-section, the results were accurate and it is reasonable to assume that scanning and decoding other parts of the tree and integrating them into a coherent interface can provide a good means for understanding local prevailing winds and increasing the resolution of the information.

**Wind Flow and Mesh Particle Capture**

It was found that an angled mesh orientation with responsive mist is preferable as a design choice for maximum particle capture and minimum wind obstruction. However, the particle sensor was unable to differentiate between water droplets and airborne particles, which therefore proved to be a glitch in the system, as more mist would trigger more particles in a perpetual loop. This could potentially be resolved by timed intervals between sprays and particle sensing so as to eliminate conflict.

**Biometric Evaluation**

Data from the GSR and heart rate sensors were made into a line graph in order to visualize any correlation between the two.
states of the experience: static (no mist), and dynamic (mist in response to wind). The data collected did not demonstrate any legible correlation between the static and dynamic state of the architecture (Figure 20). This could be due to either the resolution of the results, or the nature of the low-cost version of the GSR sensor, as it did not appear to yield any consistency in preliminary tests. The research would benefit from recreating the experiment, taking into account the use of an accurate measuring device and an increase in the duration of the test, as three minutes may be too short.

**Post-Experience Survey**

A self-administered survey was also conducted using the modified immersion diagram in section 3.5 as a basis of questions to be answered (Table 2).

Table 2. Self-Administered survey, with Yes, No, or Indifferent.

<table>
<thead>
<tr>
<th>Questions</th>
<th>S.1</th>
<th>S.2</th>
<th>S.3</th>
<th>S.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you suffer from hay fever?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Did you ever feel too cold?</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Did you enjoy better with the mist?</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Were you initially surprised?</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Was the pattern of spraying bothersome?</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Did you eventually feel you got used to it after the initial surprise?</td>
<td>Y</td>
<td>X</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Would the structures alone enhance the hanami experience?</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Would the structures and mist enhance the hanami experience?</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Would you prefer to have control over when the mist is actuating?</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Could you consider the intervention as an inherent part of the environment?</td>
<td>Y</td>
<td>I</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

All the subjects responded positively to the mist as an atmospheric and physical presence, while the modified temperature was a pleasant addition. However, the sound that the misters created when actuated was said to be distracting. Also, while some accepted the seeming randomness of the spraying in response to the wind data, others reported that having a degree of control over the micro-environment would be favorable. Similarly, the response to the quantity of artificial trees varied, although it was generally agreed that the spatial quality they provided could contribute positively to a sense of partial isolation.

**Multiple Boundaries**

A boundary could be defined along physical, spatial, and psychological lines alike. In the physical sense, a gradient boundary was created by the artificial trees, which, through their spatial organization and materialized form, maintained interplay between solid and void both visually and spatially. In spatial terms, the mist defined a different kind of boundary that could be sensed with different intensities, depending on the quantity and location of the spray; therefore, two people could be co-experiencing one type of boundary while another type is experienced individually. Finally, the psychological boundary could be effected through a combination of the two previously mentioned types, thus heightening people’s sensorial experiences as they move through the heterogeneous space.

**Next Iteration**

Two notable aspects could be further developed to improve the
experience. First, the mist was not visible to the extent desired, nor did it possess the soft haze-like quality that was initially sought after at the outset. Secondly, the sound produced by the misters had a presence that can be said to have neither contributed nor detracted from the experience. Regarding the sound specifically, it was noticed that on the one hand it contributed to the behavioral animation that triggered engagement and curiosity in the subjects, while on the other, it reminded observers of its presence, as the sprays are perceived as pattern-free and are seemingly triggered abruptly. Generally, the inclusion of more networked sensors and actuators could further enhance the experience while operating as a total climatology.

CONCLUSION
The research hypothesized that an architectural response could be designed and generated based on integrating numerical data and behavioral research in a highly local context and activity (Figure 14). The discrete parts were successful in responding to external conditions, while they demonstrated potential in reducing airborne particles and rendering invisible conditions perceivable.

At the object scale, the semi-autonomous artificial trees exhibit affordances and behaviors that trigger a curiosity and engagement with users. At the human scale, the thoroughfares maintain the cherry blossom trees as the focus while the artificial forest permeates throughout the periphery of the user’s vision, allowing for new social engagements and collapsing diametrically opposed distinctions.

As a field, the collective coloration of the mesh is speculated to communicate a mosaic of air quality, while the structural deformations indicate prevailing wind flow in a vector-field-like manner. In reference to the methodology diagram in Figure 2, the project reached its first iteration, and from both qualitative and quantitative results would benefit from tuning in order to be tested again, thus evolving the output. The authors suspect that within a different context and a different set of activities, conflicts, and constraints, the same or similar methodology could be applied with respective techniques while yielding novel outputs in creating a hybrid sentient space.

The use of biometric devices, though not entirely conclusive, placed measurable sensorial data on the receiving end of the materialized output. The authors are currently pursuing a research project titled (in)visible, which aims to use the biometric measurements as the input source in the production of a responsive spatial output.

Finally, the interactive tendency of the subjects in the experiments suggests that an approach that includes qualitative measures at the outset can enrichen user experience while also satisfying quantitative issues related to local conditions.

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REFERENCES


Academia: Disciplines + Disruption


**IMAGE CREDITS**

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