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Nocturnal Artifact: Computational Method to Optimize Vegetation Layout within Urban Landscape with Regard to Local Environmental Conditions and Behaviors of Pipistrellus Abramus (Section 2)

37-146946 SAM Ratnar

Research Objectives

The objective of this research is to optimize potential neglected site that have been selected through animal computation. The optimization process aims to create a symbiotic urban landscape through the disbursement of seeds in a random order that will mimic the natural order. The disbursement will be dictated by the local environmental conditions in order to influence the behaviors of the Pipistrellus Abramus.

1.0 Introduction

Computer optimization is applied to planting vegetation in a randomize manner to achieve a more natural outcome. Random optimization is programmed to search for a way to place the highest amount of vegetation into a selected site. Giving the site a more natural feeling with a high diversity of vegetation. A high amount of diversity in vegetation with procreate a symbiotic relationship that promotes a feedback system within the arrangement of elements by promoting the urban ethology of bats within the city.

Hierarchy of elements dictates the relationship that are being formed. Slight re-configuration of elements can greatly increase or decrease the output of these relational factors. Elements such as how which species of vegetation should be optimized first and how that will further effect the outcome of the next stage of design (see Section 1).

Through the computational optimization a research was done to extract numerical data from agents that will influence the design such as animal behavior, plant behavior and climatic conditions.

2.0 Sun and Shadow Analysis

In order to randomize the seed spreading of various vegetation, first a sun and shadow analysis must be conducted of the site to construct a methodology that will help generate a symbiotic landscape. In order to understand how vegetation will grow in a given site, we must know what kind of principle factor vegetation needs to grow. The two key factors are soil for nutrients and solar gain for photosynthesis. By selecting sites through animal computation the presents of pre-existing vegetation should already exist, meaning that the pre-existing vegetation is located within ample soil conditions and there is efficient sunlight for that particular specie of vegetation.

The amount of solar gain is crucial to the health of vegetation, too much sun can be damaging to the plant while too little can be insufficient for plant growth.

After the site has been selected through animal computation, a sun and shadow analysis is done so that vegetation can be allocated to their proper placement. The locality of the site is first analyzed by how many hours of solar gain does the surface receive throughout the year. A 3d model is produce to analyze how solar orientation will affect the site with regards to the built environment that encompass it.

2.1 Seasonal Sun Changes

The targeted time period is between April and September, it is during this time that the Japanese Pipistrelle is most active. The beginning of April the sunrises starts at 5:28 and sets at 18:03 at the latitude of Tokyo, 35.70° N. Each day towards the summer solstice the sun will continue to raise earlier than the previous day. On the day of the summer solstice, Tuesday, June 21, 2016 the sun will rise at 4:27 and set at 19:00 giving this day the largest amount of daylight for the year. (SunEarthTool 2016). The intelligence of animals is to evaluate these changes in time and adjust their behaviors accordingly. However, the spread of vegetation solely depends on chance, the chance of seed spreading to the appropriate spot. By developing an optimal seed scattering system, the reality of chance is taken into a computational algorithm that will produce a more natural environment that will allocate seed to their proper location.

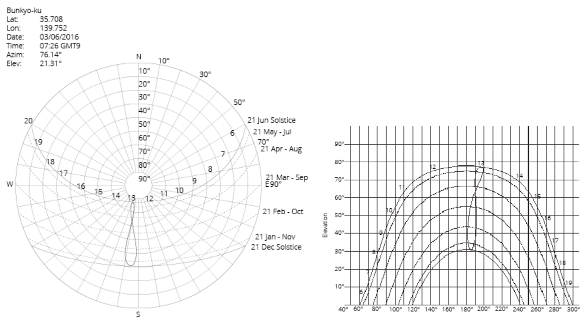

Fig 01 Sun Path Diagram

3.0 System of Analyzing

Data needs to be gathered before seeds can be allocated. To do so a system of analyzing needs to be performed. To compute the function of daylight various tools are implemented to do so. Data of location, date, time and the sun position is use to output where shadow is cast and how much. A plug-in was use for Grasshopper called Ladybug, the plug-in process these mathematical function so that a sun and shadow analysis can be outputted.

3.1 Information Gathering

In order for Ladybug to work, the right kind of information is need to be inputted into the system. The plug-in requires a set of information in the form of EPW (Energy Power Weather) file format. The data is provided by the Auxiliary Program from EnergyPlus, an open source weather data base.

3.2 Output of Information

Output of information is not always clear, even if the programming script is working properly. Sometimes the output still can be messy. The final output of script is a visual data that depicts the movement of the sun during a single day of the month. This visualize data needs to be cleaned up before the next step can take place.

When the visual data is outputted, it is outputted onto the 3D model. Non-regular brep (boundary representation). A uniform UV will have equal distance between all of its points but a non-uniform brep will produce more points along the edges. This produces a problem of easily reading the data, to overcome this problem a XY coordinate grid system was produce to read the average of points within a single cell. Any cell that contain more than a single point will be average out so that the grid contains only one piece of information. This allow for easier reading and organization.

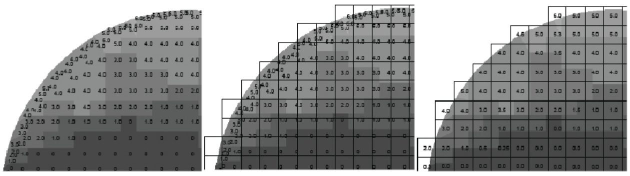

Fig. 02 Process of Organization

3.3 Re-Organization of Information

Once the steps have been laid out, any month can now be applied to the setup. The coding will be able to receive data from any month and output the results accordingly to the grid. The cell of the grid can record the hours of sunlight that it receives from any day of the months in a year.

4.0 Coding Vegetation

Vegetation can be coded by the amount of sunlight that they need, when they bloom, their seasonal changes, and their physical traits. All of these data can be inputted to calculate where is the optimal location for vegetation to be place.

There are two general types of vegetation, trees and shrubs/bushes. Shrubs and bushes can spread as far out laterally as long as the right conditions are present. Trees only tend to grow to a certain height and their branches only spread laterally to a certain distance away from the trunk, because of these two type of vegetation trees will be optimized to a site first then the shrubs and bushes.

4.1Trees

There are two type of trees, coniferous and deciduous. Deciduous trees will start to produce flower, fruits and nuts. Some trees have the ability to produce a combination of flower and fruit or flower and nuts. The byproduct of these trees have a natural relationship with their symbiotic agents that feed on them which brings about the relations to the pipistrelle. The pipistrelle will forage for these insects that feed of the byproducts of these vegetation. It is important to allocate these vegetation so that they get the proper amount of light, so that they can produce these byproducts.

Spreading trees in a randomize order will create conflict in reality, to overcome this an algorithm was constructed to ensure the optimal growth for each vegetation. Conflict of trees sharing too much space with one another, regardless of the species, trees will produce conflict in how they grow. If two trees share a single space together and there is a conflict of nutritional needs that is needed for both tree, one tree will be dominant over the other. The dominant tree will grow more toward its average ciphering most of the nutrients while prohibiting the other tree to gain enough nutrients it needs to grow efficiently. In nature the weaker tree will become smaller than average and or will die from the lack of nutrient needed.

4.2Shrubs/Bushes

Shrubs and bushes follow the same natural order as trees, when the season changes so do their behavior. Shrubs and bushes will be implemented in between the trees where the proper amount of light exist.

This habitat is optimized so that vegetation can grow to their full potential without conflict in fighting for space so that they can produce contents to attract insects.

4.3 Conflict in Nature and Coding

To avoid conflict between trees and shrubs, trees are given a circumference that is based on the average spread of the branches. The circumference of the circle is then divided into a series of equal parts. These parts are indicated through points along the circumference. If the majority of points along the circumference is occupied in a region of other trees that tree is then defined as not being able to achieve enough nutrient therefore the tree that cannot grow to their full potential will be culled out in the program.

Larger trees are optimized to the site first, the size of tree species determine how many seed is spread across the site. Large trees need more spaces to grow therefore less seed are spread to avoid conflict sharing too much of the same plot. After the larger trees have been place then the smaller trees will be place to fill in the gaps that were left by the larger trees.

4.4 Fractals

A study of fractal growth was conducted in order to understand the growth of vegetation. The study did not influence the design intervention however it did influence the thought process on how agents of the system can be related in the sense of their relationship to one another.

4.5 Voronoi

Voronoi was used to determine the outline of the randomization from the spreading of the seeds. This process came from the study of SS System (Takenaka 2011). Different randomization was produce in an order to achieve the highest amount of output according to the species of vegetation that was being targeted.

This process focused on the species of the trees. As seeds were being spread across the surface of the targeted space, the amount of seeds was determined by the size of the tree.

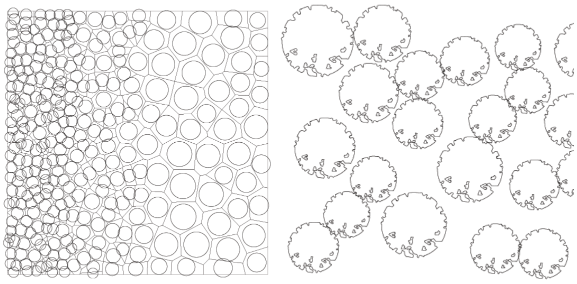

Fig. 03 Voronoi determing the size of the tree that will be allocated into the site

If two or more points share an area that produces close proximity to each other, voronoi will be created with smaller surface areas. If the area of the voronoi is too small, then that voronoi will be culled out of the process of being selected for that species of tree.

5.0 Optimization

The desired output is aim to achieve a symbiotic relationship that is enhance through the system of optimization. Through the placement of various vegetation, the influence of relationship should promote a higher level of action. More insects should be attracted into the site throughout the year therefore producing a higher number of bats in the area.

The consequences of these action should be a direct correlation to the optimization process. The area of vegetation should aim to reach the highest yield, the more vegetation that can be situated into the site the higher the possibility it is to bring in insects that feed on the various vegetation.

The data of vegetation get input into a component of Grasshopper called Galapagos. Galapagos treats inputted information as genotypes, the genotypes than goes into a process of the fitness landscape. Throughout a series of revolution, the genotype will find the most optimal way to produce the highest amount of species of vegetation that can fit into the landscape. This iterative process puts different species of trees against one another in the landscape to see which evolution will produce the most optimal number of trees for each species.

The goal of the outcome can be geared toward a single species versus the total amount of vegetation. Larger size trees can return a higher amount of area being produce but however it is harder to fit large tree into the site that already have other vegetation occupying the lot. The process is to compare all optimization option to figure out the best result.

6.0 Symbiotic Relationships

Agents in the system have a deep relationship with one another. Plants needs insects to procreate through the transfer of pollen, insects need plants as a food source, plants need bats to stabilize the insect population so that insects do not over feed. Symbiotic relationship should demonstrate that the relationship between site, pray and predator should act as a reaction base relationship. When one factor change it should set off a chain of reactions throughout the system.

6.1 Animal Computation

Animal computation looks at how the animal forage for food, where they tend to travel, why they travel, where do they roost and where do they come into conflict with people. These behaviors can be translated into data. The data can be used in various parts of the process, the global computation, local computation and how it effects the overall design.

6.2 Insect Computation

Insects computation is based on the diet of the pipistrelle. Data is gathered through insects' behavior so that vegetation can be targeted to attract the them into the site (Dugatkin 2004). Placing key vegetation in neglected sites helps attract insects within the urban condition to create a symbiotic relationship.

6.3 Biodiversity

Biodiversity is a complex relationship of multiple agents working in a symbiotic network that will balance itself out. The greater the biodiversity the greater the rate of success. If the site only has one set of vegetation, then that vegetation only attracts a certain group of insects and if that vegetation fails the whole system fails. Having a biodiverse site spread the chances of success. When there are more elements of attraction, larger number of insects will tend to forage there, creating a symbiotic site (Dugatkin 2004).

7.0 Conclusion

Taking advantage of unintentional consequences that produce neglected spaces and targeting them for design intervention. Through the process of coding the environment and the agents within it to evaluate the relationship between them will help determine the proper direction of the design intervention.

Looking at the sun and shadow as a foundation to set up the system to optimize the site will provide a framework for the vegetation to be laid out. The ability to code nature in a way that allows it to become optimal to support the existing wildlife within the city helps promote the relationship of ecology.

These ecologies will provide the agents within the system to perform their natural tendencies in a proper manner that will feed back into the larger system of the urban environment.

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