James Basson and Frederic Eichelbrenner

TITLE of proposal : Generative solution to planting design
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Authors:
James Basson
University of Greenwich, UK BA Hons in Garden Design
Resident in France
www.scapedesign.com
Fred Eichelbrenner
Master's Degree in Numerical Analysis from University of Paris 6
www.ellipsofacto.com

Main References:
www.generativeart.com

Abstract:
Computational ecology and computer aided mapping systems facilitate the input of data, coping with the variables on a deeper level, there are so many factors to consider when creating planting designs, climate, soil type, aspect, natural water fall, flowering season, height, width, colour (both flower and foliage) that the human brain can only process a limited number of variables creating what could be argued as staid and non-adventurous planting schemes worldwide, to take this medium to the next level -using computer based tools makes perfect sense.

Rather than be based on a real time study, computer data is potentially rich enough to give us new planting schemes, constantly refreshed plant associations at each turn thus avoiding the danger that planting design will become uniform and stagnant.
Having studied the game of life and other algorithmic automated growth programs we have created a programme that by entering variables into a computer model will demonstrate how we can predict planting patterns and therefore chose the best possible planting scheme for each outside space. Taking into account the wealth of information available to us that we can input whilst still posing the question just how 'good' is the quality of this information?
Is generative art and computational ecology the way to formulate the planting plans of the present going into the future in order to produce sustainable, ecological interesting yet realistic planting design?

Example: Matrix planting Cote d'Azur

Contact: james@scapedesign.com

Keywords: ecology, sustainability, planting design, future

A Generative Solution to planting design.

James Basson, BA hons Garden Design, MSGD, FFP

University of Greenwich, Scape Design

www.scapedesign.com james@scapedesign.com

Frederic Eichelbrenner, Masters Numerical Analysis

University of Paris 6, Ellipso Facto

www.ellipsofacto.com frederic.eichelbrenner@ellipsofacto.com

Abstract

Computational ecology and computer aided mapping systems facilitate the input of data, coping with the variables on a deeper level, there are so many factors to consider when creating planting designs, climate, soil type, aspect, natural water fall, flowering season, height, width, colour (both flower and foliage) that the human brain can only process a limited number of variables creating what could be argued as staid and non-adventurous planting schemes worldwide, to take this medium to the next level -using computer based tools makes perfect sense.

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Introduction

The world of architecture has long been taking inspiration from organic forms of the natural environment, and yet planting design has been slow to take up the mantle.

Unlike Architecture, Planting design is dependent on so many variables, both physical (climate, soil type, aspect etc.), human desire (colour type, style of planting etc) and the complexity of nature (plant competition – aggressivity of growth, time etc). The task of trying to come up with a natural, organic planting solution is far from easy. The idea of a human brain computing all the information required to come up with a truly inspirational, unique and natural planting design becomes impossible, we need to look to computational technology to offer us an alternative to the reductive lists currently available on plant databases and search engines to create an auto-generative list of plant possibilities that are suitable for a specific given environment and list of desires. A model could then in turn demonstrate the eventualities of these generated plant lists predicting how they would develop over time allowing us to choose the plant community that not only suits our personal aesthetic requirements but that will thrive in it's given location, all the while producing a solution that fits harmoniously within its natural location.

Architecture

Frank Gehry's Guggenheim museum in Bilbao is an excellent example of the world of architecture embracing organic forms and using computer aided design software to turn a concept into a reality. He designed the building concept by simply rolling up pieces of paper and taping them together, in 1997 technology was just starting to be able to cope with such forward thinking design…

"As the proposed curves exceeded the capabilities of conventional construction, Gehry turned to CATIA software (developed by the French aeronautical firm Dassault) to translate his concept into a built reality. Essentially, CATIA digitises points on the edges, surfaces and intersections of Gehry's hand-built models to construct on-screen models that could then be manipulated in the manner of animated cartoons.

The computer has enabled Gehry to generate formal and spatial complexity that would have been inconceivable only a few years ago. The notion that uniqueness is now as economic and easy to achieve as repetition, challenges the simplifying assumptions of Modernism and suggests the potential of a new, post-industrial paradigm based on the enhanced, creative capabilities of electronics rather than mechanics." [1]

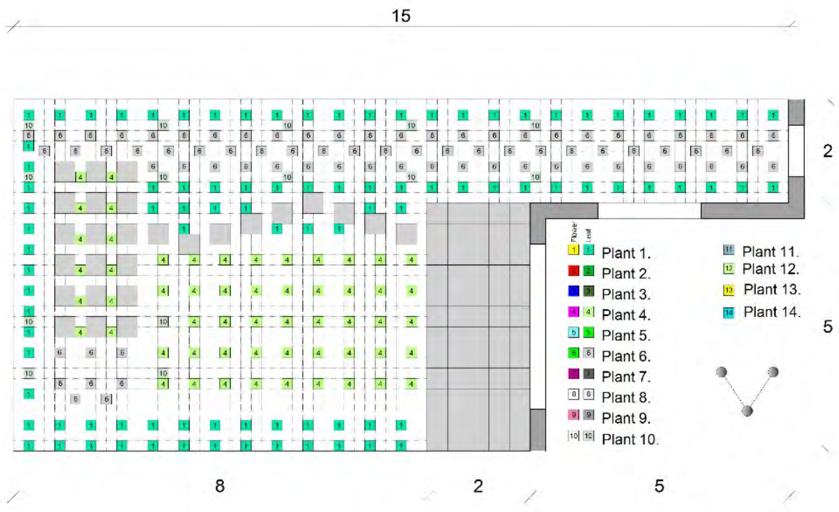
The natural world

However when we move from the static material of 3D buildings into the natural world, things get even more complicated. How could one replicate the murmurings of a flock of starlings? How can one create a garden that is a stable ecology by designing a planting solution that replicates the habits of the natural world yet satisfies the desires of the client at the same time?

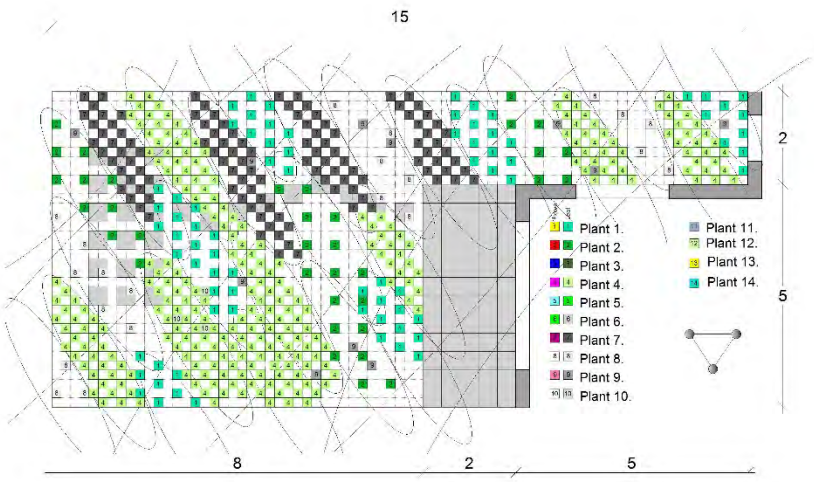
Planting design today

At present in order to create a plant list to implement a garden design we use a range of search engines and enter criteria such as: shade or sun, colour of desired flowers, flowering season, soil type and sometimes style. More often than not this generates a list of 1 or sometimes 0 plant possibilities. Nature is obviously not this reductive there are plants that can thrive in sun AND shade, or that will work in sandy AND clay soils, yet technology is such that inclusive lists are not currently an option.

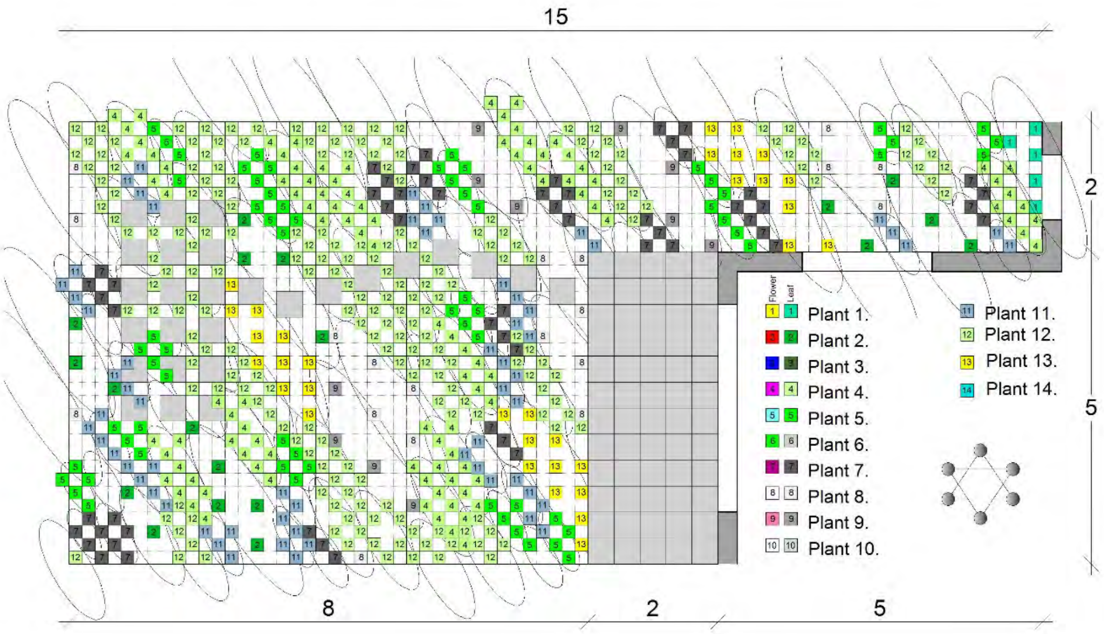
For this reason over the last few decades garden designers and Landscape architects have tended to stick to a palette of a few select tried and tested plants and use them in a variety of permutations.



Block planting (above) and mass plantings (below) whereby each plant has 3 possible interactions with other plants.

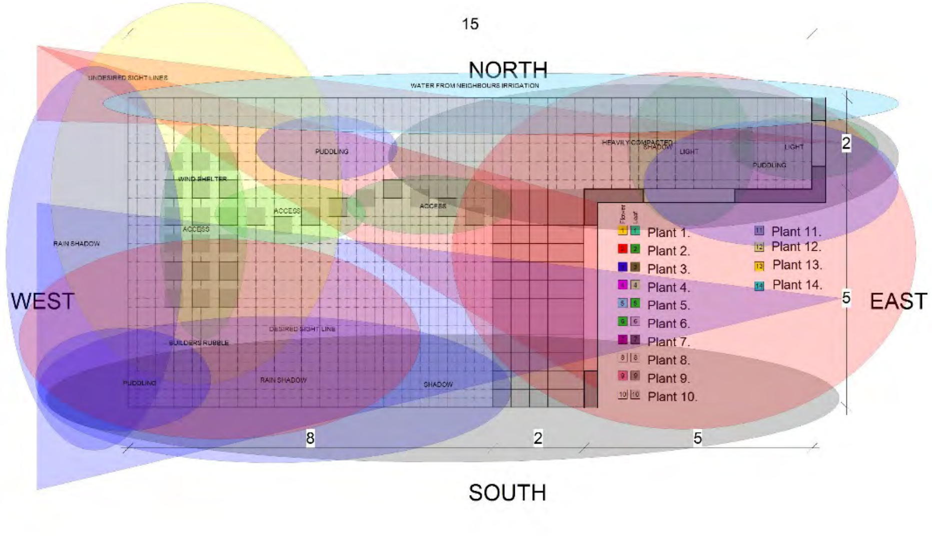


Moves towards a more naturalistic planting design where there are more possibilities of interaction (see below) have only recently started to become more developed and used. An excellent example of this approach is London's Olympic park planting.



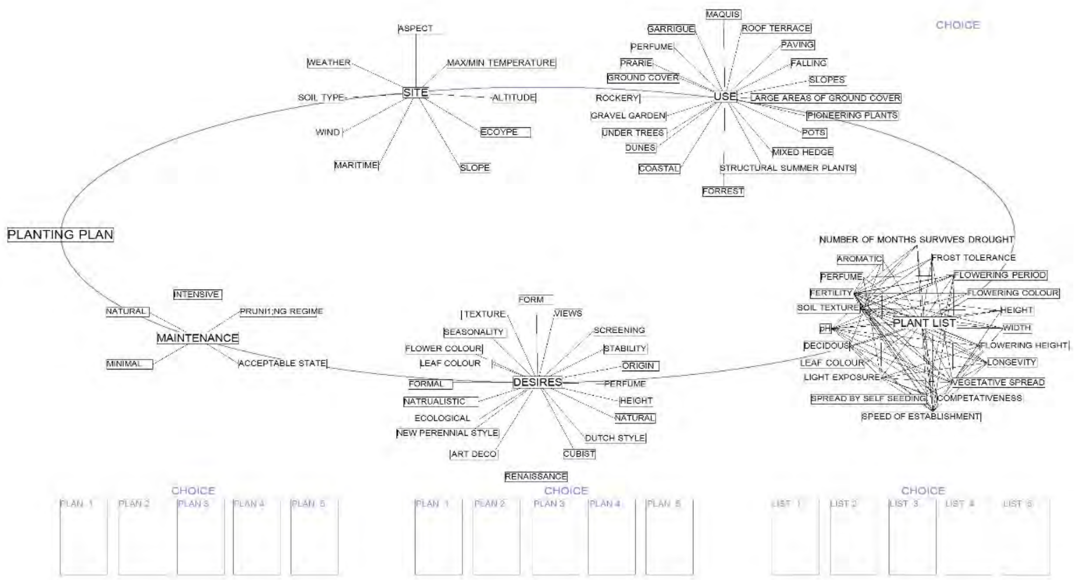
“The planting was led by two of the most innovative, cutting-edge plantsmen in the world: Professors James Hitchmough and Nigel Dunnett of the Department of Landscape, University of Sheffield. Their research-based approach to planting has produced landscapes that are both ecologically functional and jaw-droppingly beautiful. Hitchmough and Dunnett pioneered a unique approach to urban planting, which combines native and non-native plant species in low-input systems based on semi-natural vegetation types, such as meadows, woodlands and wetlands. This approach has come to be known as `The Sheffield School´ of planting design.” [2]

This type of planting was considered cutting edge and indeed was unlike anything seen previously. But we wanted to know how this could be taken further, in one square metre of natural countryside there can be as many as 100 or more plant species, how can man possibly take this inspiration and use it to produce even more naturalistic planting combinations, whilst taking into account all of the physical restraints shown below that have to be considered when created a private garden or landscape project…



…As well as the desires of the client previously mentioned? The answer, in short is we can't!

If we put all the variables into one flow chart we can see the amount of interchanges that have to be dealt with and this is where we need to look to generative computer aided modelling.



Computer Model 1 – Inclusive 'Big Data' plant lists

At this point we want to take all our restrictions and desires and create an inclusive plant list. One that takes into consideration all the grey areas and that is intelligent enough to take the data that is potentially held on an open source database that is geo-specific to generate a series of plant list options that would work on our given site.

Once we have these options of plant lists we can select one that appeals to us, happy in the knowledge that the plants selected will work in the environment in which we want to use them. But then what? How can we be sure that the end result will be what we are looking for in 5 or 10 years, how do we maintain the garden?

Computer Model 2 – Creating patterns.

Once we have chosen the plant list that appeals to us for the above reasons we can equally apply a style to create the kind of 'ambiance' we are looking for in a landscape, this again could be aided by machine learning.

Machine learning is a subfield of computer science[4] that evolved from the study of pattern recognition and computational learning theory in artificial intelligence.[5] Machine learning explores the study and construction of algorithms that can learn from and make predictions on data.[6] Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions,[7] rather than following strictly static program instructions. a good example of this is the photo to painting application.

In the same way we could apply a style of planting 'new perennial' 'post modern' 'naturalistic' etc and generate the feel of the garden we are looking to create.

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Computer Model 3 – Maintaining stability

By applying the information we have amalgamated from the previous 2 models in our planting design process we now need to apply a third layer to dictate when we stop the evolution of the garden according to desired end effect. Using our simulators instead of creating a random generative pattern we are able to create a physical workable possibility.

We want our garden reach a stable ecological state, but we need to know how it will develop in order to do this.

James Conway's 'Game of Life' uses cellular automaton to create a simulated evolutionary process

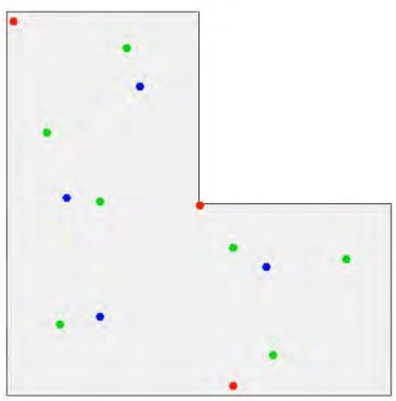
"Conways genetic laws are delightfully simple. First note that each cell of the checkerboard (assumed to be an infinite plane) has eight neighboring cells, four adjacent orthogonally, four adjacent diagonally. The rules are:

1. Survivals. Every counter with two or three neighboring counters survives for the next generation.
2. Deaths. Each counter with four or more neighbors dies (is removed) from overpopulation. Every counter with one neighbor or none dies from isolation.
3. Births. Each empty cell adjacent to exactly three neighbors--no more, no fewer--is a birth cell. A counter is placed on it at the next move." [3]

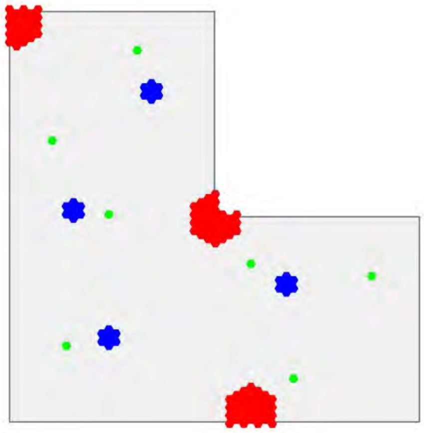
By using a few simple mathematical rules Conway was able to create a single generation evolution developed from a generative pattern.

In planting design by integrating factors or as in Conway's case 'rules' such as plant aggressivity/competitiveness in pushing out other plants, growth patterns and time to reach a mature specimen we are able to simulate a planting ecology to see which one over time delivers the result we are looking for. We start with say 5 randomly placed plants and set the generative program in action to see how those plants will interact and develop. For example :

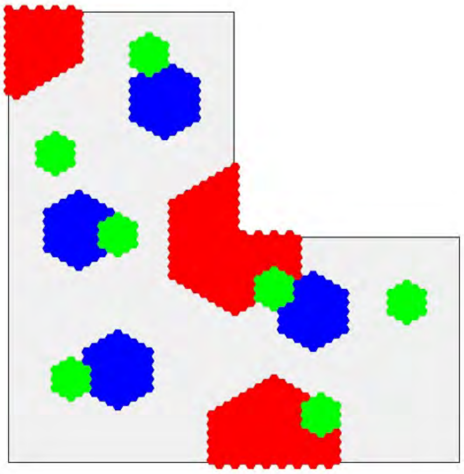
Stage 1



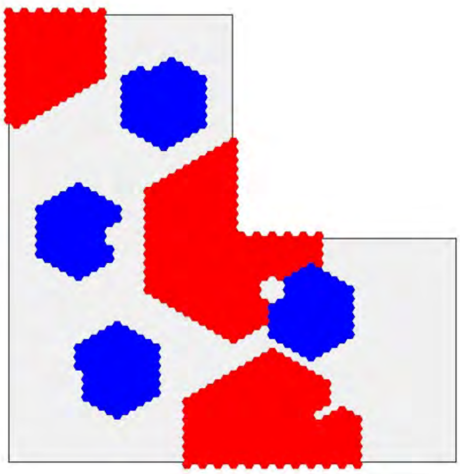
.Stage 3



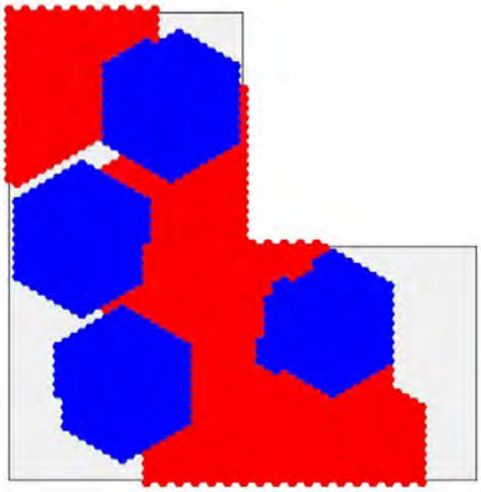
Stage 8



Stage 11 – the green plant has now been outgrown by red and blue



Stage 17 – Dominant plant is established



Once we have established the plant list we will use, the ecological stability we require and the style of the planting. We have to address the question of maintaining this stable ecology. There are many ways nature deals with this issue, wind naturally keeps shrubs low, periodic fires maintains woodlands and allows subshrubs, perennials and annuals to breathe and grow.

Conclusion

The simulators we have been looking into are just the tip of the iceberg there are endless factors that have related questions that need inputting to make a more efficient realistic simulation for example:

- “Health", depends on :
  - available resources : at the moment, we consider that required resources are guaranteed
  - health on previous iteration
  - age : plant is supposed to be weak when very young, then strong when adult (or mature), then weak again when reaching its maximum age
  - a random factor can be introduced to take into account unexpected events such as disease.
  - currently, the simulator doesn't manage health, only death of plants when exceeding the maximum age limit of the species
- "Resilience", depends on :

    - health status
    - plant species own resilience
    - season / period of the year
    - distance to the trunk (more resilient near trunk)
    - a random factor could be introduced to allow for unexpected events
    - currently, the simulator only takes into account resilience associated to the species, distance to the trunk, and a random factor
- "Growth", depends on :
    - plant species own growth rate
    - health
    - distance to trunk or stem of surrounding vegetation
    - age
    - season / period of the year
    - a random factor can be introduced to take into account unexpected events
    - currently, the simulator considers a constant growth rate associated to the plant species
- "Sociability" depends on :
    - plant species own sociability
    - distance to the trunk
    - health
    - season / period of the year
    - currently, the simulator only takes into account sociability associated to the species, distance to the trunk, and a random factor
- "Seeding", depends on :
    - plant species own seeding rate
    - season / period of the year
    - health
    - distance to trunk
    - currently, the simulator doesn't simulate seeding

All of the above are further considerations that undoubtedly will be able to be incorporated as technology develops with machine learning progressing rapidly.

The world of planting design has reached a plateau, as Penelope Hobhouse, one of Britains most respected garden designers once said “You have to be old to be really good at garden design”. Undoubtedly it cannot be denied that age and experience will influence the confidence of the designer but with generative programs and open sourcing databases surely we can take planting design to the next level. Opening a new world of possibilities of plant combinations, that can compete with nature in terms of complexity, that can be stabilized to create self-sustaining ecologies that from a conservational viewpoint will be more and more important in the near future as water becomes scarcer, and climates more unpredictable. Yet at the same time satisfying the client to create an aesthetic piece of natural art, could this field be a logical cross over point for generative art to produce practical solutions for environmental concerns and development?

References:

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