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The Advantages of Blurred Vision: Uncertainty in Architectural Production

by

Scott H. Allen

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

Master of Architecture

APPROVED, THESIS COMMITTEE:

Jason Payne, Assistant Professor, Chair
Architecture

William Williams, Visiting Assistant Professor
Architecture

Keith Krumwiede, G.S. Wortham Assistant Professor
Architecture

HOUSTON, TEXAS

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Abstract

The Advantages of Blurred Vision:
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Scott H. Allen

The field of Developmental Biology uses modeling and simulation tools to study relationships between growth and form as they are impacted by contextual factors; an endeavor architectural practice is inextricably linked with. One such tool is the Lindenmayer System (L-System), which couples a written set of production rules with drawing rules to generate morphological descriptions of phenomena being simulated. In this experiment, an L-System is developed and implemented as a means to generate usable surfaces within an office environment.

The use of a rule-based approach to architectural process is an attempt at suspending primary control over a project’s development and outcome, removing to a degree bias and habit from the equation. Such a situation where intent becomes procedurally blurred can then engender a condition of plasticity within the areas of both process and product, an advantageous position as we struggle to practice within an increasingly fluid environment.
ACKNOWLEDGEMENTS

This project could not have been completed without the expertise and
guidance of the following individuals: Jason Payne, William Williams, and Keith
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well.
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INTRODUCTION

The hypothesis, as the title suggests, begins with the notion that the interrogation of my somewhat unique physiology and, to a lesser extent, the psychological ramifications of having grown up with it, can lead to new understandings of architectural production. A number of themes, specific to traits I possess, are then introduced into the larger discussion of design process and product. Those themes center mostly on the effects of a debilitating eye condition.

The blurred image is one received with information missing. The objective meaning undergoes a procedural slippage into subjectivity. Further consideration, via squinting, varying locations of focus, and most importantly conjecture transports the image into a realm of adaptability. Opportunistic conclusions can be arrived at and supported by the selection and usage of the variable evidence that is simultaneously hidden and revealed in the blur. Ultimately, the image affords the onlooker uncertain circumstances within which to operate, and thus widens the realm of possibility for the project.

Thus, a project titled The Advantage of Blurred Vision describes a situation where the designer suspends some degree of control over the design process in order to free themselves from their own biases, habits, signatures, and indolence. When implemented in conjunction with the designers' talent and sensibilities; new, innovative, better, and more appropriate solutions to design problems will be possible. A useful metaphor is that of the non-articulated appendage of an octopus. It has no joints and therefore virtually limitless possibilities in terms of motion. However, it is important to note that this absence of limits makes full motor control of the appendage impossible. Therefore, the comparatively small
number of global intentions are controlled by the central nervous system while the
infinite number of distributed local interactions are processed by the peripheral
neural circuitry.

After experimenting with a number of models, the field of developmental
biology offered a clear method to proceed with. In general, it is the study of the
relationship between growth and form as it relates to the surrounding context,
issues that architectural practice is inextricably linked with. This branch of biology
employs a number of different visualization techniques and computer simulations
to model an organism's growth.
DEVELOPMENTAL BIOLOGY

Traditional mathematical descriptions are inadequate for explaining the complexity of development processes in biology. The discovery of fractals by Benoit Mandelbrot proved much more useful for representing the irregular geometries within nature, and eventually led others to develop mechanisms capable of modeling the development of multicellular organisms. Developmental Biologists use these tools to study the relationships between growth and form as they are impacted by contextual factors; issues architectural practice is inextricably linked with (Kaandorp, 1994).

Iteration Process and Fractals

Benoit Mandelbrot’s discovery of fractals, curves or shapes which contain self-similar form that emerges in degrees of magnification, allowed for the invention of a number of different modeling and simulation tools for biologists. It was observed that fractals could be obtained through a simple set of rules and a process which uses the output of one iteration to generate the next, a natural way to describe growth processes in biology or physics. I will very briefly describe three such tools along with their strengths, weaknesses, and utility in regards to an adaptation and application for architectural design.

Kaandorp, 1994
Modelling Methods

The Diffusion Limited Aggregation (DLA Model) is useful for modeling fractal phenomena in the field of physics such as particle aggregation, dielectric breakdown, fluid instability, and electro-chemical deposition; or growth resulting from loose particles. However, it is not suitable for modeling types of growth with coherent structure.

Kaandorp, 1994

The Iterated Function System (IFS) is a method which uses two components, mappings of a 2- or 3-dimensional space and a corresponding set of probabilities, to create images of objects which resemble biological elements. However, this system merely produces graphical representations of objects and generates no information on growth processes. While spatial mappings themselves seem to suggest parallels with architectural production, the coupling of those mappings with probabilities leaves little opportunity for the infusion of architectural issues and context.
A third system, the Lindenmayer System (L-System) contains as its foundation a set of formal production rules. However, an additional set of drawing rules are needed to generate morphological descriptions of the phenomena being modeled. An advantage of L-Systems is the ability to accommodate varied behavioral characteristics and restrictions within its basic production rules. This method shows the highest degree of potential for modification and implementation in the design process because the high degree of flexibility of both the production and representation or drawing rules.
Lindenmayer Systems

The Lindenmayer System (L-System), invented by Aristid Lindenmayer, as stated above, couples a written set of production rules with drawing rules to generate a morphological description of the phenomenon being simulated (Kaandorp, 1994). L-Systems themselves are capable of modeling biological behaviors and relationships of architectural interest such as branching, clustering, decay, clumping, and self-avoidance, as well as modeling interactions specific to an infinite number of environmental or surrounding conditions. These same issues describe important relationships for a number of architectural programs, specifically programs that by their nature develop and adapt over time and are intensely dependent on the placement, interaction, and/or movement of either people or things. Candidates range from single classrooms, retail spaces, restaurants or clubs, and office spaces to perhaps even networks of businesses, houses, or urban centers.

Within L-systems, strings are generated in an iteration process. L-systems can be defined by using the following notation:

\[ K = \langle G, W, P \rangle \]

where "G" is a set of symbols, "W" is the starting string or axiom, and "P" is the production rule. Thus, in the example below, a fractal curve known as the Dragon Sweep is denoted in this manner:

\[ K_{dragon\ sweep} = \langle G_{dragon\ sweep}, W_{dragon\ sweep}, P_{dragon\ sweep} \rangle \]
\[ G_{dragon\ sweep} = \{ F1, F2, +, - \} \]
\[ W_{dragon\ sweep} = F1 \]
\[ P_{dragon\ sweep} = \{ F1 \rightarrow F1 + F2, F2 \rightarrow F1 - F2, +\rightarrow +, -\rightarrow - \} \]

< iteration > < iterated string >
0 : F1
1 : F1 + F2
These strings in themselves carry no geometric data and require drawing rules to generate the morphological description. The drawing rule can be seen in figure (A) below and the visualization at iteration 10 in figure (B). A polyline, F1, is drawn and a 90 degree turn is made at the endpoint (a + symbol indicates a 90 degree turn to the right and a "-" symbol indicates a 90 degree turn to the left).
THE ADAPTED SYSTEM

This system uses the model of monopodial branching, or branching from a main axis, as its inspiration, and involves the translation and rotation of two alternating shapes. In L-systems describing branching patterns, brackets are used to denote branches. The brackets represent a branch which is attached to the symbol left to the left bracket. The production rules are as follows:

\[
\begin{align*}
K_{\text{surface}} &= < G_{\text{surface}}, W_{\text{surface}}, P_{\text{surface}} > \\
G_{\text{surface}} &= \{ 0, 1, [ , ] \} \\
W_{\text{surface}} &= 0 \\
P_{\text{surface}} &= \{ 0 \rightarrow 11[0]0, 1 \rightarrow 1, [ \rightarrow [ . ] \rightarrow ] \}
\end{align*}
\]

< iteration >  < iterated string >
0 :  0
1 :  11[0]0
2 :  11[11[0]0]11[0]0

In this drawing rule, the string alternates between "a" and "b" and is basically a series of translations and rotations:
I have inserted new rules which produce more architecturally viable results as well as encourage diverse outcomes. Three random number generators are used within the instructions that both determine location of new growth and also kill off strings and begin new ones at a certain distance away from the dead ones. The random numbers also provide another level of diversity within the emergent growth patterns. The first random seed determines if only one or both of the branches produces new growth.

1: Growth from long branch  
2: Growth from short branch  
3: Growth from both branches

```
1  2  1  2  2  3  3  2  2  1  
2  2  1  2  3  3  3  1  1  2  
3  1  3  3  3  1  3  1  3  1  
1  1  2  3  1  2  3  3  2  1  
2  2  2  2  3  3  2  1  3  2  
3  3  2  1  2  1  1  1  2  3  
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2  2  2  3  2  1  2  2  1  2  
3  1  2  1  2  3  2  1  2  2
```

The second random seeds serves as a string death agent. The number produced represents the maximum number of units the new growth is allowed before the string must die:

```
14  1  16  5  1  12  14  10  15  9  
  4  6  6  9  1  12  14  13  10  8  
  9 11 11  4  8  5  11 11  8  14
```
The third then determines the distance a new string is thrown from the dead strings within that iteration. This is meant to create separation for circulation as well as engender a variety of surface sizes and shapes. The distance thrown is in feet:

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In addition to these basic drawing rules, contextual concerns also enter into the equation. The following experiments are meant to show isolated interactions between the growth string and various environmental factors.
RESULTING DATA

For the purposes of this experiment, a Lindenmayer System is developed and implemented as a means to create work surfaces for an office environment. The production rules are written, tested, and modified in a series of contextual petri dishes that isolate specific variables encountered in typical commercial tenant improvement projects. This performance data is further tested on a specific office design project incorporating all relevant variables.

The following twelve sets of drawings each isolate a specific type of contextual influence for the system to deal with; including entries and exits, glazing, columns or partitions, corridors, light or sound barriers, etc. Six of the twelve are developed further through the use of a curve approximation method to define the surfaces. Finally, three of these cases are then modeled in the computer to explore the results in three dimensions. This body of material aspires, through the isolation of one variable per experiment, to provide completely objective and clear data in regards to nothing but the system and each specific contextual variable.

The final case is an implementation of the system in an actual building shell that possesses a number of the different influences. Here, more control over the outcome of the project is exercised by periodic stoppages being applied to the system, the pruning of certain strings, rewinding and restarting the process; effectively encouraging growth in some areas while stopping it in others.
Experiment 01 - Simple Enclosure

Growth Sequence
Experiment 01 - Simple Enclosure

Curve Approximation
Experiment 02 - Interior Partition

Growth Sequence
Experiment 03 - Open One Side

Growth Sequence
Experiment 04 - Door One Side

Growth Sequence
Experiment 05 - Column Grid

Growth Sequence
Experiment 05 - Column Grid

Curve Approximation
Experiment 11 - Glazing Two Walls

Growth Sequence
Experiment 12 - Multiple Partition

Growth Sequence
CONCLUSION

The use of a rule-based approach to architectural process is an attempt at suspending primary control over a project's development and outcome. As the designer is led further from a prescriptive approach, an approach susceptible to bias and habit, he or she is forced into areas of thought and production that are unconventional and uncertain. Such a situation where intent becomes procedurally blurred can then engender a condition of plasticity within the areas of both process and product.

As an experiment, this project is definitely incomplete. To prove a true utility for the design system used here, it would have to be tested across a wide array of scales and projects. The examples shown here do achieve many of the goals both stated and implied by the nature of the investigation. Clearly, the final experiment yields a range of different shapes, clusters, and relationships at many scales. These different sizes, forms, and work patterns represent the non-prescriptive and unintended relationships I am seeking, as well as destroy any sort of conventional hierarchies that dominate this particular program. The user is ultimately allowed to determine how their work and production needs interact with the new environment.
REFERENCES


Bauer, Peter; Nouak, Stephan; Winkler, Roman. *A Brief Course in Fuzzy Logic and Fuzzy Control*. http://www.fill.uni-linz.ac.at/pdw/fuzzy/fuzzy.html.


Bad design can only be attributable to human intention.