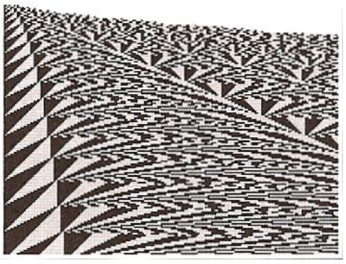

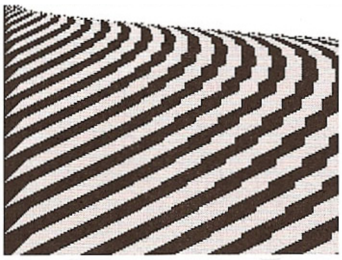

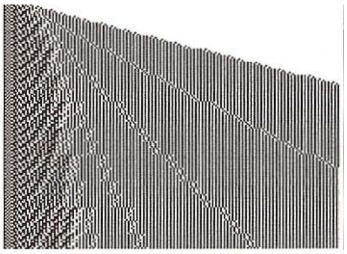

examples of cellulat automata.

Genetic architecture is a morphogenetic paradigm predicated on the generative formation of architecture based in between complimentary processes of development, endogenesis and exogenesis[1]. Endogenesis determines the emergent form according to the interactions of genotypes. Exogenesis corresponds to phylogeny, the evolution and differentiation of species from a non-linear historical perspective. Such adaptive processes in natural systems inspired the primary concepts for the first genetic algorithms. Genetic algorithms initiate and maintain a population of computational individuals, each of which has a genotype and a phenotype. They are widely used today in the modelling of ecological systems.

Algorithm is an ancient word, derived from the Latin algorismus[2], meaning a 'repeatable procedure'. Darwin[3] asserted that an algorithm has created nature's immense complexity. They are a class of highly parallel, evolutionary, adaptive search procedures. They are characterised by a structure equivalent to the chromosomes of nature; a coded form of parameters, which control the problem being investigated. They search using populations of potential solutions rather than searching randomly or adjusting a single potential solution.

A new type of biomorphology is the concept of the X-phylum, an alternative approach to architectural design, as the artificial life of information interferes into all aspects of bio-ecological systems, both natural and artificial, it has become a prelude to a new form of architecture based on an algorithmic conception of the world. It is an experiment in morphogenesis based on an abstract formal system that is autonomous and deterministic once the rules are set and defined. The project searches for morphological complexity, which is constructed and selected by rules that produce specific morphological effects. This process is partially motivated by the aesthetic sensibilities of the architect. Therefore the project puts aside traditional methods of architectural design and proposes a new method in the design process in which the architect becomes an inventor and constructor of formal systems. "Algorithmic information is an appealing concept relying on the versality and translatability of computer languages."[4]

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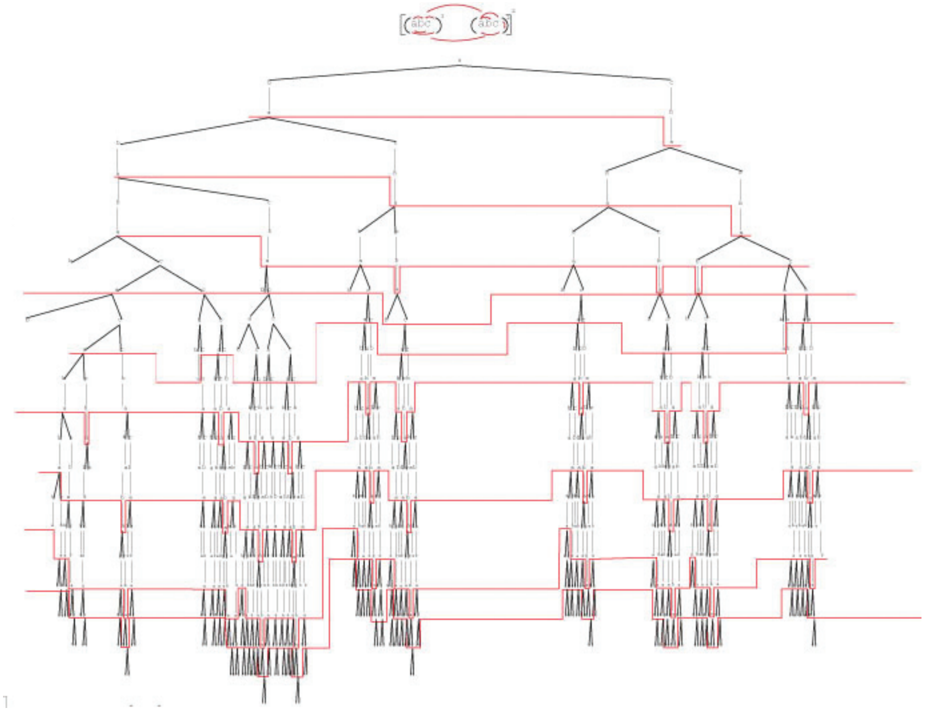
[1] Chu, Karl, Studio of metaphysics and computation, lectures in ESARQ, Universitat International de Catalunya, 3 March 2008.

[2] http://en.wikipedia.org/wiki/Algotithm, 1 March 2008.

[3] http://darwin-online.org.uk/content/, 31 October 2008.

[4] Lloyd, Seth, Programming the universe_a quantum computer scientist takes on the cosmos, Vintage Books, New York, 2006, p.182.



A visual representation of a cellular automaton, through this mapping, with each row of cells corresponding to one step, each time following the rule given. This representation leads to a simple expanding surface, also lofted in rhino.

branching systems

Simplexity within Simple programmes

There is a whole class of algorithms that deal with simplification and are usually more complex and difficult to implement. It is a term in system science that describes the emergence of simplicity out of intricate and complex set of rules. Such procedures require intelligent and responsible choices as well as some way to refer to and operate on the totality of the system. This implies that the architect needs to have a clear idea of what he wants to achieve and a deeper understanding of the system. Usually, a simplification algorithm tries to find a single optimal path within the constraints of a problem. In traditional science if the behaviour of a system is complex, then any model for the system must be correspondingly complex. A model that provides an abstract representation of a system contains various elements which consist of a set of rules that specify what, it should do at each step. There are many possible ways to set up these rules. One such example is the cellular automata that were the first kind of simple programmes investigated in 1980.

Any program can be named Cellular automata when at some level it can be thought of as consisting of a set of rules that specify what is should do at each step[5]. An important feature of cellular automata is that their behaviour can readily be presented in a visual way. Cellular automata are divided into different systems according to their complexity and the best possible ways to represent their results. Accordingly were realised the exercises in order to comprehend and dominate them.

Symbolic systems provide simple idealizations of typical low-level computer languages. At each step scanning once from left to right, and applying the rule wherever possible without overlapping do the transformation. Sequences of steps are taking into consideration in the evolution of a simple symbolic system, where each step follows the rule shown. This transformation corresponds to applying the basic operation rule[6]. One method to visualize this data is by maping the letters, to vertices to a surface. Letters are assigned numerical values, and each vertex of the surface is shifted upwards by the value that corresponds to this letter. Each letter can be interpreted as the scale, position, rotation, colour, or any other attribute of an object. Or each letter could comprise a geometrical shape, curve,etc. The letters can be interpreted as series of instructions, following commands to determine the system's movements.

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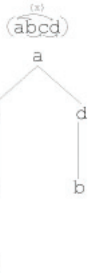
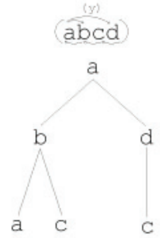
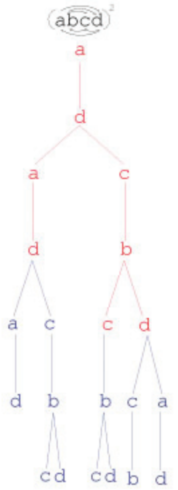
[5] See, WOLFRAM, Stephen, A new kind of science, Wolfram Media, Inc, USA, 2002, p. 45, 117, 689.

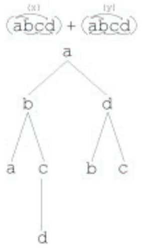
[6] Experiments and coclusion made by the author

combination of two 3D systems

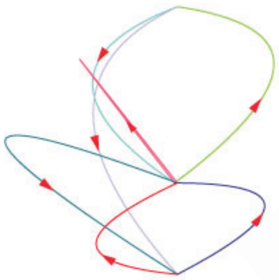




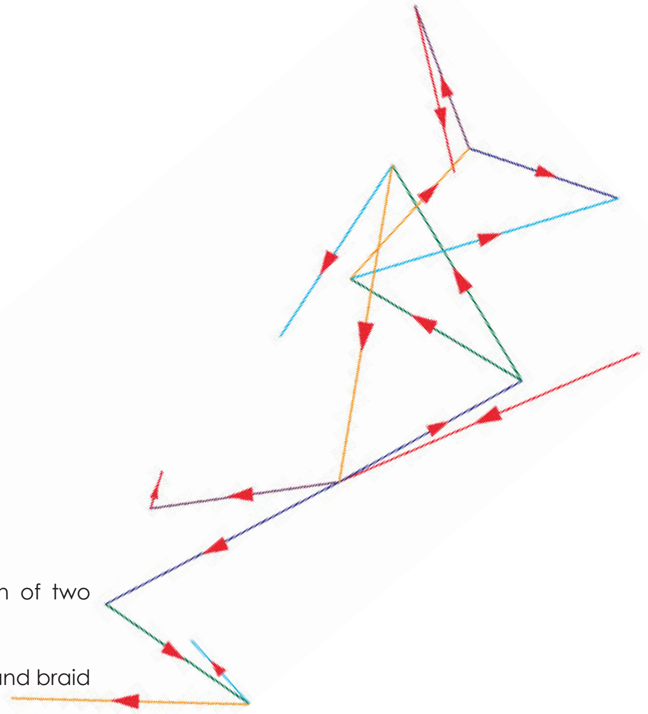




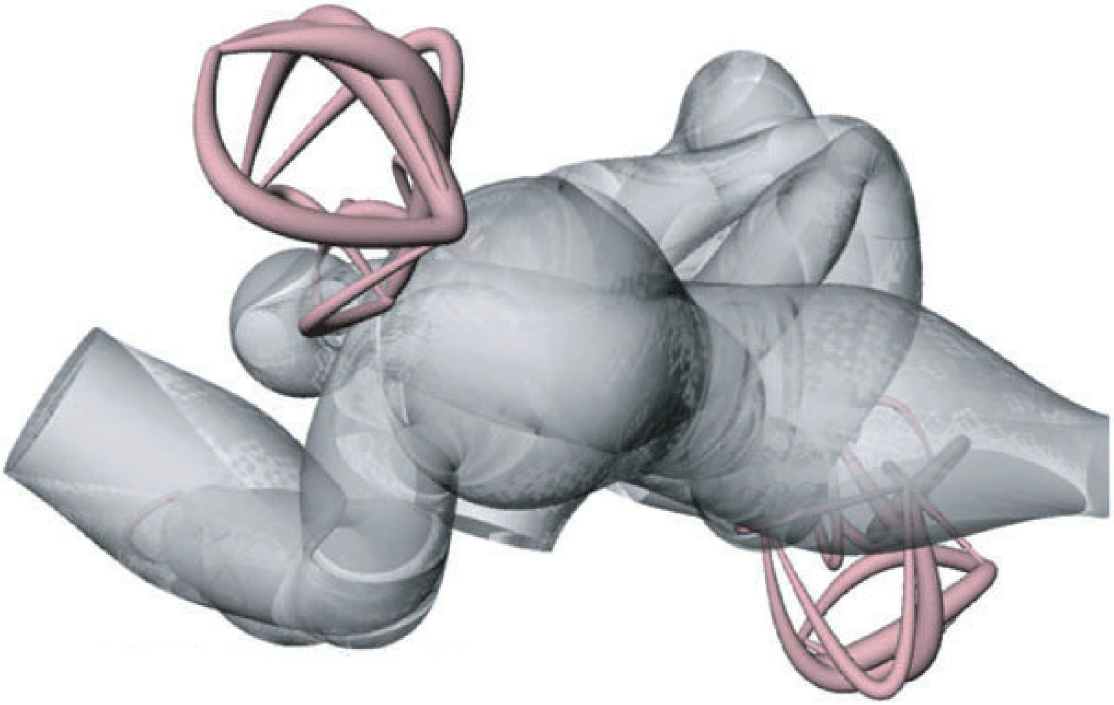
the floer emerged
from the
combination of
two
different systems



it was then
translated into
3d fractal system



3D pattern system for a flower the flower emerged from the combination of two different systems flower structure
it was translated into 3D fractal system and then lofted
the tree was formed by another system of two cycles
it was then translated into rhizome in order to interpret it graphically rhizome and braid structure.



This exercise is specially concentrated on Network systems, or branching, when the elements are set up in a regular array that remains the same from one step to the next, and so there is always a fixed underlying geometrical structure, which remains unchanged throughout the evolution of the system.

Frei Otto[7] experimented on the branching structures n order to investigate multi-performing, differentiated organizational systems, through the generative use of parametric tools; ever since there has been a generative approach to parametric design, such as iterative differentiation, adaptation through redundancy and robustness through structural-geometric interdependency.

A branching system is fundamentally just a collection of nodes with various connections between these nodes, and rules that specify how these connections should change from one step to the next. At any particular step in its evolution, a network system can be thought of a little like an electronic circuit, with the nodes of the network corresponding to the components in the circuit, and the connections to wires joining these components together. And as in an electric circuit, the properties of the system depend only on the way that the nodes are connected together, and not on any specific layout for the nodes that may happen to be used.

Of course, to make a picture of a branching system, one has to choose particular positions for each of its nodes. But the crucial point is that these positions have no fundamental significance; they are introduced solely for the purpose of visual presentation, and can correspond to infinite trees. The representation's steps are the mapping system, which ensues from following the rules and transferring the traces from the mapping system into rhino for lofting, and obtaining surfaces. By modifying the rule just slightly one can immediately get a different pattern. Systems that are effectively based on simple rules, sometimes lead to complex behaviour. Wiener writes in Cybernetics: "When we desire a motion to follow a given pattern, the difference between this pattern and the actually performed motion is used as a new input to cause the part regulated to move in such a way as to bring its motion closer to that given by the pattern"[8]. He named the self-regulation homeostasis.

The term cybernetics stems from the Greek, κυβερνήτης. It was first used in the context of "the study of self-governance" by Plato in 'The Laws' to signify the governance of people[9]. Cybernetics organizes the mathematics of responsive behaviour into a general theory of how machines, organisms and phenomena maintain themselves over time. This is achieved by the use of digital and numerical processes in which pieces of information interact and the transmission of the latter is optimized. Norbert Wiener in Cybernetics: "this desire to produce and to study automata has always been expressed in terms of the living technique of the age. In the time of Newton, the automaton becomes the clockwork music box. In the nineteenth century, the automaton is a glorified heat engine. The present automaton computes the solution of different equation."

Morphogenesis and genetic coding are processes of self-generation of the form within an environment. Geometry has a very important part in morphogenesis. It is the main principal

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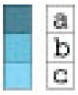
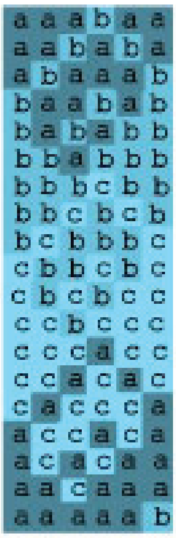
[7] See, MEREDITH, Michael – AGU – SASAKI, Mutsuro - P.ART, From Control to Design_Parametric/Algorithmic Architecture, Verb monograph, New York, 2007, p. 124.

[8] Johnson, Steven, Emergence_the connected lives of ants, brains, cities, and software, Scribner, New York, 2001, p. 180.

[9] http://en.wikipedia.org/wiki/Cybernetics.



🟦	a
🟦	b
🟦	c



a	a	a	b	a	a
a	a	b	a	b	a
a	b	a	a	a	b
b	a	a	b	a	b
b	a	b	a	b	b
b	b	a	b	b	b
b	b	b	c	b	b
b	b	c	b	c	b
b	c	b	b	b	c
c	b	b	c	b	c
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c	a	c	c	c	a
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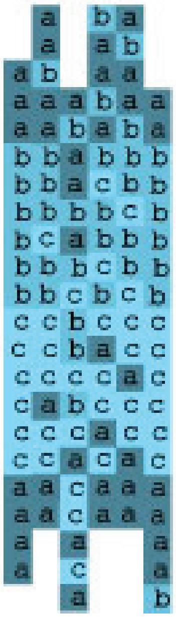
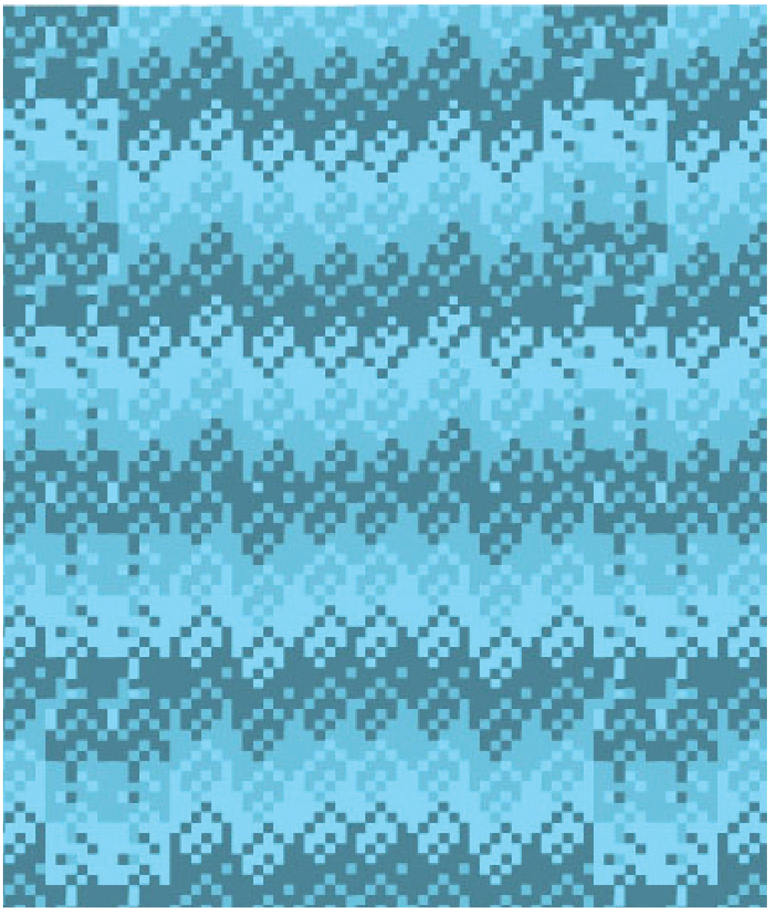
a	a	c	a	a	a
a	a	a	a	a	b



	a		b	a	
	a		a	b	
a	b		a	a	
a	a	a	b	a	a
a	a	b	a	b	a
b	b	a	b	b	b
b	b	a	c	b	b
b	b	b	b	c	b
b	c	a	b	b	b
b	b	b	c	b	b
b	b	c	b	c	b
c	c	b	c	c	c
c	c	b	a	c	c
c	c	c	c	a	c
c	a	b	c	c	c
c	c	c	a	c	c
c	c	a	c	a	c
a	a	c	a	a	a
a	a	c	a	a	a
a		a			a
a		c			a
		a			b

Sample imput: instead of letters replace with colours



register machine

Self-replicating system: 3 dimensional patterns or matrix configuration

for its self-organization process, as it sets boundary constrains, also pattern and feedback are very significant in the models of morphogenesis as they are in cybernetics systems.

Being part of the self-generation process, the phenomenon of complexity is quite universal and quite independent of the details of particular systems. The final step was to combine different 3D systems in order to obtain a more complex one, and representing it visually. While the first system obtains its components, the second system grows from and to these components and it extends its branches until it reaches the boundaries of the primary system. The rules for a particular system are sufficiently simple; therefore the system will only ever exhibit purely repetitive behaviour. If the rules are slightly more complicated, then nesting will also appear. But to get complexity in the overall behaviour of a system one needs to go beyond some threshold in the complexity of its underlying rules. If the complexity of the rules are increased, then the resulted behaviour would also become correspondingly more complex.

Other ways to interpret more complex patterns are Multiway systems or Register machines. They have rules that allow multiple choices to be made at each step, leading to multiple possible paths of evolution. Given a particular condition its evolution is completely deterministic, but with successive initial conditions it emulates each possible path. Register machines are specifically designed to be very simple idealisations of present-day computers. But as a simple idealization one can consider register machines with just two or three kinds of rules, it seems in some ways random behaviour is instead complex and seemingly quite random.

If we run the cellular automaton for more steps, then a rather intricate pattern emerges. But we can see that this pattern has very definite regularity. However, there is a certain simplicity to such perfect randomness, although it may be impossible to predict what colour will occur. As there is always a mixture of regularity and irregularity, it becomes almost impossible to predict-even approximately what the cellular automaton will do. The only sure way to answer these questions is just to run the cellular automaton for as many steps as are needed, and to watch what happens. When the behaviour of a system does not look complex, it tends to be dominated by either repetition or nesting. The basic themes of repetition, nesting, randomness and localised structures are actually very general, and in fact represent the dominant themes in the behaviour of a vast range of different systems.

The concept of an evolutionary architecture indicates the nature of the biological and scientific analogies. It relies heavily on natural science and the newer sciences of cybernetics, complexity and chaos.

Geometry & morphogenesis

Subsequently, after studying the development of form in plants, the geometrical phyllotaxis, the morphogenesis is applied by on cylindrical lattices[10]. They are formed locally rather than globally, node by node, and are further modified by growth. We can understand the morphogenesis of an organism by breaking down the symmetry and homogeneity of the emergence of the pattern.

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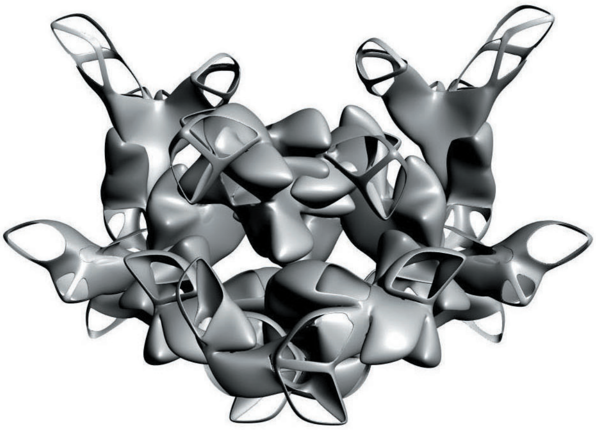
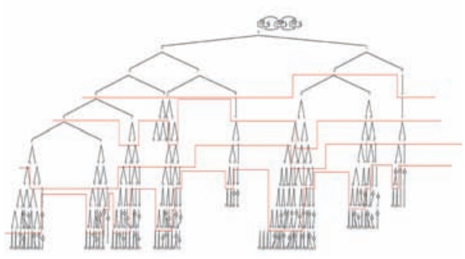
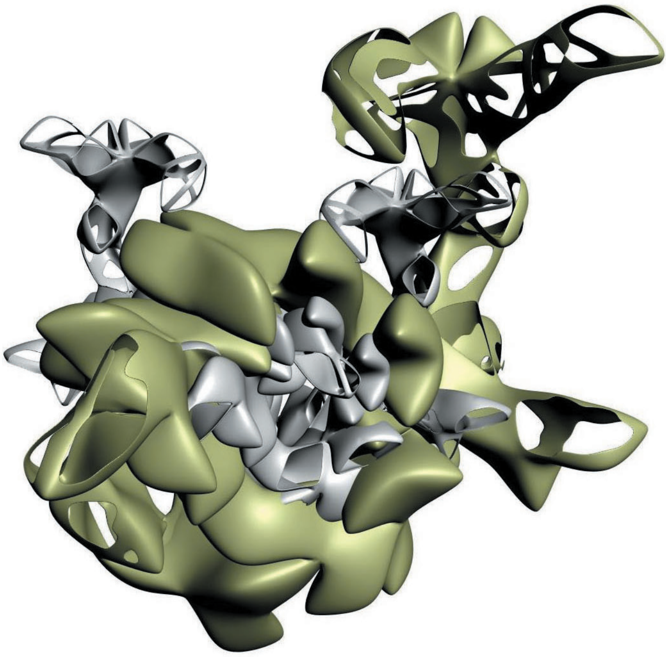
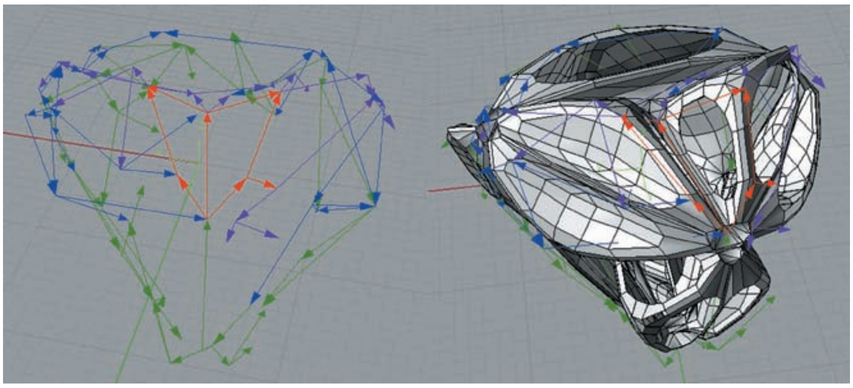
[10] See, Studio Digital Nature_Digital Systems & Architecture, p. 25.





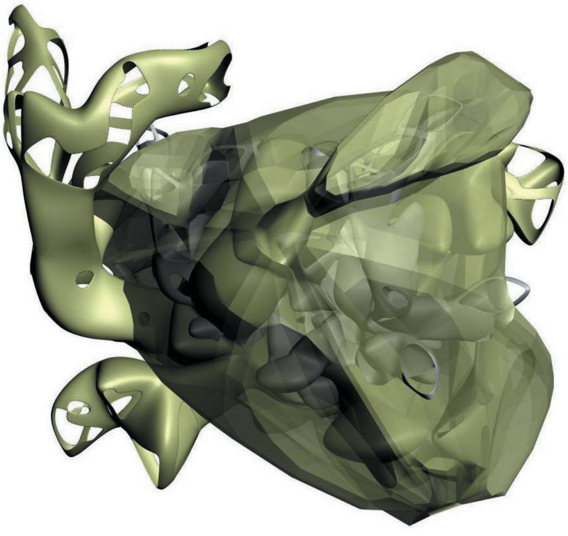
Different Networks representing different sets of sequences and the final object that occurs in their combined evolution of the cellular automata.





The combination of the 3 systems leads to the creation of a new object which consists of the 4 elements.

The interior parts are positioned symmetrically so that the rule grows in both directions
The second layer begins to interact not only with its relative interior part, but also with the exterior layers
The first of the exterior layer is semitransparent so as to reveal the internal layers
It is partly released when the final layer allows it



final project, combination of complex 3D systems

For example Out of Order patterns[11], these aperiodic patterns are always changing. They carry more information than the repetitive ones. The problem is that this amount of information is overwhelming. The seemingly combination of local stability paired with ultimate long-range unpredictability accounts for the pattern's shift between form and formlessness. It's not that the pattern is unstructured, but that it threatens our conception of what order is, and our ability to control or even understand it. Another form of complexity appears in the chaos theory. The mathematical term 'chaos' does not imply absolute disorder. Its properties do not emerge from random, totally disconnected accumulation. This is based on the observation that certain mathematical systems behave in a way that depends on the details of their initial conditions. Its main significance is that it implies that if any of these details were uncertain, then it would become eventually impossible to predict the behaviour of the system. This phenomenon is responsible for most of the obvious complexity we see in nature. Another perception on the 'chaos' theory, noted by Farmer and Packard[12] in 1986, is that whether in chaotic systems, unpredictable behaviour emerges out of lower-level deterministic rules, in self-organising systems; orderly patterns emerge out of lower-level randomness. This results to the fact that the study of chaos and the study of self-organising systems are 'related opposites'.

Another structure of system where behaviour changes according to the conditions in its environment is the open system. It may be defined as the region of space characterized by a collection of components or elements related in some way[13]. The idea is researching through the generative use of parametric tools, seeking to investigate open systems as multi-performing, differentiated organizational systems.

Architectural design needs to be understood as a process of formation. It is essential to analyse and compare different network topologies, as branching is a whole organizational system. Its geometrical logic is then developed and created through parametric tools. An intricate matrix is then emerging from the proliferation of differentiated geometrical operation. Geometrical arrangements, spatial affects, structural performance and organizational logic contribute to the formation of the system and its performance-based logic.

Conclusion

Parametric design fits within an architectural discipline that is simultaneously searching for a unified organisational clarity and visual complexity, but no matter how patterned, totalising and parametric it is, architecture requires cultural and social relevance. It's not the parametric, the relentlessness malleability of form, nor is it complexity for its own sake, but a complex of complex relationships that produce architecture. "A field of cultural production[14]" where the distinction between form and material is too simplistic and dogmatic.

This can be achieved through the parametric design tools the architect uses to define his own vocabulary by applying his own principles. It is possible to generate thousands

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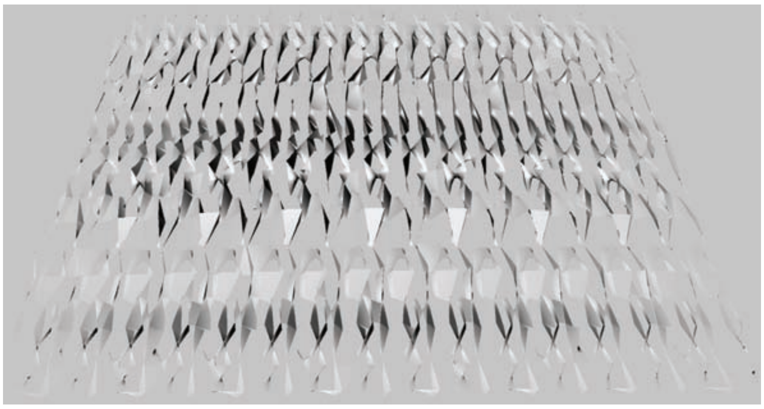
[11] See, WOLFRAM, Stephen, A new kind of science, Wolfram Media, Inc, USA, 2002, p. 100.

[12] Dr. Doyne Farmer and Dr. Norman Packard are two physists who were largely responsible for formulating much of the structure of the chaos theory in Santa Fe in 1986.

[13] MEREDITH, Michael – AGU – SASAKI, Mutsuro - P.ART, From Control to Design_Parametric/Algorithmic Architecture, Verb monograph, New York, 2007, p. 118-127.

[14] CHU, Karl, Studio of metaphysics and computation, lectures in ESARQ, Universitat International de Catalunya, 5 March 2008.



3D visual presentation of systems

of different options using scripting, as well as having a high degree of geometric control.

Hugh Whitehead[15] believes that the intent and methodology of parametric design applied to architecture was established and applied to pioneering buildings such as the Grimshaw Waterloo International Rail Terminal and the Allianz Arena in Munich, for the creation and control of more complex geometry. Two buildings with a potent presentation in the field of contemporary architecture, although constructed during different time periods. The architects accomplished a combination of structural efficiency and environmental sensitivity, by using simple geometric mechanisms into more complex approaches to the generation and evaluation of built forms. The arrival of parametric digital modelling changes digital representations of architectural design by setting up geometric relationships and principles through parametric equations. These operations provoke the emergence of complexity and differentiation from the set-up of coherent and controlled operations.

Historically architecture has successfully combined different ways of thinking that spanned both the intuitive and the formal. The computational universe spontaneously gives rise to every possible form of computable behaviour, as it does everything it has been programmed to do. Some of this behaviour is orderly, some is random, some is simple and some is complex, as it happens in natural phenomena in biology. The theory of genetic architecture deals with the construction of possible worlds. Architecture is the art of the emerging conceptions because it germinates emergent relations and ensembles. It is neither a representation of biology nor a form of biomemesis.

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[15] HENSEL, Michael – MENGES, Achim – WEINSTOCK, Michael, Techniques and Technologies in morphogenetic design, AD_ Architectural Design, Wiley-Academy, Vol.76, No.2, March/April 2006, pg. 34.