Being Paintings

Author
Alain Lioret lioretalain@hotmail.com
ATI, Université Paris 8
8 bis, rue de la Marne
95220 Herblay
France

ABSTRACT
This paper focuses on art created by new techniques such as cellular machines, L-Systems, genetic algorithms, neural networks ... We propose here several methods of implementation combining the rules of construction of cellular machines and L-Systems with genetic, neuronal networks, couplings, translation of codes. These methods result in the morphogenesis of bodies, as well their structure (shape) and their functional aspect (neuronal networks with driving, sensory neurons, balance, etc.). It's a part of what we can call "a new kind of art", and we can see here how Beings Paintings emerge.

Keywords
Cellular Machines, L-Systems, Fractals, Morphogenesis, Neuronal Network, Genetic Algorithm. ACM Classification Keywords H.5.m.

Introduction
For a very long time, artists were inspired by forms of nature. Without referring to the myths of antiquity, we can quote notably the fundamental influence of Odilon Redon, in his 1883 series of pictures Les Origines,[1] which presents some hybrid and surprising creatures. Also, Goethe contemplated biology and more particularly the very particular theory of the evolution of plants in his work *La Métamorphose des plantes*.[2] These works inspired the fundamental publications in this domain of Ernst Haeckel[3] (see fig. 1), which presented the main lines of art and forms of nature in the art, followed a short time later by authors as Martin Gerlach and Karl. More recently, with the arrival of the computer as the working tool for as a new generation of creators appeared. After the fascinating discovery of fractals by Benoît Mandelbrot,[6] new perspectives of nature were born. Then "breeders of art" used the techniques of Darwin adapted by Richard Dawkins[7] and his famous biomorphs.

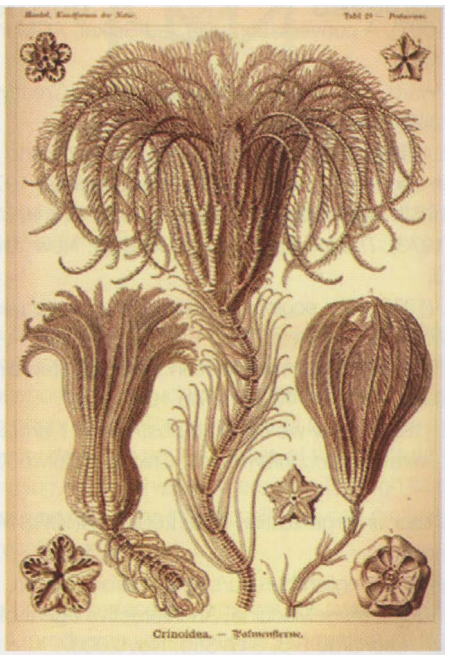

Figure 1 Crinoidea, Ernst Haeckel.

Among the best-known artists in this category are William Latham,[8] Karl Sims,[9] Steven Rooke,[10] Jeffrey Ventrella,[11] and Michel Bret[13] (see fig. 2).

A New Kind of Art
In the vast field of tools implemented by applications of artificial intelligence, cellular machines were some of the first to appear, notably in the famous game of life proposed by Conway.[14] Tools abound, and the models of cellular machines diversify with great names that strangely advance the domain, as in Stefen Wolfram's work, *A New Kind Of Science*.[15]

Naturally, a certain number of artists tries to bring to the foreground new styles. Let us refer for example, to Paul Brown,[16] who has interested in this domain since the 1970s. Also Scott Draves[17] (see fig. 3); Erwin Driessens and Maria Verstappen,[18] who create real 3D constructions; and Matthew Fuller who introduced the group Human Cellular Automaton.[19]

Figure 2 Hybrid Creature, created by Michel Bret.

Comutational Beauty of Nature

As is described well by G.W. Flake in his magnificent work *The Computational Beauty of Nature*,[31] very many creations can be modeled by tools such as L-systems, fractals of types IFS, strange attractors, etc. At the same time, another language that shapes the intentions of new morphogenesis was invented by Lindemmayer:[20] L-Systems, which enable generation of forms, in particular plants, from recursive grammars. The results obtained with this technique are excellent, and artists such as Laurent Mignonneau and Christa Sommerer,[21] and Christian Jacob,[22] among others, are interested in these new modes of expression, by coupling them very often with evolutionary algorithms to get closer to the theories of Darwin.

Morphogenesis

We shall not return in this paper to the impressive literature that defines the techniques of morphogenesis. Let us refer simply to the inspiration provided by the works of D'Arcy Thompson[23] and Rupert Sheldrake,[24] thanks to his innovative theories on "formative causality" and "morphogenetic fields," which are inescapable on this topic. Morphogenesis is a fascinating subject that raises big, not-yet-resolved questions. It is an area of magnificent experiment for artists, and the works presented here illustrate their fascination with the subject.

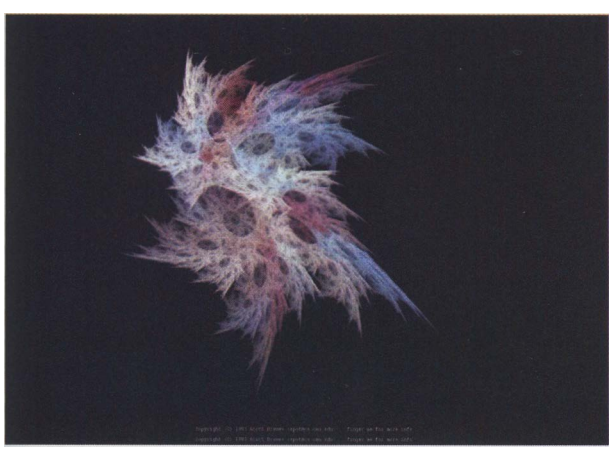

Figure 3 Flames by Scott Draves.

Structural and Functional Aspect

These comments do not, however, amount to research on structural morphogenesis alone. Indeed, if the shape, and thus the aspect, of the body are necessarily areas of major concern for artists creating images, we are interested just as much in the functional aspect of the engendered creatures, which can not be separated from the structural aspect. It is, moreover, this difference that is too present in current realizations (3D characters, the first virtual actors), the visual aspect of which is already pushed to a very high level, even to photo-realism. On the other hand, the functional aspect of new semi-intelligent creatures is, for the moment, only at the experimental stage.

Hybrid Creations From Chaos Tools

The originality of this work rests essentially on combining cellular machines and L-Systems, although we also use fractals IFS, Flames, strange attractors, etc. This research ensues from a simple report: all the systems that propose realization of virtual creatures (vegetable or animal) start generally at assembly of components that have already been already realized, as in the famous blocks or sticks we encounter in the works of Sims (see fig. 4), or in the creation of Golem, the Framsticks software that we use in our work, etc. The stage of development corresponding to molecular chemistry is systematically avoided, because we believe that it can not help us understand of an original development. So far, nobody has all the answers necessary for development of life, vegetable or animal, and we can allow ourselves as artists to experiment in new directions and show the results of hybrid creations (an unmistakable advantage compared to scientists, who must prove what they advance).

Figure 4 Galapagos © Karl Sims

Several methods of combining cellular machines with L-Systems are proposed. We quote here only those who are beginning to report interesting results, but many other citations are possible. The principle in every case is to use the rules of generation of cellular machines as a function of chemical processes, which occur in various stages of physical morphogenesis.

Method 1: creation of whole landscapes with cellular laws. This method consists simply of covering (marking out in squares) a 3D ground and in using rules of cellular machines to place L-Systems seeds, which survive and grow according to very precise plans.

Several levels of complexity are studied, according to the forms of these rules. The simplest are based on combinations of surviva/birth vectors, on which we can grow a variety of L-Systems where life is possible. More complex rules, with parameters of machine evolution, can influence the L-Systems grammars that change according to these parameters (for example, states, generations, etc.) (see fig. 5).

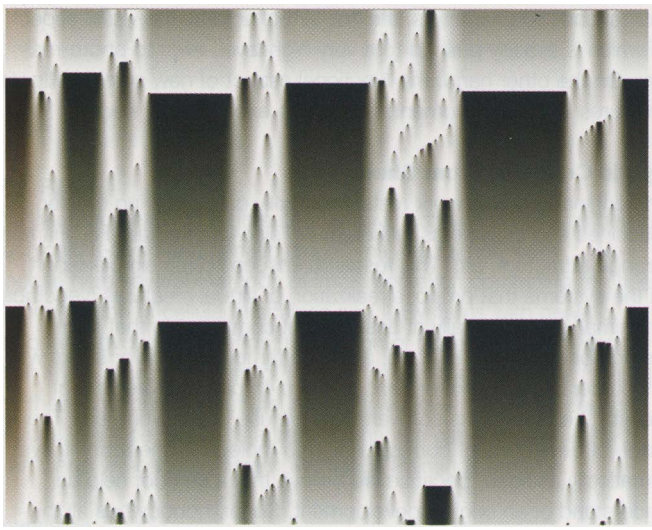

Figure 5 A cellular machine used for painting strokes.

Method 2: form L-Systems modified by cellular machines. In this case, it is a question of using the cellular machines to generate rules used in every recursive stage of the construction of L-Systems. So in addition to the usual grammatical rules used in these systems (among whom F to draw branches), we add the use of rules (A, B, C, etc.), which are in fact rules of classic cellular machines. At every new stage of the process of creation, the cellular rules apply to the shoots of new branches/sheets/segments, according to the principles of survival and birth. This slightly more complex method presents the advantage of creating less predictable creations, which are more natural.

Method 3: genetic coupling up of the rules of L-Systems with the rules of cellular machines. This method is possible only with certain forms of machine rules (there are numerous variants, but we based our work on those presented in Mcell, software created by Mirek Wojtowicz.[26] Here, as well, L-Systems cellular rules are considered as phenotypes, and genotypes are built on the basis of binary multi-parametrized coding. Surprising results are obtained, even if scientific justification of such a process is excessively difficult to explain. But, after all, morphogenesis is indeed a very complex process that can be achieved by combining in a very narrow way chemical reactions with physical evolutions (see fig. 6).

Method 4: The images created with tools feigning the forms of nature and chaos are used to generate paint brushes (or other effects) that will be directly applied (we should say transformed) in the bodies of virtual creatures. It is this last method that allows creation of "beings paintings."

Figure 6 A creature plants created with Method 3.

Cellular Morphogenesis

In addition, our research led us toward other uses of cellular machines for morphogenesis. So, in the same way we used the rules of cellular machines to generate vegetation, we applied them to construction of elementary forms from Metaballs (or blobs). This very simple method allows us to obtain various base forms, which we can consider either as future creatures (for the structural aspect) or functional organs of these creatures (muscles, sensory neurons for touch, smell, sight, the search for balance, etc.). The forms used are the simplest to generate and are built from basic rules of survival and birth: what we can consider as the essential cells of living bodies. Those created for the functional aspect can be generated only with more evolved rules in machines. It is interesting to note that evolutionists' experiments on populations of cellular machines were also used for this process.

Other Morphogenesis

In the same kind of idea, the grammatical rules of L-Systems were used to create creatures, vegetable or animal, in their structural aspect. This type of rather classic creation did not generate very innovative tracks in our system of creation, but it completed the realizations. It was especially one of the test stages for neuronal co-evolution applied to creatures, which was realized mainly with the Framsticks.[27] We also use other fractal rules, such as IFS fractals, flames, stange attractors, dispersion-diffusion models, boids trajectories,etc.

Neuronal Co-Evolution

One of the very important stages of our study of morphogenesis takes place within Framsticks. It focuses on a simulator of artificial life that is very evolved and programmable, which allows us to realize all sorts of experiments, so it is included in our pipeline of realization to develop creatures in their structural aspect and especially in their functional aspect (network of neurons) (see fig. 7). Different populations of creatures realized with these various higher methods were subjected to the evolutionary system of Framsticks. With various established criteria (speed, balance, or simply aesthetics), we mimed the processes of large-scale evolution to obtain original, autonomous creatures that could be used for various basic tasks: running, catching prey, escaping, and even dancing!

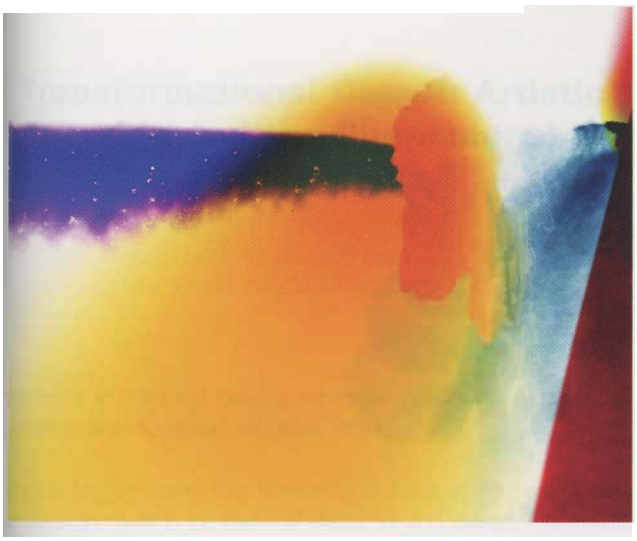

Figure 7 An evolved creature stemming from the process of creation. mage from "Otedal Ahoahoha."

Realizatons

From this creative plan, it is possible to create three types of work: fixed images, pre-calculated full-of-life images, and real-time full-of-fe images. Only the last category can really exhibit the functional aspect of creatures, even if the quality of the real-time depiction does not allow one to totally appreciate the structural quality that can be mplemented with this system. For that, we also realized calculated works, with various types of depiction, to take advantage of a very interesting pictorial morphogenesis. Notably, we performed a certain number of trials with non-photo-realistic rendering methods, accord-ng to the principles published by Aaron Hertzman[28] for video paint-ng. Among our realizations, these present the advantage that they supply new styles of "alive" paintings that are self-organized original pictures directly derived from artificial life (see fig. 8). Furthermore, this method results naturally in new aesthetics, as described by the author.[29]

Beings Paintings

Using these techniques, "Otedal Ahoahoha" was created as an "alive" painting, rather than a painting of artificial life. The work's con-cept rests on the generation of full-of-life painting created by artificial beings. These creatures do not paint themselves mon a canvas. Instead, they use their bodies to compose new paintings, in ballets of autonomous movements.

Numerous experiences of different painting modes were attempted in the pas. We can notably quote the very well known Jackson Pollock, who painted with leaky jars, or Yves Klein, who used women's bodies to paint canvases. Examples of digital paintings are also rather numerous, and they demonstrate many different processes of repro-duction; for example, those implemented by Roman Verostko in his algorithmic art works. The realizations that I present here are created in a very different way, and the film "Otedal Ahoahoha" is a good demonstration of this technique. Indeed. it presents virtual, genetical-ly evolved creatures that possess a neural network that allows them to move in the space where they compose full-of-life paintings. But these compositions are directly made by artificial bodies that move, become entangled, and contact each other. These bodies are thus themselves the painting. They form the pigments and paintbrushes, just as they form the jets, the tracks, the touches of painting on the picture. They are beings paintings, and they are becoming the instru-ments of their own creations.

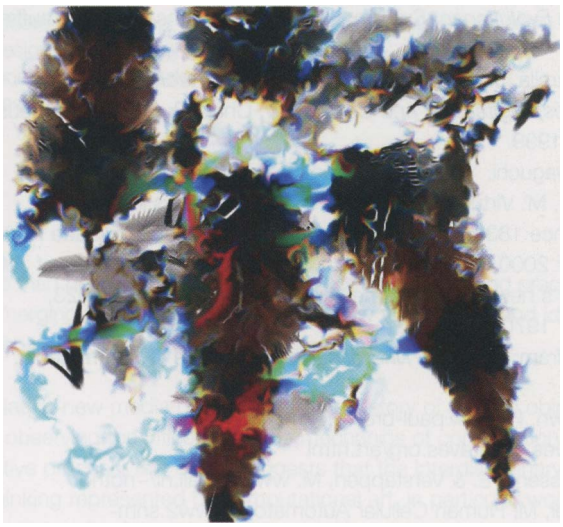

Figure 8 Another creature made with a non-photo-realistic technique, "alive painting."

Image from "Otedal Ahoahoha."

Conclusion

The originality of this system lies in the combination of techniques presented to build models of new morphogenesis. The rules of cellu-lar machines and L-Systems have never been used in this way before. The main purpose here was to supply "patterns" of creation of life such as described very well by Fritjof Capra in his work, *The Web of Life*.[30] On the other hand, the system allows achievement of very different results from a visual point of view, which leaves to the artist the choice of a particular aesthetic, whether to present fixed or full-of-life images, even in real-time, especially for producing beings paintings.

Acknowledgements

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Notes

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