

# Generative Art and The Aesthetics of Emergence

Alan Dorin. August 2005

Humans operate successfully using assumptions, preconceptions and generalizations. Only when problems arise is their existence exposed and their value questioned. This new awareness presents one possible avenue for successful art. Either consciously, subconsciously or completely by chance, an affective artwork may entice us to seek alternatives, it may generate a world that does not operate according to our assumptions. If well conceived, the work may surprise both the audience and the artist. One age-old assumption is that order and coherent structure come about only through the concerted effort of a cognizant individual. This hypothesis of intelligent design would tend to be supported by much of the world as we perceive it. For example, birds must build their nests since twigs don't miraculously self-assemble into homes. An enormous orchestra does not spontaneously coalesce and play a Mahler symphony without a conductor and consistent score, nor did the notes on that score naturally fall into place without the organizing genius of the composer. Still, there is unmistakable evidence that in nature complex structure spontaneously emerges without the need for an intelligent designer. The new-media works of Erwin Driessens and Maria Verstappen explore the potential of such self-organization for constructing aesthetic artifacts. Their work employs autonomous processes to produce artistic results that are beautiful and unusual, even (or especially) to sophisticated critics, theorists and often to the artists themselves.

The theme that underpins this idea and consequently the artists' work, is the concept of *emergence*. General agreement has been reached amongst philosophers of science that emergence describes the appearance of novel behaviour from the coherent actions of many small components. Emergence is not a conjurer's trick in which an essential secret remains hidden. Despite the viewer having full information about the underlying interactions that govern a system's behaviour, emergent phenomena arise that are not obviously implied by the superposition of these interactions.

For example, a flying bird may : keep its distance from neighbouring birds; prefer a position surrounded by other birds; align its direction of flight with that of neighbouring birds. A group of birds sharing these preferences forms a dynamic yet cohesive flock. There is no need for a rule that dictates how the flock should be managed, nor is a leader required to instruct the birds on formation maintenance. Instead, the flock *emerges* from the interactions of the birds. Similarly it may be said that human emotions emerge from the interactions of biological cells or that ugliness emerges from the interactions of the elements in a particular painting.

The exact definition of *emergence*, its utility, even its very plausibility, continue to be hotly debated. Nevertheless, the term is widely and usefully applied in Artificial Life research, a field specifically focussed on such phenomena. Ideas from Artificial Life underly many of the concepts apparent in Driessens and Verstappen's work. The concept of emergence is especially relevant to art that utilizes dynamic, autonomous processes: *generative art*.

*IMA Traveller* (1998) is screen-based, generative artwork. It plunges the viewer into a void generated by software incessantly and rapidly filling space. *Horror vacui* is taken to an extreme — there is not an infinitesimal emptiness on *IMA Traveller's* digital canvas. Surely it is paradoxical that oblivion may emerge by filling space rather than emptying it? The machine's ability to overwhelm human senses through calculation conflicts with the knowledge we simultaneously hold that its power is harnessed by us through software and hardware design. This conflict between helplessness and control holds for the viewer an element of the sublime, in this context, a *computational sublime*<sup>1</sup>.

The exemplary Eames' film *Powers of Ten* (1977) is clear concerning humans : to many processes we act as an insignificant speck, to others we are a universe unto ourselves. *IMA Traveller* shares this explicit and dizzying relativity of scale and makes the personal connection through human-machine interaction rather than photography.

---

<sup>1</sup> McCormack, J. and A. Dorin: Art, Emergence and the Computational Sublime, *Proceedings of Second Iteration: a conference on generative systems in the electronic arts* (Dorin, ed.), CEMA, Melbourne 2001, pp. 67-81

This individual connection does not appear in the fractal zooms of the eighties which superficially resemble *IMA Traveller*. At a deeper level there are similarities between a fractal and the algorithm employed by the work, but these are less significant than the shared synthetic origins of the patterns they generate. By linking a viewer with the computational process through interaction, *IMA Traveller* intelligently highlights our relationship with the machine. In contrast, fractal zooms tiresomely re-iterate themes of mathematics, complexity and infinity without bringing the poetry of our relationship under direct scrutiny.

Computationally *IMA Traveller* is a minimalist piece: a process of subdividing space is executed iteratively across a grid of points and recursively within each point in an extension of the Artificial Life systems, *cellular automata*. These are many simple machines (automata) connected in a grid (of cells) to their direct neighbours. The behaviour of each machine is governed by rules describing what it should do next based only on what it and its neighbours are doing at present. The result of the interactions between machines is an emergent, complex and often beautiful display of large-scale pattern formation and decomposition across the grid. *IMA Traveller's* generative process is perceived visually and the focus of the subdivision is guided by the viewer in a feedback loop. Texturally the result is akin to navigating a satellite image of the earth, or perhaps continuously magnifying a moldy patch on a slice of bread. This coupling of suggestive power with an interactive, computational process lends *IMA Traveller* its novelty and fascination.

One of the attractions of generative works is the wonderful discovery of a new technique for generating aesthetic outcomes. A more recent work by the artists, *E-volved Cultures* (2005) utilizes a small group of software *agents*. An agent is a mobile construction that in this instance, wanders ant-like over a virtual grid of tiny, coloured cells. The agent itself is invisible, however as it encounters a cell it responds to its environment by choosing a new colour to place at its current location and a new direction in which to wander. These decisions are based only on the colour at the agent's current location and in immediately surrounding cells. The changes it makes occur according to its own internal rules. The idea matches closely a cellular automata devised in the nineteen eighties, *Langton's Ant*, but facilitates the production of rules to generate complex, multicoloured patterns.

Rather than determine the agents' colouring and movement rules themselves, the artists have written further software that automatically generates and develops images from many rule sets. This software tests its results utilizing the principles of natural evolution, a powerful organizing process. Collections of *E-volved Cultures'* agents are selected based on the subjective judgment of a human audience assessing the images they produce. The elements of these agents responsible for successful images are rewarded and over time become more frequent in the virtual offspring of the agents. Hence, offspring eventually come to inherit the successful characteristics of their forebears. As unsuccessful traits are bred out and elements that draw interesting forms proliferate, an evolutionary lineage of agents evolves to produce aesthetic textures.

The agents that evolve may generate images closely reminiscent of those produced by *IMA Traveller* but the approach is far more general and therefore capable of a much wider range of visual outcomes. Once again, emergence has a part to play in *E-volved Cultures*. None of the agents on the grid stores a plan for the textures to be generated nor do agents communicate directly with one another. Instead each agent responds to the conditions it finds by making a local change to the colour of the cell at its current position. Agents therefore communicate only indirectly through the coloured traces they leave in the environment. These will be detected and interpreted by other passing agents, even the very agent that left the traces originally. The resulting large-scale textures are emergent from these small-scale, indirect actions.

It is not clear to many that a machine blindly executing instructions may produce Art of its own. That it *should* be able to do so is not even clear to philosophers and computer scientists familiar with psychology, aesthetics and creativity. Is it possible to encapsulate in a computing device all that is necessary for a *human* to produce an artwork? The argument rages. Nevertheless, it is probably not necessary for machines to imitate humans in this way. Works such as those of Driessens and Verstappen explore the possibilities for generative art by allowing the machine to work in its native tongue. The artists may define its initial conditions and attempt to specify in advance how it should behave. However the countless and rapid transformations of the computer's internal structures surpass human ability to grasp the process in detail. Audience and artist alike may therefore wonder at the machine's limits and lose themselves in its uninterpretable speed and intricacy. This ensures that the best generative art will continue to provide novel and interesting experiences as long as we are willing to invest the time required to fathom them.