Accretor: Generative Materiality in the Work of Driessens and Verstappen

Mitchell Whitelaw*
University of Canberra

Keywords
Cellular automata, materiality, fabrication, generative art

Abstract *Accretor,* by the Dutch artists Erwin Driessens and Maria Verstappen, is a generative artwork that adopts and adapts artificial life techniques to produce intricate three-dimensional forms. This article introduces and analyzes *Accretor*, considering the enigmatic quality of the generated objects and in particular the role of materiality in this highly computational work. *Accretor* demonstrates a tangled continuity between digital and physical domains, where the constraints and affordances of matter inform both formal processes and aesthetic interpretations. Drawing on Arp's notion of the concrete artwork and McCormack and Dorin's notion of the computational sublime, the article finally argues that *Accretor* demonstrates what might be called a processual sublime, evoking expansive processes that span both computational and non-computational systems.

In the work of the Dutch artists Erwin Driessens and Maria Verstappen, artificial life techniques help drive a creative inquiry into generative novelty and the emergence of form. Spanning some twenty years, their practice is notable for its profile in the contemporary art world and its thoughtful engagement with both computational and non-computational processes. In the context of art and artificial life, their work demonstrates the generative (and conceptual) value of adapting and modifying familiar ALife techniques [10]. This short article describes the artists' recent work *Accretor* (2012)—a software system that generates intricate sculptural forms. After outlining the work's generative system, it considers some of the issues prompted: questions of interpretation, materiality, computation, and complexity, with correspondingly broad implications for art and artificial life.

Like the artists' earlier works *Breed* (1995–2007) and *Tuboid* (2000), *Accretor* is a computer program that generates complex sculptural forms. While *Accretor*'s forms are the most intricate and complex the artists have yet produced, its generative process is relatively straightforward. The software generates models made up of millions of small cubic particles (voxels) on a three-dimensional grid. As the name suggests, these forms are accretions of individual particles. Starting with a small *seed*, new particles are added to the form according to a set of deterministic rules. These rules use the configuration of each cell's *neighborhood* of adjacent cells to determine whether a new cell is to be added. At each step in the process the system tests each cell in the model, potentially adding a cell and thus transforming the neighborhood for the next cycle of the process. Thus while the growth process is completely deterministic—shaped entirely by the rules and the current state

* Faculty of Arts and Design, University of Canberra, Australia. E-mail: mitchell.whitelaw@canberra.edu.au
Supplementary materials for this article can be found at www.mitpressjournals.org/doi/suppl/10.1162.ARTL_a_00171.

of the model—the form emerges through cycles of feedback and interactions between rules, all operating on local neighborhoods of cells. A certain rule may shift cells into a state that triggers a second rule; this may in turn trigger a third and fourth rule, and so on. The complex structures of the *Accretor* forms develop as this process runs through millions of cycles; large-scale forms emerge as changes in each overlapping neighborhood influence others.

In formal terms, *Accretor* is a cellular automaton (CA). It uses a set of deterministic rules to operate on a gridlike "world" that is discrete in both time and space. However, this system is quite unlike familiar CAs such as Conway's *Game of Life* [2] or the "elementary" one-dimensional automata studied by Wolfram [12]. Conway's *Life* is a "totalistic" cellular automaton, whose rules operate based on the total number of cells in each neighborhood, whereas elementary one-dimensional CAs are non-totalistic, with one rule for each possible configuration of the neighborhood. In *Accretor*'s three-dimensional space, however, each cell has 26 neighbors, resulting in some 130 million (2^{26}) possible neighborhoods; rules addressing each one would allow the widest range of possible forms, but working with such a large rule set becomes impractical. A totalistic approach compresses the rule set, but greatly limits the range of possible outcomes. The artists' innovation here is a "semi-totalistic" CA, in which the six face, twelve edge, and eight corner neighbors are counted separately, and a single rule set accounts for all 576 permutations of these totals.

Another quirk of this system is that it adds cells, but never removes them; the resulting forms can only grow over time. In this respect it resembles growth-based systems such as Eden growth models [6] or diffusion-limited aggregation [11], more than traditional cellular automata. *Accretor* also applies an important spatial constraint: Each new particle must have at least one face in contact with an existing particle, resulting in a continuous form that can be fabricated in a single piece.

Even with these constraints, the total number of possible rules (and thus growth processes) is an immense 2^{576}. Sampling and mapping such a vast space of possible forms is a challenge: The artists generate large batches using random rule sets and seeds, and use automated tests to weed out forms that fail to grow before hand-selecting candidates for fabrication. Like other cellular automata, *Accretor* generates structures ranging from the regular and repetitive to the highly disordered; the artists select examples from an elusive "in-between" zone, with rich but irregular structures. Driessens characterizes the range in terms of "octahedra, spheroids, cuboids, plates, spiky things, blobs," though many forms have features from multiple classes (Erwin Driessens, pers. comm., 9 October 2013) (see Figure 1). He observes that the most interesting forms are "slow growers," with delicately balanced feedback between different growth rules. At the same time as exploring this family of forms, the artists continue to experiment with variations on the *Accretor* system, including non-totalistic rule sets, and additional cell states; Driessens reports that introducing a second "on" state, along with a corresponding rule set, seems to enable more complex morphogenetic processes.

As a formal system, *Accretor* is novel and ingenious; like Driessens and Verstappen's earlier work, it demonstrates the creative potential of new variations on familiar systems. Yet as an account of the work, this description is incomplete; for this is not merely a generative machine, but an artwork and a set of sculptures. To reconsider it as such, we can begin with the sculptures themselves.

There is an enigmatic quality to these objects. They offer few clues for interpretation: They don't seem sculptural in any conventional sense, either figurative or abstract. There is no trace either of the conventions of design and manufacturing, or any mark of the maker—in fact, they don't seem made at all; they seem more like something found, a strange mineral formation or an odd-shaped sea sponge. These artefacts seem to have serial numbers rather than names. In interpreting works of art we habitually seek out the voice of the artist, the traces of intention and the cues of communication: What did the artist mean? What is the work about? What familiar signs and conventions does it deploy, what language does it speak? The *Accretor* objects resist all these questions; they are reticent, quiet things; at a cursory glance they could easily be passed over as blank, odd-shaped gray lumps. But like sea sponges or mineral formations, they reward close attention, opening up into intricate riots of structure and variation. *#2777-4* is a jumble of angular, toothy blades and rough fungal masses (Figure 2). *#5188-3* is a nodular lump with jutting conical growths at multiple scales and

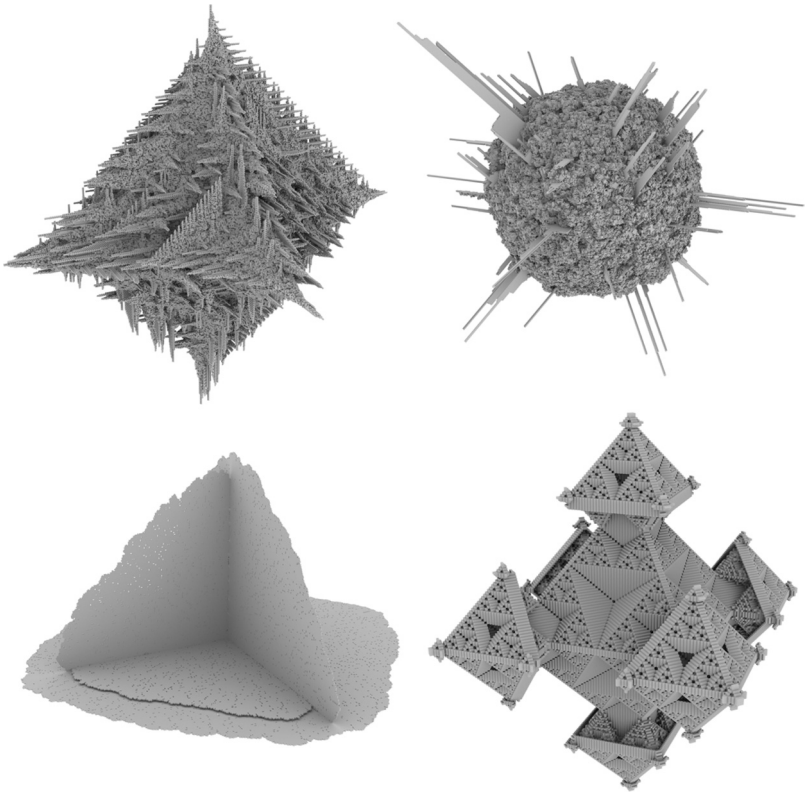

Figure 1. A range of generated *Accretor* forms not selected for fabrication.

angles. In *#1016-0* flat, pointed fins grow porous and coral-like from a dense central mass. Together, these artefacts reveal patterns of resemblance and variation. While they don't speak the familiar language of art and intention, they share enough to suggest another language, a logic that is consistent and variable, but impossible to clearly grasp. Each object presents a variation of this consistency, leading us to question: What are the limits of this logic; how many more of these strange objects are waiting to be found?

While the formal procedures of computation are essential to this work, the artists argue strongly that the results must be physical. Driessens writes:

> The physicality of the objects enables people to approach them in a different way, to see them as things that are part of this world. I think when people encounter the *Accretor* growths, they do not associate them with virtuality or "computer fantasy", as they would if we [showed] them on screen. (Erwin Driessens, pers. comm., 9 October 2013)

The enigmatic intricacy of these artefacts is conveyed through their material presence as well as their structure; in fact, this elusive quality is in a sense engineered. The material—an acrylic photopolymer—resembles stone or charcoal. The cubic volumes (voxels) that make up each form are less than half a millimeter in size—barely perceptible at human scales (Maria Verstappen, pers. comm., 9 October 2013). These choices prolong our uncertainty about the origin of these forms, and again this is central to the artists' intentions. As Driessens writes, "presenting them as any other object makes the question of origin deeper. What are they, where do they come from? How have they come into existence?" (Erwin Driessens, pers. comm., 9 October 2013).

Yet at the same time the artists clearly describe the technical processes involved in *Accretor*. The work does not conceal its own artifice; instead it enacts a process that questions our habitual distinctions between natural and artificial, physical and digital. As Verstappen says, "When people discover that these are … grown with a computerized process, they look at them differently, but not in a negative sense. Not as a fake, but as a new way of artistic creation, that is inspired by the natural" (Maria Verstappen, pers. comm., 9 October 2013). In much of the rhetoric around 3D printing and other forms of digital fabrication, there is a narrative of "materialization," the making physical of an intangible digital form (see for example [8]). This narrative plays an explanatory (and marketing) role, but it also reinforces a simple-minded distinction between the physical and the digital. *Accretor* demonstrates instead a tangled continuity between digital and physical domains. Certainly digital models are translated into physical forms; but equally the physical domain "reaches back" through the process. The formal rule sets of the system are constrained to produce contiguous, joined-up forms, suitable for 3D printing. Even so, some of the resulting forms are unprintable, and those that have been realized stretch the technical capacity of the fabrication process. The intricacy of these artefacts demands more memory, new software, and sophisticated multi-material printing processes. The more complex forms are too large to be easily rendered; so here the generative process runs into the physical constraints of the computational systems it encounters. The *Accretor* forms are not simply physical manifestations of digital objects, but artefacts of a complex process that is always, in Driessens' words, "part of this world." In fact, as the

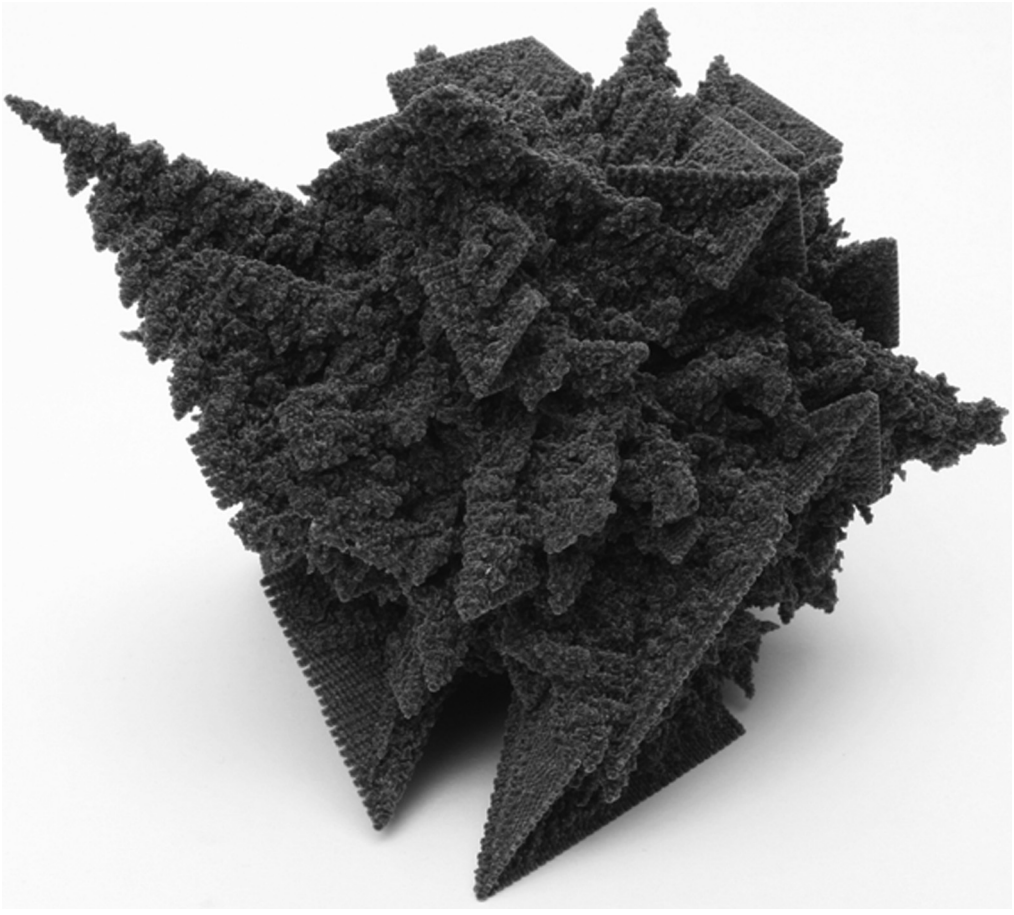

Figure 2. Driessens and Verstappen, *Accretor #2777-4* (2012).

artists' other works show, their core concerns are with material generative process rather than computation itself. In *Top-down Bottom-up* (2012), for example, drips of melted wax accumulate into massive filigreed stalagmites, in a non-digital echo of *Accretor*'s growth process [5].

The not-quite-natural character of the *Accretor* forms is familiar territory, of course, for artificial life. When artists take up artificial life techniques, the focus turns to big questions that the concept provokes: the prospects of living machines, and our very definitions of life. ALife enables experimentation with a "cybernetic ballet" of complex interactions with artificial agents [9] or a reflexive investigation of our human tendencies to biophilia and anthropomorphism [3]. Yet in the works of Driessens and Verstappen, life—or rather, life-as-we-know-it—is hard to find. The *Accretor* objects suggest geology as much as biology. So too the sinuous towers of *Tuboid* could be stalagmites, and the colorful tapestries of *Ima Traveller* and *E-Volved Cultures* could be clouds, patches of lichen, or aerial landscapes. If there is life here, it is not a virtual pet or an emotional agent, but a more abstract process: the emergence of form from the formless, and the intricate, inconceivable, nonhuman complexity of simple rules playing out across millions of cycles of feedback. The undecidable forms of *Accretor*—sponges? crystals?—suggest a continuity between the living and the nonliving, a shared language of processes that traverse rocks and fungi, landscapes and computation. That continuity, central to complex systems sciences, has implications even more profound than the prospect of living machines, for it directs us to the continuum of material machines that we are already enmeshed in.

As to the role of art here, Driessens and Verstappen invoke Jean Arp's notion of the concrete: The artwork is not an image of self-organizing form, but an instance of it. Arp writes: "We do not wish to copy Nature; we do not wish to reproduce, but to produce. We want to produce as a plant produces its fruit" [1]. The artwork here is a self-sufficient artefact: For Driessens and Verstappen "the artwork itself is the reality" [4]. However, the artists also distance themselves from the Modernist project of Arp's time, which they characterize as demonstrating universal harmony through "rational ordering and reduction." Instead of a humanistic, orderly universe, Driessens and Verstappen—drawing on contemporary science—hold that "chance, self-organisation and evolution order and transform reality"; they strive for "complexity and multiformity" rather than the simple stasis of the plane and the grid.

This expansive quality in the work of Driessens and Verstappen inspires McCormack and Dorin's notion of the "computational sublime"—"the instilling of simultaneous feelings of pleasure and fear in the viewer of a process realized in a computing machine" [7]. McCormack and Dorin identify a broad tendency in generative art, where a computational process provides partial access to phenomena too vast for us to experience directly; computation plays the role of the romantic landscape painting, providing a proxy through which we sense the beauty and terror of nature. The computational sublime provides an insight into the experience of these works—their tendency to exceed our cognitive grasp, and the thrill that comes with that. This is an acute analysis, though it leaves open the question of what narrative or value is served by these experiences. If the computational sublime is an end in itself, we can expect digital generative artworks to do no more than affirm the expansive potential of their own computational processes.

Alongside the other works of Driessens and Verstappen, *Accretor* articulates an alternative to computational self-referentiality. These works outline what might be called a *processual* sublime, manifesting complex processes that span computational and non-computational systems. Even as *Accretor* is shaped by a negotiation with matter, works such as *Top-down Bottom-up* show how material systems self-organize outside the formal frame of the computer. The object of wonder here is not the scope of computation, but the whole complex, self-structuring universe in which we find ourselves.

References

1. Arp, J. (1944, 1972). Abstract art, concrete art. In M. Jean (Ed.), J. Neugroschel (Transl.), *Arp on Arp: Poems, essays, memories*. New York: Viking Press.

2. Conway, J. (1970). The game of life. *Scientific American*, *223*(4), 4.

3. Demers, L.-P., & Vorn, B. (1995). Real artificial life as an immersive media. In *Convergence: 5th Biennial Symposium for Arts and Technology* (pp. 190–203). Retrieved from http://www.processing-plant.com/web_csi/projects/alife/alife.pdf.

4. Driessens, E., & Verstappen, M. (n.d.). Generative art and experience of nature. Retrieved October 21, 2013, from http://notnot.home.xs4all.nl/text/introduction.html.

5. Driessens, E., & Verstappen, M. (2012). Top-down Bottom-up. Retrieved October 21, 2013, from http://notnot.home.xs4all.nl/drip/drip.html.

6. Eden, M. (1960). A two-dimensional growth process. In *Proceedings of the Fourth Berkeley Symposium on Mathematical Statistics and Probability, Volume 4: Contributions to Biology and Problems of Medicine* (pp. 223–239). Berkeley: University of California Press. Retrieved from http://projecteuclid.org/euclid.bsmsp/1200512872.

7. McCormack, J., & Dorin, A. (2001). Art, emergence and the computational sublime. In *Second iteration: Proceedings of the Second International Conference on Generative Systems in the Electronic Arts* (pp. 67–81). Victoria, Australia: Centre for Electronic Media Art. Retrieved from http://www.csse.monash.edu.au/~jonmc/research/Papers/art-2it.pdf.

8. Ratto, M., & Ree, R. (2012). Materializing information: 3D printing and social change. *First Monday*, *17*(7). Retrieved from http://firstmonday.org/ojs/index.php/fm/article/view/3968.

9. Rinaldo, K. E. (1998). Technology recapitulates phylogeny: Artificial life art. *Leonardo*, *31*(5), 371–376. doi:10.2307/1576600.

10. Whitelaw, M. (2003). Morphogenetics: Generative processes in the work of Driessens and Verstappen. *Digital Creativity*, *14*(1), 43–53.

11. Witten Jr., T. A., & Sander, L. M. (1981). Diffusion-limited aggregation, a kinetic critical phenomenon. *Physical Review Letters*, *47*(19), 1400.

12. Wolfram, S. (2002). *A new kind of science*. Champaign, IL: Wolfram Media.