Artificial Life Art, Creativity, and Techno-hybridization (editor's introduction)

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Abstract   Artists and engineers have devised lifelike technology for millennia. Their ingenious devices have often prompted inquiry into our preferences, prejudices, and beliefs about living systems, especially regarding their origins, status, constitution, and behavior. A recurring fabrication technique is shared across artificial life art, science, and engineering. This involves aggregating representations or re-creations of familiar biological parts—techno-hybridization—but the motives of practitioners may differ markedly. This article, and the special issue it introduces, explores how ground familiar to contemporary artificial life science and engineering has been assessed and interpreted in parallel by (a) artists and (b) theorists studying creativity explicitly. This activity offers thoughtful, alternative perspectives on artificial life science and engineering, highlighting and sometimes undermining the fields' underlying assumptions, or exposing avenues that are yet to be explored outside of art. Additionally, art has the potential to engage the general public, supporting and exploring the findings of scientific research and engineering. This adds considerably to the maturity of a culture tackling the issues the discipline of artificial life raises.

Now a corpse has the same shape and fashion as a living body; and yet it is not a man. Again, a hand constituted in any and every manner, e.g., a bronze or wooden one, is not a hand except in name; and the same applies to a physician depicted on canvas, or a flute carved in stone. —Aristotle, *Parts of Animals*, I (LCL 323: 66–67), 640b

On the walls of the Chauvet caves in France are images dating back 30,000 years to the Upper Paleolithic (Aurignacian) period [2]. Many depict animals, life as the artists knew it. But the *Venus and the Sorcerer*, one of the oldest images at the site, also establishes a tradition of invention that should resonate with artificial life researchers. The Sorcerer has the arm and shoulder of a man and the head of a bison. He visually resembles the Minotaur of Homer, who unknowingly replicated the idea thousands of years later. In fact, this archetype has appeared repeatedly from antiquity to the present. Notably, the resemblance of the entire *Venus and the Sorcerer* to a drawing made tens of thousands of years later by Picasso, *Minotaur caressant une dormeuse* (1933), has been remarked upon [26]. Most of the Chauvet image-making might be interpreted as technological mimicry of living things,

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but the Minotaur is potentially early physical evidence of new life conceived and formed by human minds and hands.

It is possible that the Aurignacian artist(s) simply depicted reality—a man wearing a skull or mask—but the abundant conglomerates of animal parts illustrated across continents and centuries suggests this needn't be the case. Their use as cultural symbols is diverse [14], but history's chimeras are unequivocal flights of fancy calling to mind Langton's prompt to explore *life-as-it-could-be* [22]. This catchphrase asking us to become *creators* remains pertinent today, especially in the arts, even though the philosophy and concerns of artificial life have arguably shifted since then.

The Chauvet works highlight an ongoing concern of artificial life that relates to their status as images, and potentially (but unknowably) as instances rather than simulacra of a precursor to our concept of a living thing. The perspective of "strong artificial life," derived originally from the concept of strong AI [31], admits the possibility that software running on a computer could live if its components were organized so as to generate an instance of the behavior characterized by life. While artificial life researchers study animated visualizations of virtual creatures whose limbs and sensors can be organized analogously to those of real organisms to generate lifelike behavior, these images aren't typically given the status of living things, even by their creators. What arguably has a stronger claim to life by today's disciplinary view is software organized structurally according to the interactions and dynamics of biological generative processes. For instance, the organizations required to generate the metabolism of an organism, the self-establishment of a semipermeable membrane, or the self-reproduction and evolution of a population of machines are candidates. If we accept software as a potential vehicle for life, we have to discard the idea that organisms are necessarily physicochemical phenomena. If we discard this, the basis for current biology, we need to field counterarguments, especially from biologists, that we aren't justified in making the leap, that we are conducting "fact-free science," for instance [18]. By analogy, from the (retro-)perspective of the ancient artists at Chauvet, their images, built from the technology of the time, might be "real" artificial life consistent with *their* requirements for a category under which to classify organisms. Or they might never have made the kinds of distinctions that concern us today. We will never know. But the Chauvet pictures prompt questions like these, something all art can motivate when we engage with it.

Artists can play devil's advocate to researchers exploring the boundaries of life's possibilities, especially as these relate to technology. Creative melding of biology and technology in artefacts surged in the late 1960s as artists, and the theorists that considered their work, explored the principles and practice of cybernetics and computer programming. Jonathan Benthall provided a detailed survey of the activities and theoretical concerns of the time. He started from the basis that the relationship between humans and art was symbiotic and worked towards a reinterpretation of individual works and arts culture generally from perspectives provided by ecology [4, pp. 127–141]. But it was the writer Jack Burnham who arguably provided the most active and enthusiastic voice in the discussion surrounding art, technology, and biology, a contribution that remains relevant to contemporary discussions [41]. Burnham wrote with insight on the biotic sources of modern sculpture, sculpture and automata, robot and cyborg art [8], systems esthetics, and real-time systems [9], but his dream of realizing a new form of sculpture that quite literally became life in the hands of artists[1] was sadly ahead of technology's ability to deliver and the public's ability to engage with such novel and challenging territory. Following what he saw as many artistic, technological, and social failures, he became disillusioned with his own earlier idealism [10].

Burnham needn't have been so dismayed. Using biologically inspired artefacts as their medium, artists have continued to prompt reconsideration of our views on life and its manufacture; this is *artificial life art*. Its methods sometimes differ from those of science (for instance, art often poses questions, disrupts conventions, and explores aesthetics without wishing to preach solutions or argue alternatives), but it shares artificial life science's concerns. Many of Burnham's dreams have

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1 Burnham's prophesy that "The stabilized dynamic system will become not only a symbol of life but literally life in the artist's hands" [8, p. 376] is echoed in Langton's comment in the context of science, "We would like to build models that are so life-like that they cease to be models of life and become examples of life themselves" [21].

been revitalized in the last decades within artificial life art. Arguably it is not a mainstream art activity (an issue that troubled Burnham in the 1980s), but it seems to have staying power. For instance, consider the survey in Rinaldo's article on the subject [34], the artists explored in Whitelaw's *Metacreation* [45], twelve years of VIDA artificial life art submissions from 1999 to 2012 [30], or even the contributors to the current journal issue. These people share a deep-seated curiosity about our relationship with living systems and technology, and a firm commitment to explore it artistically.

For artists, or indeed scientists, to find acceptance of creative ideas, their offering must be novel, surprising, but not so bizarre as to alienate or confuse [13]. One of Burnham's criticisms of the technological art of the late 1960s was that it went too far. As Nell Tenhaaf has put it in relation to artificial life art and coincidentally with reference to the same Chauvet cave imagery introduced above, "artists want our art to (mis)behave … to fit into its era … but at the same time we want it not to fit so that it can expand the scope of human imagination" [41]. This desire for acceptance carries beyond the individual assessor or critic to the society in which an idea is presented. That creativity can be understood as a social phenomenon is strongly supported by Saunders and Bown, who, in this issue, promote the study of *computational social creativity* through software simulations [37]. Especially favored are models enabling the investigation of the emergence of creative phenomena from groups of interacting agents, each with unique local conditions, subgoals, and behaviors. Also in this issue, Hiroki Sayama and Shelley Dionne [38] report experiments of the kind suggested by Saunders and Bown. They explore how human groups and artificial agents alike collectively generate creative ideas using software and social metaphors derived from evolutionary processes. The results reveal the extent to which social creativity is a combination of incremental processes of generating new ideas from old ones within the minds of individuals, and how the social critique and support of ideas currently in the milieu can influence creative processes.

Art and science are highly social activities; artificial life art and science are not special cases in this regard. They are heavily influenced by the disciplinary community's perception of acceptable questions or topics and defensible methods of responding to them. Margaret Boden, in this issue [6], outlines her general categorization of creative activities. Of particular relevance here is her idea of *transformational creativity*: that "one or more of the defining constraints of the possibility- space is itself altered, in a more or less fundamental way, so that *structures* that were strictly impossible before become possible—and, by hypothesis, instantiated" [6, p. 357]. This is potentially a risky approach to creative activity in any field. For a start, we might expect such dramatic changes to take longer to gain traction in a social disciplinary network than, by contrast, incremental shifts in thinking, if only because transformational creativity flips world views and drops them on their heads. By my reading, the perspectives presented above that images or software might *actually* live are potentially such creative transformations. Langton remarked on the significance of the transformation he was proposing at the conclusion of his introductory article for the field of artificial life [22]. Likewise, as can be seen from the present article's introductory Aristotelian quotation, in the case of images this has been noted for thousands of years. Similar discussions have abounded concerning the relationship between man-made machines and living things.

A safer (less adventurous, maybe, but valuable all the same) approach to creativity in devising life-as-it-could-be is incremental construction from references to life-as-it-is. A common incremental creative method of consequence in artificial life research, and one of direct significance to evolutionary processes, is hybridization. The conjunction of familiar biological parts or processes in novel chimerical combinations safely grounds any exploration in life-as-it-is, but pushes into the realm of invention. With firm grounding we reduce the risk of straying beyond behaviors and interactions of life that our research community, or in some cases even the general public, would find acceptable, comprehensible, and interesting. If we did stray too far, it is likely that the disciplinary community would find nothing legitimately relevant in our project.

Apart from the Minotaur, humans have been prolific inventors of hybrid life, mixing body parts and behavioral traits to make centaurs, sirens, sphinxes, harpies, gorgons, satyrs, and chimeras. The Chinese dragon is probably also familiar to Western readers. "Ancient native writers like Wang Fu inform us that it has the head of a camel, the horns of a stag, the eyes of a demon, the ears of a cow,

the neck of a snake, the belly of a clam, the scales of a carp, the claws of an eagle, and the soles of a tiger" [23, p. 46]. These chimeras are life-as-it-could-be, *assemblages* of ready-made parts sourced from life-as-we-know-it. The historical chimeras immortalized in literature and visual art have successfully maintained their relevance to art, to culture, and even to modern science [3]. They resemble contemporary artificial life experiments in that they are attempts to construct believable new life forms, archetypes intended to convince us of their plausibility. Some hybrids, such as the Chimera itself—a lion sprouting an incongruous goat's head from its back and a snake's head on the tip of its tail, which now represents the general idea of cobbling together bits and pieces—are arguably unsatisfactory experiments [35]. But a well-executed chimera tests our ability to distinguish fact from fiction, a capability wielded by the Nazis who fused Jews with rats in visual print media, literature, and cinema. A prominent example of this subterfuge appeared in advertising material for the anti-Semitic propaganda film *The Eternal Jew / Der ewige Jude* (Fritz Hippler, 1940).

As late as the 19th century, mermen and mermaids were manufactured by artisans in the Far East (e.g., the Japanese *ningyo* [43]). Some were shipped to Europe and displayed in private scientific and ethnographic collections of curiosities, or to the paying public (Figure 1). They were less lovely than the romantic painted inventions of John William Waterhouse (*A Mermaid*, 1901), but no less seductive, attracting considerable sums and public interest. The freak-show creatures were faked by stitching or wiring wooden and clay parts to the jaws, tails and other bones of fish, sometimes disguising junctions and framework with papier-mâché or lacquer-soaked cloth, sometimes adding hair for effect [43]. Naturalists worth their salt were unconvinced by these "Feejee mermaids," but nature kept the scientifically inclined on their toes too. Imagine the surprise when the platypus was first introduced to European science from New Holland (now Australia): a duck-billed, furry-bodied, venomous-spined (male), warm-blooded, clawed, web-footed, water-loving creature that lives in muddy riverside burrows far, far away from familiar Britain. It would have seemed even stranger had they been certain at the time that it laid eggs.

(a)   (b)

Figure 1. (a) *The Mermaid* (a feejee mermaid). Etching by George Cruikshank, c. 1822, reproduced in [11, p. 266]. Image in the public domain. "A contemporary journal described it as '… a disgusting sort of compound animal, which contains in itself everything that is odious and disagreeable.' Though naturalists and journalists fully exposed the imposture, we are at the same time assured that 'this circumstance does not appear to affect the exhibition, which continues as crowded as ever'. " (b) Feejee mermaid/merman. © Image copyright Heini Schneebeli, Horniman Museum and Gardens. Used with permission.

> Of the Mammalia yet known it seems the most extraordinary in its conformation; exhibiting the perfect resemblance of the beak of a Duck engrafted on the head of a quadruped. So accurate is the similitude, that, at first view, it naturally excites the idea of some deceptive preparation by artificial means […] nor is it without the most minute and rigid examination that we can persuade ourselves of its being the real beak or snout of a quadruped. [This creature] verifies in a most striking manner the observation of Buffon, viz. that whatever was possible for Nature to produce, has actually been produced. […] On a subject so extraordinary as the present, a degree of skepticism is not only pardonable, but laudable; and I ought perhaps to acknowledge that I almost doubt the testimony of my own eyes…. [39, Vol. 1, Pt. 1 (Mammalia), pp. 228–232].

The platypus might as well have been life from another planet. To European eyes it was certainly life-as-it-could-be, familiar parts in a surprising assemblage. Even the indigenous Australian Euahlayi people believed the creature to be a hybrid water-rat–duck [16, pp. 10–18].

In some respects contemporary artificial life's iconic products are more mermaid-like than platypus-like. The most successful of our pinups present a naturalistic surface and avoid incongruities that might raise skepticism. For example, we might tell a coherent story of simple, locally acting components giving rise to large-scale patterns. A cellular automaton (CA), for instance, must operate without resorting to a *deus ex machina* in the form of a centralized overseer that saves the prized patterns from disintegration. But in our discipline, processes and attributes of biological systems are in fact stitched together in software and their connections masked beneath "papier-mâché." Part of the veneer arrives with the stories we tell and the analogies or metaphors we apply to tell them [44]; part is inseparable from the graphics and visualizations we use [25].

A typical example of hidden stitching binds a virtual ecosystem of physically modeled organisms. The movement of the creatures appears to obey real-world dynamics. Their morphologies and behaviors, such as predation or nest construction, might appear to be the result of an ecologically grounded evolutionary process. Everything can look very familiar. But, as the article of Rui Antunes, Frederic Fol Leymarie, and William Latham highlights, the images and sounds we perceive are not *generated* by underlying ecological processes [1]. They are the result of the mapping decisions between computational processes and perceptible machine outputs made by an artist or programmer *representing* a real system. The result, without any contextualization on the part of the artists or through deliberately subversive rhetoric, has the potential to bewilder or mislead audiences. The artists could instead choose to relate underlying ecosystem-like interactions of their software to observable events in the presented work, and to artistically motivated narratives. This may even allow them to engage viewers in generating new layers of meaning above and beyond those concretely represented in the software.

The complexity of the underlying programs and the opacity of the physical machinery ensure that what artists actually do with computers, and what computers do with programs, can remain a mystery to viewers. This technology can potentially make art inaccessible and exclusive [36]. Consequently, it can be problematic for an audience to unquestionably accept a seemingly natural mapping from artificial life code to textual narrative. The extent to which even human languages are subject to interpretation, especially by computing machinery, is exposed by two pioneering artificial life artists, Christa Sommerer and Laurent Mignonneau. Like Antunes et al., they are concerned with the ambiguity and manipulation of mappings from code to agent morphology and behavior [40]. They focus particularly on an analogy between, on the one hand, patterns in human-constructed texts and the diverse ideas these represent, and on the other hand, the DNA of organisms or viruses and the structures and behaviors these might generate. In Sommerer and Mignonneau's works *Life Spaces* and *Life Writer* phrases entered by a user are reinterpreted according to a disguised, programmed logic to produce and control novel virtual organisms. The artists seem to be highlighting both the meaninglessness of isolated components of text (individual characters, for instance) and the extent to which the meaning of an assembled text is generated relative to the context in which it is read. The point of the user's engagement with their art then can't be to depart

understanding the mapping process in detail, but to leave with the knowledge that text does not unambiguously reveal its meanings or implications. Once set loose, its behavior can be surprising even to those who write it.

Taking ambiguity into account is particularly relevant when creating and interpreting computer simulations. In software we have an unlimited ability to construct processes that could never be instantiated physically, chemically, or biologically (because they would break fundamental physical laws, for instance), but to present them under a veneer of normality. When we look under the hood of a virtual ecosystem with an evolutionary component, we find that the mechanism of creature reproduction is usually a hard-coded algorithm independent of the dynamics that the virtual organisms themselves are subject to. The fact that the evolutionary algorithm and the agent-based model it operates on are independent processes stitched together is not apparent to the observer, but it may have significant consequences for system dynamics. For example, it may prevent evolutionary programs from being *open-ended* [20, 28]. Unfortunately, building an evolving virtual ecosystem from artificial-chemistry components or on a CA grid has proven to be difficult. So we are forced to work with surface models and high-level abstractions that capture and enhance preferred traits of life and subdue details—at least for now.

Artists are particularly adept at dissecting, manipulating, and reassembling surfaces and mechanisms. Alice Eldridge presents a beautiful experiment in this issue, *You Pretty Little Flocker* [15]. This reworks Reynolds' *Boids* to highlight the system's intricacy without the familiarity of bird bodies. The imagery is simultaneously familiar and surprising. It seductively evokes flocking but reveals aspects of the dynamics that were previously invisible. Reinterpretations like this are valuable, as they force us to acknowledge the decisions that have been made to observe or represent some aspects of a system, and to (sometimes inadvertently) ignore others. In their article, Prophet and Pritchard call these *observational cuts* [33]. These are the points at which decisions and interventions made by an observer influence (or dictate) their perception of a system. Taking a few artificial-life-related case studies, the authors make explicit the points at which each researcher observes the subject of his or her inquiry. They can therefore demonstrate how the interventions highlight or disguise aspects of the framework binding each researcher's investigative method. The knowledge that may be gained following observational cuts is always constrained and biased by the choice, but cuts, as Pritchard and Prophet indicate, are unavoidable.

Sometimes observational cuts are effectively masked by overfamiliarity, or just lack of critique on the part of an observer. Then they can remain unnoticed even when skepticism would be worthwhile. But at other times, willful ignorance of the stitching (such as the disjointed interface between the software governing an agent's moment-by-moment behavior and the software governing its reproduction and evolution) and the papier-mâché holding together contemporary artificial life (such as the visualizations that convert data manipulation processes into processes perceived by observers) may usefully facilitate artistic enquiry and scientific endeavor alike. This is especially true when the aim is to address a question, or experience phenomena, for which the artifice is irrelevant experimental scaffolding. If, in cases like these, we intend to engage with artificial life at the level of our senses, we must be conscious of the deeply ingrained seductiveness of intuition. Reason is easily swayed in the consideration of perceptually apparent lifelikeness—anthropomorphism and zoomorphism are ubiquitous, for instance. We must be mindful of the degree to which this can color our theorizing about models and systems.

The desire to assess a mechanism of artifice can prompt a work of art. In this scenario, artificial life art is a *mode* of enquiry [4, pp. 150–165; 5] into our preconceptions or beliefs about living systems. One disarming way artists achieve this is by devising artificial complex system dynamics on a human scale and in our physical space. This entices us to abandon rational concerns about technology's status—a performative aspect of artificial life that is a disciplinary strength—and to engage ordinary bodily sensations. Arguably this is more persuasive and potentially subversive than conscious abstract symbol manipulation.

The cybernetic works of Simon Penny [32] test our willingness to engage directly with technology and artificial systems. His physical works are designed to explore the "poetics of interaction" but are

as far from click-and-drag interfaces as technology allows. Penny prefers embodied, dynamic agents that can be exhausting, puzzling, threatening, or exciting to engage. By craftily combining responsive and autonomous behavior, Penny's works cause us to consider our actions from the perspective of an agent foreign to us, an "other." His agents reflect and refract our movements and interventions to encourage exploration and rediscovery of physical space and sound. Through this theatrical exchange Penny intends for participants to form bodily relationships with his art. A part of his original motivation arose from dissatisfaction with good old-fashioned AI's lack of attention to embodiment, something that will ring true to many in the ALife community. The experience of Penny's work is more akin to theater than to the traditional art gallery visit.

Given the historical ties of artificial life to interest in the physicality of biological systems—for instance, in the work of Ashby, Pask, Grey-Walter, and Ihantowicz (who explored art and cybernetics in the 1960s [19])—perhaps it is surprising that theatrical theory hasn't entered more clearly into the discussion surrounding the field. Second-order cybernetics focuses on the continuity and intermingling of loops and circuits of processes through machines (including organisms) and their environments—a theater of interaction within which we too have evolved. Not just in Penny's work, but in the exemplary experience of interaction with Richard Brown's *Neural Net Starfish* described in this issue [7], we see the importance of this theater to artificial life. Brown has demonstrated how such interaction provides longevity for a work that engages even infants with questions raised by artificial life.

Sally Jane Norman [29] explicitly relates artificial life to the centuries-old practice of stage performance, with a focus on the containment structures placed around the artificial systems we construct and observe. In this respect her article addresses issues overlapping those of the observational cuts and emergence of agency from interactions between observers and observed covered by Pritchard and Prophet [33]. But Norman's context is the relationship between artificial life, human actors, and the stage. Actors are literally living, breathing simulations of other lives. They cease to be themselves so as to present the appearance of life extending beyond the performance and the stage into an implied external reality. From this position actors can transform the solidity of the boundaries between the individually and socially understood real world outside the theater, the artificial world occupied by the characters but external to the experience of the audience (observers), and the created world that is depicted explicitly on stage as a play (the system). As with Penny's and Brown's art, human theater can eliminate any perceived clarity concerning distinctions between natural and artificial systems by placing the observer in a tightly coupled sensorial feedback loop shared with an artificial system.

An alternative approach to artificial life art is the application of dynamic pattern-making biological processes to the generation of aesthetic works. This has the potential to evoke the sublimity of dynamic biological phenomena many artificial life researchers experience [24] while using static or noninteractive media. Whether implemented in software (e.g., Dawkins' *Blind Watchmaker* [12], Latham's evolved sculptures [42]), or explored with real biological morphologies (e.g., Verstappen and Driessens' *Morphotheque* works, which offer multiple arrays of surprising real vegetable shapes [27]), this approach is also a means to discover the creative potential of generative processes. For these reasons among many, Gary Greenfield and Penousal Machado review a practice that adopts the processes of ant pheromone path-laying to software for image generation from the bottom up [17]. A degree of faithfulness to ant behavior is maintained (a life-as-it-is grounding), but this is far less important to the artists than the ability of the final image, usually a map of pheromone trails, to trigger the viewer's interest, and a question as to how it might stand as a symbol of the capabilities of the process that generated it (a life-as-it-could-be component of their work). So the decisions about what to leave in their models, and what to leave out, are made on a different basis to those made for answering biological questions, but Greenfield and Machado too desire to inquire into the living system's operation, and to map it into an intelligible space.

The work *Accretor* by the contemporary Dutch artists Maria Verstappen and Erwin Driessens is analyzed in this issue by Mitchell Whitelaw [46]. As in the ant and ecosystem projects described already, they take natural processes as a point of departure rather than an end goal. In many of their

projects a fascination with dynamics leads the artists to evoke nature through software-based and physical or constrained biological processes. *Accretor*'s generative processes are computational, but the artists fabricate the resulting forms to allow engagement beyond the screen. The insistence on physicality is something that simulation fetishists might see as unnecessary, but researchers working with hardware should be familiar with the desire to engage directly with their work, and to permit its assertion of presence. This is vital here: *Accretor*'s outputs are presented most enigmatically in physical form. As Whitelaw indicates, the audience is told very little about the objects. In exhibition they don't shout to be noticed; they are quiet and subdued, resisting interpretation. The pieces evoke natural processes to the extent that, in the absence of any narrative other than that provided by their form and the gallery context, they might just be geological structures turned up on a beach or dug from the earth, rather than the artefacts of a human metacreative process. Without their physicality this ambiguity would suffer.

I hope this issue will promote discussion about the relevance of artificial life art to a new audience. Of course, there are now dedicated conference tracks, exhibitions, and competitions catering specifically to artists engaged with the creative potential of artificial life [30]. These events are valuable in cementing the ALife art community, enhancing its visibility, recognizing those who excel, encouraging those who are just beginning, legitimizing the work we do, and above all else, sharing ideas. But their existence mustn't become an excuse for segregating the arts and the sciences. It is, I feel, an interdisciplinary approach that has historically lent the whole enterprise of artificial life its spark. Interaction between thinkers of many styles, workers with many media, and scholars from many backgrounds is fundamental to understanding our attempts to model and construct technological living systems.

Acknowledgments

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