Art between Synthetic Biology and Biohacking
Searching for Media Adequacy in the Epistemological Turn
Hauser, Jens

Published in:
Leonardo Electronic Almanac

Publication date:
2019

Document version
Publisher's PDF, also known as Version of record

Document license:
CC BY

Citation for published version (APA):
Art Between Synthetic Biology and Biohacking

This paper discusses media adequacy in light of the trendy discipline of synthetic biology.

by Jens Hauser


Published Online: May 15, 2017
Published in Print: To Be Announced

ISSN: 1071-4391
Abstract

While the creation of lifelike appearances has been an ever-recurring historical feature in art, contemporary artists who employ biotechnology are particularly ‘close to life,’ and the new discipline of synthetic biology is well-suited to upgrade art historical paradigms of ‘creation.’ In conjunction, the democratization of lab tools leads to their appropriation by tinkerers and tactical media activists who apply the potential of open-source culture from the digital age of media art to do-it-yourself (DIY) biology and biohacking. Hereby, the formerly distinct features of the technologization of the animate and the animation of the technological merge in an unprecedented way, both technically and metaphorically. This paper discusses media adequacy—the aesthetically and epistemologically convincing implementation of the instances of mediation of living entities or beings with regards to the corresponding appropriate materials and strategies—in the light of the trendy discipline of synthetic biology. This discipline aims at designing living systems from scratch, and is emerging at a time when DIY biology seems set to be the next pop-culture phenomenon. Art is increasingly linked to knowledge production.
and dissemination within a larger scope of what can be called an epistemological turn, in which cultural practitioners do not so much translate and transform what we know, but rather question how we know what we know.

**Keywords**

Media Art, bimedia, DIY biology, biohacking, synthetic biology, artificial life

**Introduction**

Beginning with the earliest anthropomorphic sculptures, myths of vivification have surrounded artifacts made by the artist’s hand. The animation of malleable matter stands in a long pictorial tradition that includes the automata of the eighteenth century or the robotic art of the twentieth century. From the nineteenth century on, biological metaphors began to be employed in the discussion of the artwork itself as an organism. The creation of lifelike appearances is an ever-recurring historical feature in art. By means of form, material, or process, a touch of aliveness is staged or referred to, ideally favoring an empathic mindset in order to bolster reception, aiming at involving the viewer viscerally. Art has imagined, represented, and mimicked, then simulated and—quite recently—manipulated living beings and systems effectively, even at the cellular or molecular level. Contemporary artists who enter labs or create their own in order to employ biotechnology are particularly ‘close to
life,’ and the new discipline of synthetic biology is well-suited to upgrade these art historical paradigms of ‘creation.’ In parallel, the democratization of lab tools leads to their appropriation by tinkerers and tactical media activists who apply the critical potential of open source culture from the digital age of media art to DIY biology and biohacking.

**Biomedicality**

Such cultural practices, therefore, need to be analyzed beyond an image-based, hermeneutic approach, and on the basis of the artistic media themselves. Mediation and technologies are not employed merely to achieve aesthetic effects; rather, they are themselves entire elements of the aesthetic idiom. These developments are also indicators of a larger epistemological shift. Both on a technical level and with regards to their artistic implementation or representation, two complementary approaches historically coexisted: on the one hand, the *technologization of the animate*—which implies the ‘instrumentalization’ and manipulation of existing organic systems, beings, or their constitutive parts—and, on the other, the *animation of the technological*—which means the construction and staging of lifelike processes or entities in other than biological media. [1] [2] With the progressive convergence of hard-, soft-, and wetware, [3] it becomes necessary to outline these new principles of ‘bio-mediality’ [4] and to functionally trace how media based on
physical principles can be shifted toward bio-
and convergent technologies. This shift is made
possible by conserving existing media functions
and adding potentially novel capacities to self-
repair, adapt, or evolve. Bio-mediality can be
divided into three instances:

1. Media in the sense of *milieu*, as an enabling
condition that can solicit changes in organic
entities. Beside abiotic factors such as air,
water, and temperature, this category
includes today’s growth media in tissue
engineering, for example, as well as
incubators or artificial environmental settings
at large.

2. Media in the sense of *means* of transformation
or generation, that shift the ability to
transmit, store, and process into the biological
realm by making use of living systems’
internal mechanisms. These media can be
organisms genetically modified to produce
substances; recombinant DNA; bodies
enhanced by convergent technologies; wet-
dry-cycles in bioinformatics; [5] or even
information-processing devices such as DNA-
or cell-computing prototypes, whose
programmed outcomes have a computational
rather than biological goal, and most of the
‘genetically engineered machines’ within the
framework of today’s synthetic biology.

3. Media in the sense of instances of *measure*, in
line with traditional media of perception and
analysis such as optical or other physical
instruments, but in which one biological entity is measuring another. Examples of these media include gel electrophoresis where enzymes cut DNA molecules to locate genetic sequences and DNA chips or biomarkers such as the Green Fluorescent Protein, but also whole organisms such as amphibians serving as ecological indicators.

These instances of bio-mediality can overlap and link to other media types. This is based on the assumption that media in general can be conceived of as the “loose coupling” [6,7] of atomically separate physical elements that, rearranged, produce forms. But in biological systems, with cells and organic macromolecules as their crucial smallest units, the de- and reorganized elements themselves still remain structurally relevant—and example being the organizing function of the carbon atom itself. Here lies an epistemological difference.

**Carbophobics vs. Carbophiles**

This difference has always played a role in the debate about the media and materials that artists and other cultural practitioners may adequately employ for the presentation, simulation, or manipulation of ‘the living.’ Of the many characteristics crucial for the ‘the living’, which are being selected and emphasized, as well as when, why, and how? Following painting, sculpture, automata, and so on, art in the late twentieth century has
employed ‘dry’ informatics and robotics as well
as ‘wet’ cell and molecular biology. Here, we can
observe an antagonistic relationship between
the animation of the technological proposed by
what can be called the carbophobics, and
the technologization of the animated vindicated by
the carbophiles. Especially since the 1980s, art
has often been first concerned with artificial
life, simulations, and robotics following
Christopher Langton’s oft-quoted manifesto:

Artificial Life is the study of man-
made systems that exhibits
behaviours characteristic of natural
living systems. It complements the
traditional biological sciences
concerned with the analysis of living
organisms by attempting to
synthesize life-like behaviours within
computers and other artificial media...
Since we know that it is possible to
abstract the logical form of a machine
from its physical hardware, it is
natural to ask whether it is possible to
abstract the logical form of an
organism from its biochemical
wetware. [8]

Artificial life should therefore be “extending the
empirical foundation upon which biology is
based beyond the carbon-chain [sic] life that has
evolved on Earth” by therefore “locating life-as-
we-know-it within the larger picture of life-as-it-
could-be.” Ironically, Langton seems to be so
allergic to carbon that he even misspells the word on the first page of his manifesto, amputating its “r”. It is as if he unconsciously wanted to annihilate the organizing function of the carbon atom as such, while bluntly wishing to get rid of “incubators, culture dishes, microscopes, electrophoretic gels, pipettes, centrifuges and other assorted wet-lab paraphernalia.” [9] The text has become the foundation of a battle between carbophobics and carbophiles for the criteria that should be taken into account to define the new tendency of so-called ‘bio art.’ For example, the ‘carbophobic’ artist Leonel Moura, known for his paintings robots, affirms:

Bio Art is a new kind of biological inspired art that campaigns for the emergence of new artificial, dynamic and self-sustainable Nature. The main point is to generate life as an artistic expression (but not life as it is, rather life as it could be). This new kind of art departs radically from the (sad) idea of using human and animal bodies transformed in art works, as well as from the practice of employing organic materials in the pieces and installations that have plagued 20th-century museums and art galleries. [10]

On the opposite side, ‘carbophile’ artist Eduardo Kac, who introduced the term transgenic art in
1998, claims that:

Bio Art is a new direction in contemporary art that manipulates the processes of life. Bio Art employs... the following approaches: 1) The coaching of biomaterials into specific inert shapes or behaviours; 2) the unusual or subversive use of biotech tools and processes; 3) the invention or transformation of living organisms...from a single cell to a mammal. It is in this organic sense that bio art uses the properties of life and its materials, changes organisms within their own species, or invents life with new characteristics. [11]

The visceral animosity between carbophobics and carbophiles is obvious, the former accusing the latter of anachronistic materialism and lack of complexity, the latter blaming the former for naïve ‘digi-centrism,’ inadequate art media, and the blind belief in programmable, code-based, in silico processes beyond the particular materials.

**Living Machines: Swans and Ducks**

Conceptually, however, this opposition already prevailed in relation to the eighteenth century fascination with automata. Jessica Riskin has demonstrated how the illusion of aliveness is first created through behavior or movement, and then, later on, through material organic
aspects. In her seminal text, *Eighteenth-Century Wetware*, Riskin contrasts those animated machines that generate the illusion of aliveness by simulating activity against their counter-models, which use “soft and moist substances” such as rubber, leather, or cork, as well as “fluids and airs,” pneumatic systems combined with organic-looking exteriors and simulated material metabolisms. [12] She opposes Maillard’s mechanical swan from 1733 and Vaucanson’s well known mechanical duck from 1738. While Maillard’s animal paddled through the water, its exterior aspects only roughly resembled an actual organism—it was merely intended to represent, rather than to simulate, a natural swan. By contrast, Vaucanson’s duck staged organic metabolic activity, as it not only flapped its wings but also seemingly digested grain and rejected excrement—a process that was later demonstrated to be fraudulent. It is peculiar that Riskin has dedicated a whole anthology to the history and philosophy of artificial life, *Genesis Redux*, [13] in which all artificial life research since the seminal 1980s Santa Fe conferences on simulated living systems is afforded only minor significance in the historical context. It is striking, though, that both Riskin and Langton refer to nearly identical historical examples. However, Langton generally emphasizes the development of control mechanisms and behavior generators for simulating lifelike features, while Riskin is more interested in the cultural analysis of the desire
to artificially create life without wanting to reduce it to equivalents of machinery.

Now, in the emerging and much-hyped field of synthetic biology, software, hardware, and wetware meet in an unprecedented fashion. Synthetic biology is currently being approached as a discipline in which top-down and bottom-up approaches, and the virtual and the actual, oscillate, and where simulation is being conveyed into synthesis. As Manuel DeLanda has outlined in *Philosophy and Simulation: The Emergence of Synthetic Reason*, [14] the increasing capacity of simulation has itself become the very motor of synthesis. For the art of artificial life today, this means that simulation and organic re-materialization should not be regarded as being divided, but rather as wetware-compatible and, in their interplay, ‘media adequate.’ Synthetic biology aims at applying engineering principles to biology so as not to merely modify but also to build up ‘life’ from scratch and design ‘living machines.’ The discipline merges various fields: In DNA synthesis, genetic information is chemically produced and transplanted into foreign cells; with DNA-based biological circuits, organisms can be equipped with new functions; research on minimal organisms tests biological units reduced to their minimal functions necessary for survival; protocells, early stages of cellular lifeforms, can be produced out of lifeless chemical substances; and xenobiology constructs functional biological systems not yet
found in nature and not intended to interact with it. [15] Strikingly, the term itself is already one hundred years old, coined by French natural scientist Stéphane Leduc. He saw strong resemblances among crystal formations, plant growth, and cell tissues. In his pursuit of the synthesis of living phenomena, Leduc was concerned with studying precisely that grey area between the inorganic and the organic in order, at some point, to synthesize ‘life’ through the combination of the most basic units and their progressive evolution. Epistemologically speaking, Leduc predicted that biology would follow the path of the other natural sciences, such as physics, by “successively being first descriptive, then analytical before becoming synthetic.” [16]

**Subverting, displacing, hacking**

In recent years, some artists, creators, hackers, and tinkerers have appropriated so-called ‘biobricks,’ DNA sequences to be assembled mainly in order to implement new functions into model organisms such as *E. coli* bacteria, and to contextualize and aestheticize them. These standardized genetic building blocks are collected in the Registry of Standard Biological Parts set up by MIT and presented in now-popular events such as the International Genetically Engineered Machine Competition (iGEM). Sometimes they are even prone to humorous or subversive design projects, such as the *E. chromi* (2009) project by Daisy Ginsberg...
and James King wherein engineered bacteria secreted colored pigments to serve as purposeful bio-indicators. Other artists go beyond this fascination with the technical features to the microscopic level, confronting ‘biobricks’ in the context of their potential ecological and societal consequences.

In his project Pigeon d’Or (2011), Belgian artist Tuur van Balen combined bio-informatic ‘programming’ with real organic implementation. In order to make pigeons defecate soap, he modified the metabolism of bacteria occurring in their gut with the help of two specifically customized ‘biobricks’—one that lowered the pH level in the Bacillus subtilis colonies, and another that made them express lipase, a grease-digesting enzyme. These animals, commonly seen as ‘flying rats,’ were proposed to be equipped with new functionalities and potentially turned into swarming urban disinfection machines. Pigeon d’Or addresses issues linked to the release of genetically engineered organisms into the environment and to the possible consequences of xenobiology. Both on the micro and the macro scales, Pigeon d’Or addresses the ethical, political, environmental, and safety-related consequences of synthetic biology. But the work must also be analyzed in light of its epistemological sub-texts: Only the gut bacteria were genetically altered, not the pigeons themselves; the pigeons were merely conceived of as ‘messengers’ of the
transgenic. Van Balen here alluded to a new research paradigm called metagenomics that studies not only DNA sequences of individual organisms, but also their symbiotic or parasitic interactions with other members of their environment. The project voluntarily triggers apparently naïve questions: Whom will Greenpeace then need to attack? Will we suddenly care for the manipulated pigeon’s health? Will we treat pigeons differently once they become useful for cleaning our cars? Will our technophile anthropocentrism let new invasive species emerge? In addition, Van Balen has designed two functional objects: a pigeon coop to be attached to the windowsill that allows pigeons to be fed with food containing the modified bacteria, as well as an interface for parked automobiles that allows pigeons to land and defecate soap on the windscreen. Here, the design of these absurd artifacts metaphorically echoes the design of the genetic circuits themselves, as well as the dominant engineering discourse in synthetic biology. Instead of organisms or living beings, it speaks of ‘circuits,’ ‘modules,’ ‘standardized parts,’ or ‘chassis.’ The jargon is dominated by the concept of orthogonality. Imported from computer sciences, it implies that—unlike in most living systems—the technical effect produced by one component does not create side effects on other components of the system, “just like in a car,” where “adjusting the rear-view mirror does not affect the steering.” [17]
Such art also questions predominant genetics-centered approaches to synthetic biology, which in fact continues the genetic engineering of organisms that biologists have been carrying out since the 1970s. This definitional limitation has also been criticized by Antoine Danchin and Víctor de Lorenzo, who campaign for a more holistic approach. Asking whether synthetic biology leads only to “new words” or in fact to “new worlds,” they call for a specific European perspective beyond ‘biobricks’ that would combine vastly different fields such as engineering, computing, modelling, molecular biology, evolutionary genomics, traditional biotechnologies, origins of life and artificial life research, protocell research, and protein modelling, etc. [18]

But aren’t code- or circuit-based conceptions indeed fueling events like the International Genetically Engineered Machine Competition (iGEM), which specifically advertises synthetic biology as an open-source concept borrowed from computer and internet culture? These kinds of gatherings emphasize the collaborative culture of shared programming, as opposed to the soft- and wetware owned by corporations. It needs to be asked whether this cool dressing-up of synthetic biology is not a clever way to de-dramatize a technology that critical observers have called “extreme genetic engineering.” [19] The ambiguity between institutionally promoted technologies and collaborative
community practices stemming from digital—and even hacker—culture seems to be voluntarily entertained. And it needs to be questioned whether this analogy to the movement of computer hacking since the 1960s is even appropriate, or if it represents an attempt to integrate emerging bio-practices within the tradition of communication-based digital media art or ‘hacktivism.’ The concept of ‘biohacking’ evokes the ideas of subculture and anti-institutionalism. It most often distinguishes itself from art that subverts biotechnologies to create aesthetic objects or processes—art that is increasingly considered bourgeois within the community. Biohacking, which usually involves open soft-, hard-, and wetware at-home or field-gene sequencing, has become a new, fanciful cultural practice; a practice compatible with grassroots citizen-science, poised in its claim to be the real avant-garde as it relates to other cultural movements, such as the Situationists International in the 1950s and 1960s, whose political actions and social interventions also went far beyond the confines of artistic practice itself. Indeed, within the community itself, this Janus-faced attitude prevails, remaining open to opportunities of economic entrepreneurship, and yet claiming a critical position towards a bio-economic system, which has started to advertise itself with the open-source model. Despite relevant questions of risk assessment, the contrast between the ‘happy hacker’ in his DIY community, producing a generally positive
image of tinkering, versus the ‘evil and narrow-thinking engineer’ who purposefully engineers living systems, is striking.

In a famous article entitled *Evolution and Tinkering*, molecular biologist François Jacob argued that the evolutionary process of natural selection should not be described by the metaphor of engineering, but rather by that of tinkering. Nature, as a molecular tinkerer,

would slowly modify his work, unceasingly retouching it, cutting here, lengthening there, seizing the opportunities to adapt it progressively to its new use. Unlike engineers, tinkerers who tackle the same problem are likely to end up with different solutions...The tinkerer gives his materials unexpected functions to produce a new object. From an old bicycle wheel he makes a roulette, from a broken chair the cabinet of a radio. [20]

In direct response to François Jacob’s suggestion of natural creativity, artist Joe Davis, who began practicing biohacking *avant la lettre* in the 1980s, has recently used variants of a gene from the orange puffball sponge to plate electronic circuits. Normally, this gene codes for the protein silicatein, which forms the puffball sponges’ glass skeleton. But here, in its modified version employed in *Bacterial Radio*, [21] it
metabolizes metals from the environment. The genetically modified bacteria can then plate conductive, if anachronistically analog, radio circuits. By taking the metaphors of circuitry in synthetic biology literally, Davis ironically reverses its goal: by tinkering, he applies biological principals to electronic engineering, rather than vice versa.

On the one hand, industry’s greenwashed discourses on engineered bacteria—for example, for the purpose of more efficient bioremediation—contain an instrumental ‘biotechno-romanticism’ and common feature in human wishful thinking: they harbor the promise that new technologies might undo damage to the environment caused by past human technologies. Yet there seems to be a broader cultural desire to see in the technological tinkerer a still-reconciling sign of ‘nature.’ Biohacking, then, may well be the ‘new Green.’

References and Notes


[9] Ibid.


Author Biography

Jens Hauser is a Copenhagen and Paris based media studies scholar and art curator. He has been curating numerous exhibitions focusing on the interactions between art and technology since 2003. He holds a dual research position at both the Department of Arts and Cultural Studies and at the Medical Museion at the University of Copenhagen, and is a distinguished affiliated faculty member of the Department of Art, Art History and Design at Michigan State University. Hauser is also a founding collaborator of the European culture channel ARTE and has produced numerous reportages and radio features.