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Searching for Media Adequacy in the Epistemological Turn

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

by Jens Hauser

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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, biomedia, 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.

Biomediality

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 cabon-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 'bio-techno-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.'

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