

# Greene Epiphytes, an Immersive Bio Artwork

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## Abstract

In the last two decades, emerging fields alternately termed Synthetic Biology, Artificial-Life Art, Bio-inspired Design and Smart Materials, to name a few, have acted as loci that spawned new methods for creating novel artworks based on phenomena that is generally described as “*natural*”. At the same time, there has been increasing interest and research in creating differing kinds of immersive environments, responsive architectures and inhabitable worlds. *Greene Epiphytes* is an artwork that grew from an exploration of bio-inspired theories and a rethinking of engaging and immersive inhabitable aesthetics. It offers a perspective grounded in the lineages of immersive artworks and aesthetics that engage participants (not with representations of other life-forms, but) with non-human life-forms, and question the distinctions of human and nature. In this paper, we articulate assumptions and theoretical constructs that inspire our approaches for creating and “*engineering*” this artwork, and address some of the challenges. Rather than creating nature-like experience where humans are assumed to be at a remove, rather than part of nature, the inhabitable environment presented here is focused on a context enlivened by human and non-human entities, their varied responses to each other and to aspects of their intertwined worlds, as well as a questioning of materials.

## Keywords

Biomimetic- Performative Materials- Synthetic Aesthetic- Immersive Artwork- Algae- Bio Inspired- living and non-living

## Introduction

As interests in interactive immersive environments re-emerge and grow, so too do the ways in which the aesthetic aspects of their design and conception are considered. This move toward interactive, immersive and affective aesthetics is partly generated by a desire to create more engaging and complex levels of nature-like beauty and conceptual interaction.

A set of approaches, each representing slightly different terminologies such as Synthetic Biology, Bio-inspired Design and Smart Materials carry with them certain assumptions about the role of the user, artists and ideas of interaction [20]. Broader processes of interaction that grants a participant’s full-body interaction and sensory immersion

with emphasis on design and style seem to be reappearing [13].

Nature -assumed to be somehow distinct from the human- has inspired artists and designers for centuries; but recent developments in technology and in our understanding of biological systems have expanded the range of possibilities for combining design and biology. At the same time, questioning the centrality of humans above all other life forms, and its purported distinction from “*nature*” is evident. The so called posthumanism, as well as an increased interest in materiality, sustainability of a planet threatened by humans and renewed interests in “*the nody*” embodiment and the plastic aspects of senses and capabilities that were thought to be static and separate. Taken together, this combination of new and renewed ideas and practices challenge the status quo on fundamental levels, which, in turn, also offer opportunities to reimagine what art and human-made inhabitation may mean and may be.

The postnatural [19] approach between humans, nature and technology becomes more and more apparent within art and design discourses surrounding so-called performative materials and Synthetic Biology. Postnaturalism and posthumanism argue not only new methods, but also fundamentally different ways of being where living and non-living, human and non-human boundaries are breached through cybernetic, biological substrates, systems and contexts. These become, in a sense, palettes, subjects and experiences for artists who are creating novel artworks [13].

The setting for creating such artworks has never been more auspicious. The revelations of systems theories and computation combined with biology (e.g. in the field of Synthetic-Life), has changed our understanding of life. Notions of life and computation has been deeply invested in art and has greatly inspired artists, addressing new approaches to creating art based on the synthesis of life-like phenomena.

## Goals and Motivation

Experiences from our childhood persist, almost as specters that overlay our daily experiences: playing with the flow of water in the river, disturbing the marching path of ants, following the attractive and colorful butterflies – beauties to us, but horrific and monstrous bodies for our colleagues.

Some of us leapt off fences; convinced we could, if only we tried hard enough, to fly. These memories became our first motivations for an interdisciplinary research and development of an interactive and immersive art installations.

Our two key areas of interest are Biomimetic and Inhabitation. We draw from biology as a material and inspiration for designing artworks by exploring its unique properties and exploring processes of “*nature*” and radically different ways of being, such as imagining how bees see, how bats taste, how vines might sense the fence they wind around.

What motivate our artistic practice are interests in the synthesis of life-forms and materials that possess life-like properties and affordances. The challenge is how to create an aesthetic openness in which art, life, play, and computation momentarily cohere, akin to fascinating, sublime experiences of nature. In fact this is not a new goal, John Dewey in his book *Art as Experience* called for “*recovering the aesthetic experience with normal processes of living*” [4].

## Background, Concept and Theory

### What is Life?

In order to create evocations of nature-like experiences, and aesthetic experiences that involve human and non-human life-forms, one needs to not only understand and study “*natural phenomena*”, in traditional ways, but one also needs to study in other ways; that is, *to be* and *to be with* non-human life-forms. This implies the expansion of the artists’ task — from representing the way nature looks, to expressing and evoking in the manners of how nature works. “*Nature*” has been one of the most powerful sources of inspiration; however, our contemporary notions of nature reinforces our habits of assuming that we are outside of it, more distant from what humans paradoxically see as the original creative force. Therefore, in studying and observing non-human life-forms, we believe it is necessary to be with them in ways that may open our experiences from observing and “*interacting*” with them as still-separate, other beings, — and to nurture alternative ways of being with non-human life-forms.

The question of what life is has been a primary preoccupation for scientists and artists since ancient times, yet no single clear answer is agreed upon as satisfactory by all [9]. Contemporary accounts of life usually include such characteristic features as growth and development, reproduction, evolution and adaptation, responsiveness and autonomy, metabolism, self-organization and emergence [19].

For any explanation of life to be useful for the artists who engage in creating with inhabitable life-forms, that explanation must, in some way, be capable of coping with ways of thinking and being that are also required by an aspect of their medium; in this case, for example, that aspect is a model made by computer-generated prototyping. Computational language may indeed seem antithetical to

our enterprise, but at the same time, it makes evident that even computational prototypes must allow levels of sensitivity, adaptation and responsiveness; accompanied by design methods where complex relationships can be analyzed and refined as part of exploratory processes [14].

### Bio-Art

Bio-Art is art composed partly or entirely of living, non-human organisms, and/or art created in association with nonhuman organisms, remains in common use as stated by Capucci, Torrani and Gessert [10]. It crosses the line between the scientific domain and the domain of art and it may touch the border between the living and the nonliving therefore it has transcendence boundaries.

Bio-Art is a new direction in contemporary art that explores the processes of life. Thus, it is frequently deployed as one approach to generate and express Synthetic Life. Invariably, Bio-Art employs one or more of the following methods to address how life is brought into real world contexts and how to seek the meaning of life through such interactions with the world [5]: “(1) *the coaching of bio materials into specific inert shapes or behaviors*; (2) *the unusual or subversive use of biotech tools and process*; (3) *the invention or transformation of a living organism with or without social or environmental integration.*” Bio-Art emphasizes the dialogical and relational (such as cell interaction, interspecies communication, and so on) as much as the material and formal qualities of art (such as shapes, colors and patterns,) [5]. Contrary to traditional art, which generates and produces objects, crafts, or environments, Bio-Art focuses more on its “*core materials*”, which means the organism’s development and species’ evolution.

### Boundaries of living and nonliving

Are there categories of life? Biologists would answer yes, presenting the whole discipline of taxonomy. However, as regards ethical issues such as the moral status of natural or artificial life, the boundaries must be drawn somewhere other than simply between species.

As Christian Martin [2] points out “*life*” is not a merely descriptive phenomenon but also includes a normative component. He suggests a differentiation of the term *life*<sup>1</sup> into three steps: (1) “*mere life*” (2) “*prereflexively self-conscious life*” and (3) “*reflexively self-conscious life.*”

Even in biology, there is no satisfactory definition of life. Most attempts to describe what life is are limited to a list of functional features of life [17]. Therefore it is hard to define a boundary between the living and the nonliving, even from a scientific point of view.

### Disciplinary Boundaries

Bio-Art is a new direction in contemporary art that explores the processes of life. Thus, it is frequently deployed as one approach to synthetic biology, which challenges

<sup>1</sup> The prototype for mere life is that of single-cell organisms, whereas self-conscious life encompasses the experience of a “*self*” in the form of pain. Reflexive self-conscious life entails understanding, judgment and the ability to conclude [2].

biotechnology by applying engineering principles in biology. Synthetic biologists intend not only to understand life better but also to utilize it in applications to minimize and optimize, to variegate and transcend life, to design and to standardize it.

A fundamental trait of synthetic biology is its interdisciplinary character. To be able to deal with the complexity of biological systems, synthetic biology crosses disciplinary boundaries. So does bio-art which, crosses not only disciplinary borders within science but also the line between science and art.

## Related works

Invariably, Bio-Art employs one or more of the following methods to address how life is brought into real world contexts and how to seek the meaning of life through such interactions with the world [5]: “(1) *the coaching of bio materials into specific inert shapes or behaviors*; (2) *the unusual or subversive use of biotech tools and process*; (3) *the invention or transformation of a living organism with or without social or environmental integration*.” Bio-Art emphasizes the dialogical and relational (such as cell interaction, interspecies communication, and so on) as much as the material and formal qualities of art (such as shapes, colors and patterns,) [5]. Contrary to traditional art, which generates and produces objects, crafts, or environments, Bio-Art focuses more on its “*core materials*”, which means the organism’s development and species’ evolution.

In exploring the journey of life and synthesis of life, while certain artists experiment with plants (e.g *Streptocarpus hybrid* by Gessert, 2002), other groups look into “*tissue culture*” (e.g *Digital montage* by Catts and Zurr, 1998), some might also follow the coupling of the organic and inorganic, or the living and the machine (e.g *Victimless Leather* by Oron Catts and Ionat Zurr 2004). Some might look into biological systems of self-organization and collective decision-making, and the process of achieving dramatically varied results with very small alterations in an initial settings. (e.g *Objectivity* by Bar-Shai, 2007) and some might use the living organism as new material for design of inhabitable aesthetics (e.g *Alive: New Design Frontiers* by ecoLogicStudio) [5].

In our work, we adopted the third approach (*the invention or transformation of a living organism*) during the process of designing algae and its behaviors, precisely because it works in the living, from a single cell to a mammal. Such synthesis uses the properties of life and its materials, changes organisms within specific species, or invents life with new characteristics.

We believe that Bio-Art is not simply about creating metaphorical representations of scientific concepts — it is about using actual scientific techniques, creating hybrids and manipulating live organisms. As Eduardo Kac stated: “*After the age of robotics and digital technology, the new*

*media is biotechnology*” [4].

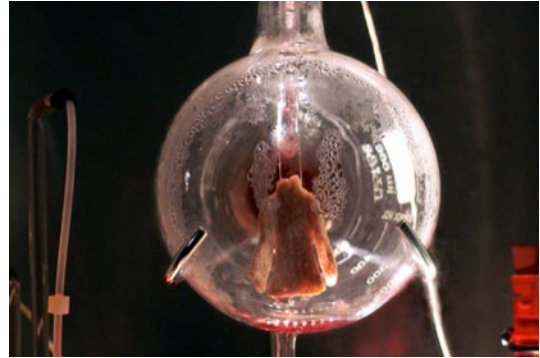


Figure 1. The Tissue Culture and Art project (Victimless Leather), led by Oron Catts and Ionat Zurr, have used tissue culturing in art. Their work features the semi-living: animal cells (which have included frog, human, pig, and mouse cells) that live and grow within bioreactors. The series is an ironic commentary on the positivist promises of growing leather and meat in a vat, without the ethical murkiness of having to kill an animal [5].

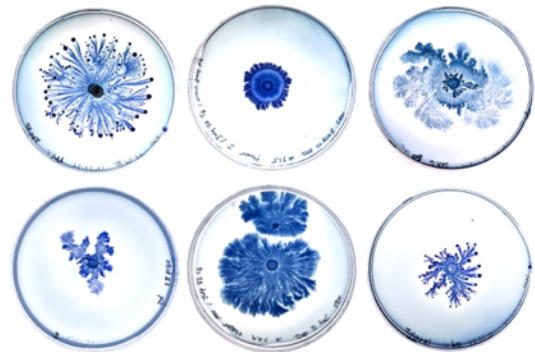


Figure 2. Nurit Bar-Shai’s Objectivity [tentative]. The work explores the network and communication systems of *Paenibacillus vortex* bacteria. It explores the intersection of Art, Science and Technology. Using various settings to visualize the “chemical tweets” of microorganisms as beautiful and rare image patterns [5].



Figure 3. *Alive: New Design Frontiers* is an interactive / living environment installed at the EDF Foundation in Paris. Its morphology emerges from the reinvention of one of the archetypes of architecture, the column; imagined as a living and responsive organism, a photobioreactor of microalgae, ecoLogicStudio [24].

## Creation of the artwork

### Art as it could Be

To create the aesthetic relationship between living and nonliving, we gather interdisciplinary knowledge that supports the development of an analog computation to study biological behaviors within digital computational systems, including such processes as growth and evolution. This strategy of making possible complex phenomena by simulating simple components is known as a “*bottom-up*” approach [1].

A consequence of a “*bottom-up*” approach may be uncertainty regarding the outcome, but proponents of Artificial-Life are interested in the multiple phenomena that emerges from biologically-inspired artificial processes, even if the results have no direct counterparts in the natural world: an ecology of possible life made or orchestrated by humans rather than by nature. Langton characterized it as “*life as it could be*”, in contrast to “*life as we know it*” [7].

The study of “*life as it could be*” has cultural importance; it implies a movement from an anthropocentric view toward regaining a balance with a cosmocentric point of view. This means that humans become one of many possible intelligent beings in the universe, rather than the only one [7]. The suffix “*as it could be*,” indicates a shift in thought and experience beyond the immediately apparent to the imaginable and possible: this lies at the heart of exploratory aspects of our artwork [8].

Our tendency is to find consummation in our experiences, to integrate or crystallize the loose ends of expectations and anticipations into an aesthetic experience. However, we believe that art capable of stirring our usual conceptions in ways that do not fully resolve into an easy experience and understanding has its own merits, ones that may persist beyond the initial experience with an artwork. One may be disturbed, delighted or struck with awe or disgust by participating with an artwork. Such an experience may reflect intensified emotions, and may be remembered as significant. An aesthetic experience is made of the same “*material*” as experience in general, but is intensified, without being arrested, diverted or distracted; “*Then and only then is it integrated within and demarcated in the general stream of experience from other experiences*” [4]. Life is not an uninterrupted flow, but has a distinct rhythm; Art also follows this principle (regardless of the medium), and those rhythms may be dissonant or sublime.

By deepening our knowledge of how nature works, and by questioning uneasiness by redefining ourselves as nature, we can integrate life and art in the creation of speculative new worlds capable of engendering more powerful aesthetic experiences.

### The installation

*Grene Epiphytes* is an interactive-living installation emphasizing the sense of aliveness and implying continual changes in living things/organisms.

The morphology of *Grene Epiphytes* emerges from a

lattice system housing arrays of clusters filled with algae; a living and dynamic network that arc above and around our attention and senses.

The system employs a series of transparent tubings, which are knotted into networks of a mesh-like structure; these in turn form the bio-matrix, connecting floor to ceiling in an arch-like shape. Living algae is pumped through the textile-like mesh, soaking up the daytime sun. Through photosynthesis, the algae forms a continuum of growth, change and interaction from processes of photosynthesis to harvesting by humans. The tubes, arranged in a textile-like mesh become an inhabitable form not only for the algae, but for human participants as well. The transparency of the tubes, help in directing participant’s attention to the living forms and processes of the algae that temporarily “*house*” human participants. In this manner, the Spirulina algae are multiplied food for humans and other animals, co-producers of the very air we breathe, and in a way, keepers of time and transformers of light.

The overall shape of the installation offers an immersive experience for participants: an otherworldly space made of living biological substances and entities. Somewhat unexpected behaviors emerge in continuous motion and exchange in across differing time-scales.



Figure 4. Growing an algae culture and production of different colors with medium and nutrient changes in a lab setting (to test the changing color behavior in exhibition).

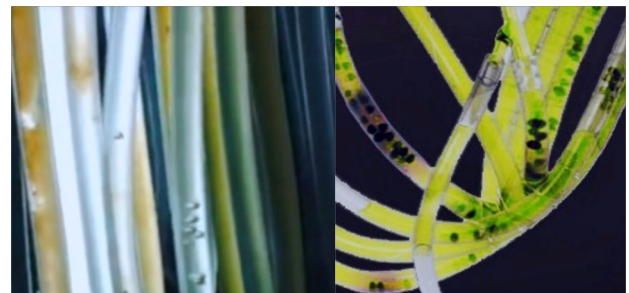


Figure 5. Fidelity prototype of the *Grene Epiphytes* concept using tubings filled with blue-green algae.

### The Algae

Microalgae, like any other plant, when grown using sunlight, consumes (or absorbs) carbon dioxide (CO<sub>2</sub>) and as they grow, releasing oxygen (O<sub>2</sub>) and Biomass (lipids-natural oils).

The flows of energy and growth pattern in *Grene Epiphytes* responding and adjusting to weather patterns and participants movements during the exhibition. With more direct sun, for instance, the algae photosynthesize and grow more intensively; thus transparency, variant colors and the growth are some of the “products” of this complex set of relationships among climate, micro-algae, participants and the synthetic control system.

The bio-matrix hosts blue-green microalgae organisms (Spirulina) embedded with ambient light, sensors, actuators and a programmable virtual interface. Flows of energy (natural glowing light in dark), matter (biomass, carbon dioxide) and information (participants behaviors and movement) induce multiple mechanisms of self-regulation and evolution of novel forms of self-organizing algae during the exhibition.

The life of this hybrid organic system tries to marginalize Wilhelm Reich’s idea that “*all plasmatic matter perceives, with or without sensory nerves. The amoeba has no sensory or motor nerves, and still it perceives... The terror of the total convulsion, of involuntary movement and spontaneous excitation is joined to the splitting up of organs and organ sensations. This terror is the real stumbling block...*” [18].

## Why Algae?

It is now time to overcome the separation between technology and natural phenomena, to embrace its fuller potentials and genius across the multi-levels of design and everyday life. In this artwork, the boundaries between the materials, spatial and technological dimensions have been carefully articulated. The goal is to experiment the notion of hybrid space and the boundaries of living and non-living and to introduce and illustrate one of the natural sources of energy on earth and its efficiency, flexibility and beauty.

Algae are the fastest-growing organic material on the planet (ten times faster than trees). Some species double their volume every 6 hours. Compared to some of the plants that humans grow, microscopic Algae’s yield per hectare is considerably higher than that of sunflower or rapeseed. Moreover, microscopic algae are a group of relatively simple organisms that capture the energy of light through photosynthesis, using it to convert inorganic substances into organic matter. Perhaps most surprising is that while humans in industrial mindsets see algae’s potential as a form of energy which may replace petroleum (oil), it is also a food, but a food not commonly consumed as other animals do (whales, shrimps, flamingos). Rather, it is packaged and sold as tablets (e.g boosting the immune system, improving memory, increasing energy and metabolism). That algae, then, is not used as a form of common, widely available food, full of anti-cancer properties and so high in nutrients that it would outstrip the so-called “superfoods” is curious.

## Conclusion

This artwork is intended to reveal the evolving beauty and complexities of a life-form we regularly take for granted and dismiss on the one hand, or to a much lesser extent, revered as a new raw “superfood” (in encapsulated form) on the other hand. *Grene Epiphytes* creates ways in which algae transform in our imagination from an annoyance that clouds our ponds and pools to an immersive environment that reveals its own responsiveness to our changing climate and movement of participants. Also the artwork enables complex understandings of its responsiveness and of mechanisms that transform light into the invisible ether we breathe. It emphasizes the many ways in which easy definitions of ‘the virtual’ and ‘the physical’ are problematic categories that cannot be maintained, and provokes speculation more on direct experience rather than on abstract concepts of creativity and beauty, and of nature and design. In these and other ways, *Grene Epiphytes* expands recognizable art-forms into more specular experiences of “art as it could be” [8].

## Contribution

This research contributes to emerging interests in Bio-Art, nurturing ways that humans and non-human life-forms may explore the inhabitable moments when their perspectives, needs and relations collide and collude. Implicitly, participants are asked to ‘a-volve’ their imagination and notions of life and evolution as they immerse themselves in physical, intellectual and emotional dialogues with the work. Artwork such as this may also facilitate diverse forms of interaction and alternative understandings among the art, computer science, life sciences and scientific communities. Ultimately, *Grene Epiphytes* may encourage artists and their public participants to further seek out informative resources and multiple engagements with this fascinating form of art.

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Mahsoo Salimi is a PhD student under supervision of Dr. Diane Gromala at School of Interactive Arts and Technology (SIAT), Simon Fraser University. Her doctoral project is about Bio Robotic Architecture and Immersive environments.

Before joining SIAT she was a research fellow at Terreform ONE, working under supervision of Dr. Mitchel Joachim and Maria Aiolova. During almost 6 month residency at Terreform ONE she was part of a collaborative team for BioWall exhibition series: Venice Biennale International Architecture Exhibition 2014, Biodesign exhibition (NAI) in Rotterdam and OCAD gallery University of Toronto. During Spring 2013 she was a Visiting Scholar and Research Assistant at Professor Nikolaus Correll Lab at the Department of Computer Science at the University of Colorado with focus on swarm robotics and smart materials. She received her Master of Architecture from University of Colorado, where she has started the research on Biomimetic as inspiration for architectural design.

#### Diane Gromala:

Prof. Diane Gromala is the Canada Research Chair at Simon Fraser University in Canada. Her research works at the confluence of computer science, media art and design, and focuses on the cultural, visceral, and embodied implications of technology, particularly in the realm of pain. Gromala's insistence that her theoretical work is tested in fleshy, messy, meaty milieu results in work that tends to raise and wrinkle brows. She misspent her youth in the 1980s working in the Silicon Valley, mostly at Apple Computer.

#### Xin Tong:

Xin Tong is a MSc student under supervision of Dr. Diane Gromala at School of Interactive Arts and Technology, Simon Fraser University. She holds a Bachelor of Engineering degree from Beijing University of Posts and Telecommunications. Her graduate research concentrates on how to alleviate chronic-pain patients' pain on the basis of developing Immersive Virtual Environments. Her work focuses on Virtual Environments body interface and wearable technology, and interaction design.