PROJECT

Biological-Imaginations for the Biscayne Bay Estuary

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INTRODUCTION

Which kind of imagination do we need to rethink Miami in the advent of sea-level rise? Most of the South Florida region was a subtropical wetland until just 120 years ago. In the land natives called Pa-hay-Okee (grassy river), we build a 20th-century industrial sprawl and completely transformed the ecology of the region by altering significant parts of the wild into rural. This is not an isolated story for South Florida. Today more than 50% of living organisms, plants, and ecological systems in the world are determined by human industrialization.

The latest IPCC and UNEP reports show that we are quickly arriving at points of no return in the warming of our planet. The 2015 Paris agreement based on emission reduction will not be able to reduce global warming in time and the temperature in the arctic is already locked-in to rise to 3-to-5 C by 2050. When we architects look at ways to mitigate climate change we tend to go back to just slightly improved technologies with which we created the emergency. We are in a crisis of imagination! This project attempts to reimagine Miami, we develop a speculative vision/plan for the Biscayne Bay estuary that envisions infra-structures in Biscayne Bay that grow by themselves using synthetic biology.

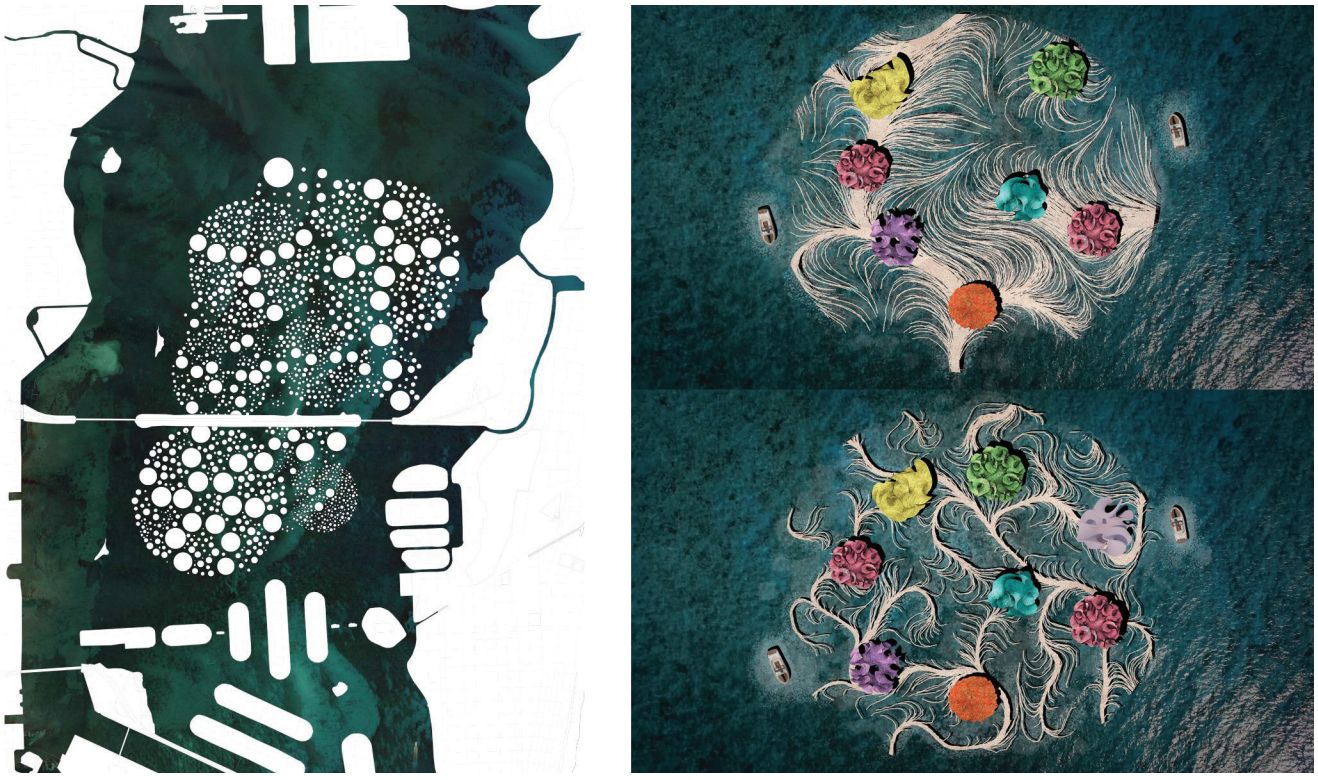

Figure 1. The proposal envisions a series of islands that grow in Biscayne Bay by reengineering cyanobacteria. A biological circuitry allows cyanobacteria to capture carbon dioxide in the water via photosynthesis and transforms it into finely layered rock material. The process is similar to the living stromatolites that were abundant in the Precambrian age. Cyanobacteria created the earth's atmosphere. Left image: Site plan, 2018. Right image: a project by Daniela Romero & Solange Salinas (Alfredo Andia Design 8 Studio, FIU, Fall 2019).

Figure 2. Top Images: desalinization, absorption, and retention tower that follows the process of growth via aggregation through a semper's knot weight distribution; a project by Renzo Lopez. Middle images: self-folding synthetic plant based on the design structure of a stellate mesh; a project by Judith De Rojas. Bottom images: Spa-structure made of a soft cellular skin-membrane around a skeleton structure; a project by Daniela Zerrate & Alexander Bahensky, background model by Andrew Guzman (Alfredo Andia Design 8 Studio, FIU, Spring 2018 & Fall 2019).

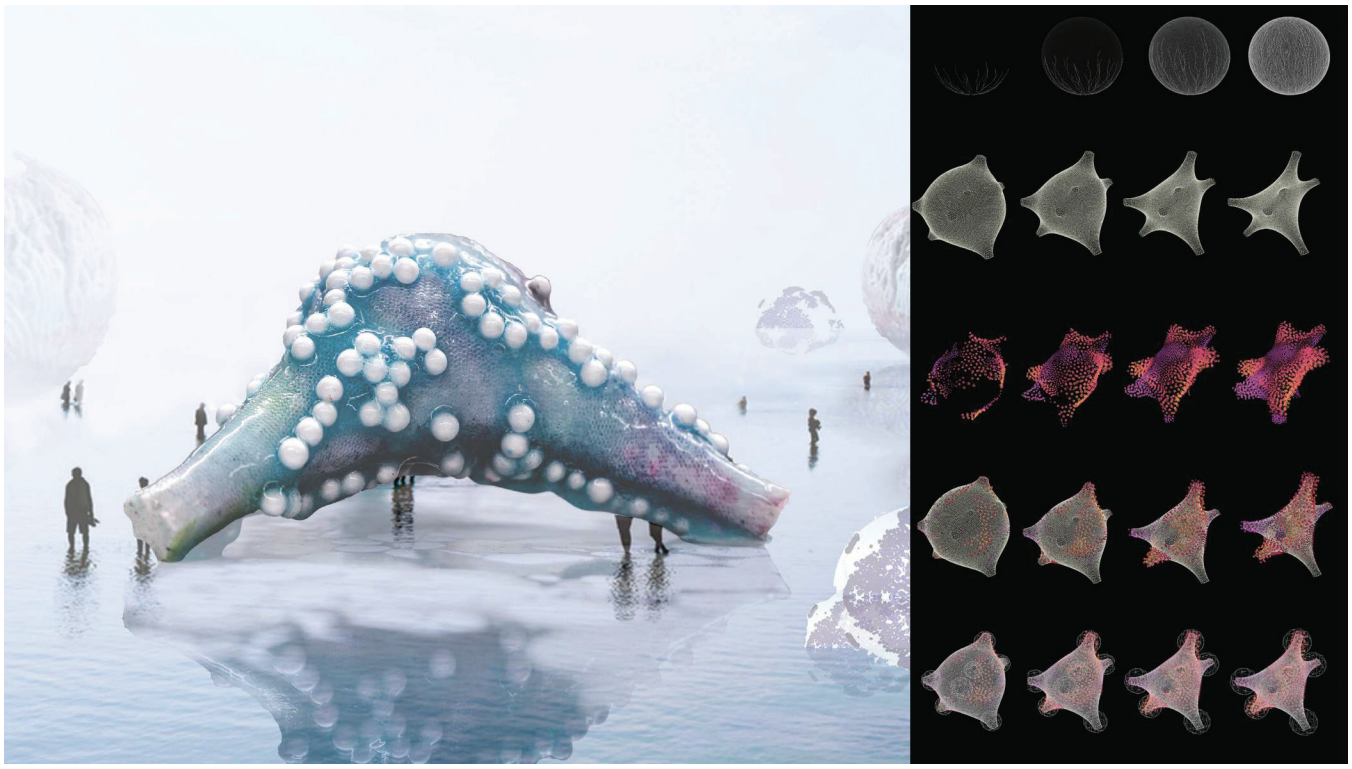

Figure 3. The goal of this transgenic biomes scheme is to allow its inhabitants to connect with a fragile synthetic nature. The project works with the embryonic development of membrane-structures and particle aggregation. Images: a project by Vanessa Osorio & Lina Sarikhani (Alfredo Andia Design 8 Studio, FIU, Fall 2019).

NATURE AND BIOLOGY

As our planet changed so did the field of Biology. The Biology of the 1800s was based on voyages into the wild that lead to the immortalized "theory of evolution" by authors such as Darwin and Wallace. By the 1900s biological studies began to move away from natural environments into labs that began to study the principles of life which obtained a major breakthrough with the discovery of the "DNA structure and function" in the 1950s. By the last decade of the 20th century the genetic branch of biology began to gather traction as DNA reading (DNA sequencing) and DNA writing (DNA synthesis) know-hows propagated aided by the accelerated power of computers.

SYNTHETIC BIOLOGY (SYNBIO): GROWING BY THE POWER 10

In the past decade, SynBio has surfaced as the fastest growing technology in human history. SynBio involves emerging techniques that allow us to design, edit, and engineer all kinds of living organisms. Today we can manufacture molecule by molecule: lab-grown meat, bio-grown leather, milk, wood, plants that do not need fertilizer, fuels, fragrances, fabrics, novel pharmaceuticals, and even age-reversal techniques, which has already been proven in mice in laboratories at the Salk Institute in CA. Synthetic Biology was officially born in 2006, but it is growing by a factor of 10 times per year, compared it to computer technology that is rising at a factor of 1.5 times per year. [1]

FROM A MAKER COMMUNITY TO DESIGN ENVISIONING

The SynBio community emerged as a "maker" movement in the 2000s around the IGEM student competition, the Biobrick foundation, and the emergence of CRISPR Cas9 in 2013. A significant number of the earlier pioneers of SynBio derived from engineering and computer science. They were interested in "making" or "manufacturing" life rather than understanding the principles of life which controlled the ethos of traditional biology. [2] Today, as the first generation of SynBio matures into disrupting major industries it is also a time to begin to question if these narratives are only about industrializing biology for a profit? A new generation of narratives is emerging in the SynBio diaspora that searches for a deeper integration with design and art communities. [3] The work we present here is in the direction of that integration.

BIO-CITIES

How can SynBio alter our infrastructures and cities in coastal communities vulnerable to sea-level rise? In this project, we visualize a series of islands and buildings in the estuary of Biscayne Bay which grows by using living matter. Based on previous research on a gene circuitry that uses bacteria that

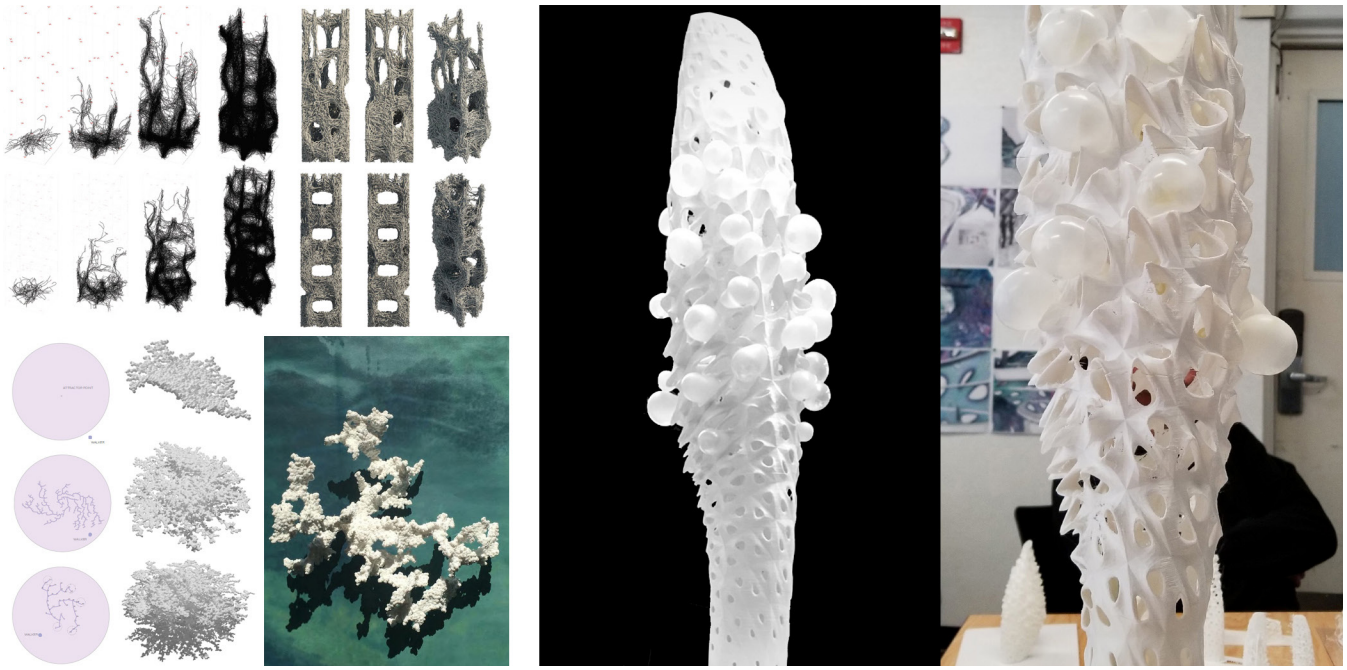

Figure 4. Top left images: physarum polycephalum shortest path towers by Martha Morales. Bottom left images: diffusion limited aggregation project by Van Le. Right images: bioengineered plant tower by Allison Tapia (Alfredo Andia Design 8 Studio, FIU, Spring 2018 and 2019).

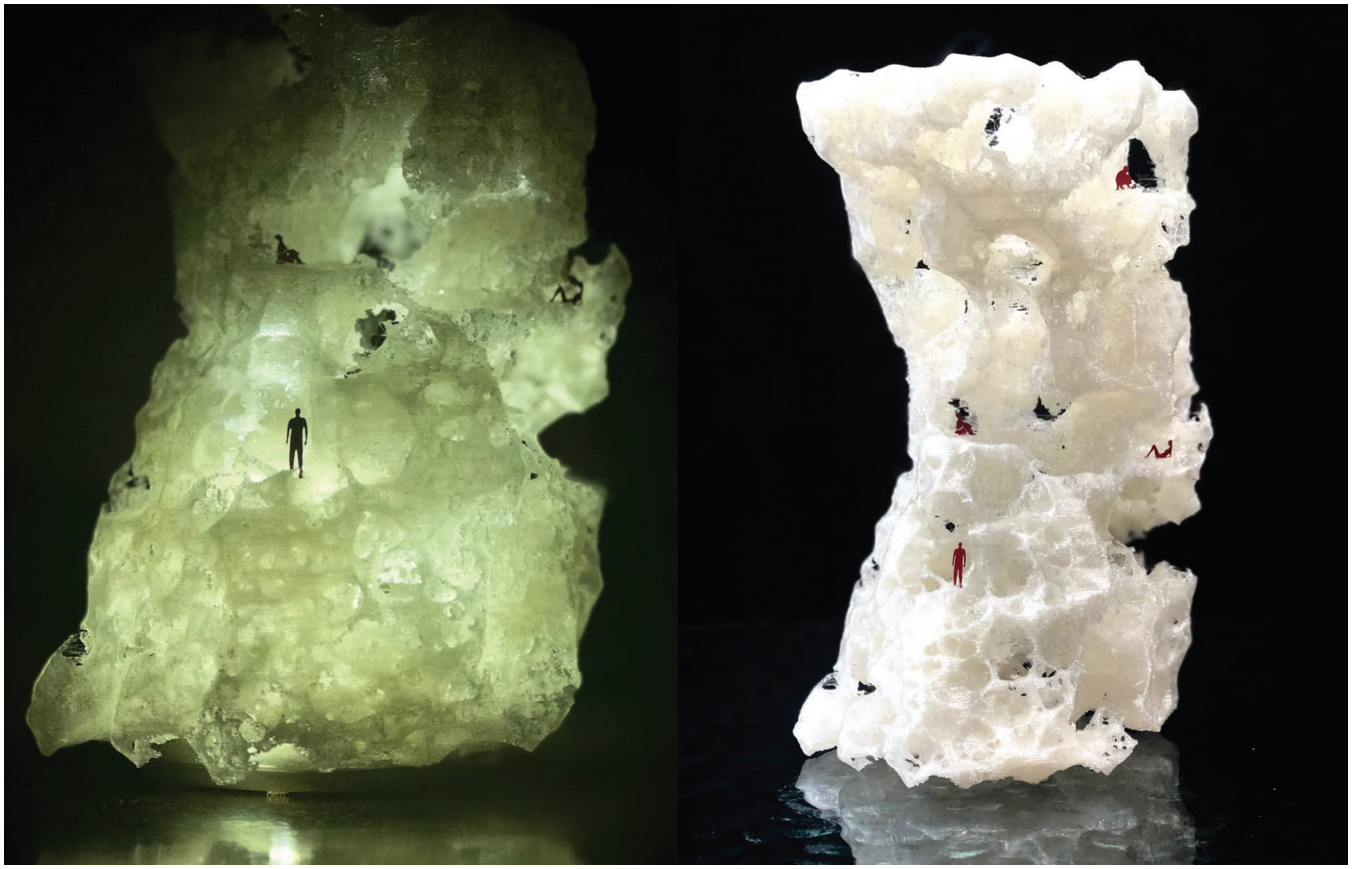

Figure 5. A living structure inspired by the process of secretion of calcium carbonate in corals. Image: project by Rosanna Rodriguez (Alfredo Andia Design 8 Studio, FIU, Spring 2019).

Figure 6. Various working prototypes models. Images: several design studios at FIU.

has the ability to precipitate calcite to solidify sand we envision the growth of a series of islands over the shallow Biscayne Bay as a way to create a "living shoreline" for relocating populations from Miami threatened by sea-level rise. These growing territories will have increased soil pressure that will self-transform according to the levels of rising seas. The proposed system of islands works like atolls that will create defenses from currents and surges.

The infrastructures above the islands are designed for living, entertainment, work, food production and functions such as water desalination. Synthetic Biology has the possibility to make living matter fully programmable. In this project, we try to challenge our imagination and move more deeply into bio-aesthetics. We find the process very difficult to visualize with traditional architectural methods and thinking. One of the main drivers is to observe biological agents that could activate spatial evolution and how our bodies will be augmented in a SynBio age. Each project we work on is developed based on particularly desirable condition, we study particular processes of growth, and investigate what makes an organism develop their shape.

TECHNOLOGY VS. FICTION

Fiction can be a taboo in architecture. The method of making in SynBio inhabits in a different epistemic space than traditional scientific discovery, by celebrating making synthetic biology has a deeper relationship with seeing, with envisioning. In this project, at first, we tried to find existing SynBio techniques. We studied processes that could produce quick methods and low-energy practices of biomineralization such as sporosarcina pasteurii bacteria, synthetic protein, and collagen to produce artificial bone materials, synthetic spider silk, and others. However, after conversations with several SynBio researchers, we were convinced that the next plateau of SynBio was envisioning, fiction, not just technology. A space in which the next generation of SynBio can begin to reinvent itself.

ENDNOTES

1. George Church and Ed Regis, *Regenesis—How Synthetic Biology Will Reinvent Nature and Ourselves* (New York: Basics Books, 2012).
2. Sophia Roosth, *Synthetic: How Life Got Mad* (Chicago: University of Chicago Press, 2017).
3. Alexandra Daisy Ginsberg, Jane Calvert, Pablo Schyfter, Alistair Elfick, and Drew Endy, *Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature* (Cambridge, MA: MIT Press, 2014).

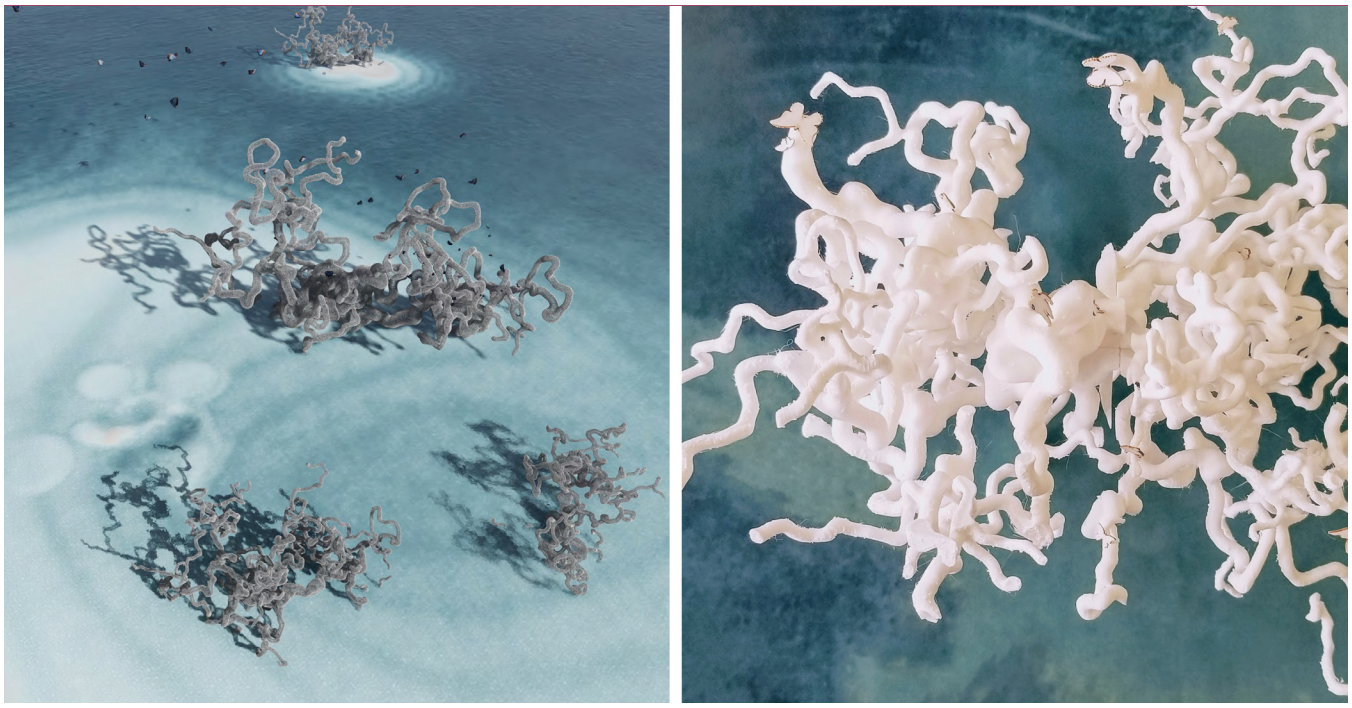

Figure 7. Branching organisms that support the habitats of specific species that migrate throughout South Florida. Images: a project by Stephanie Sampedro (Alfredo Andia Design 8 Studio, FIU, Spring 2019).

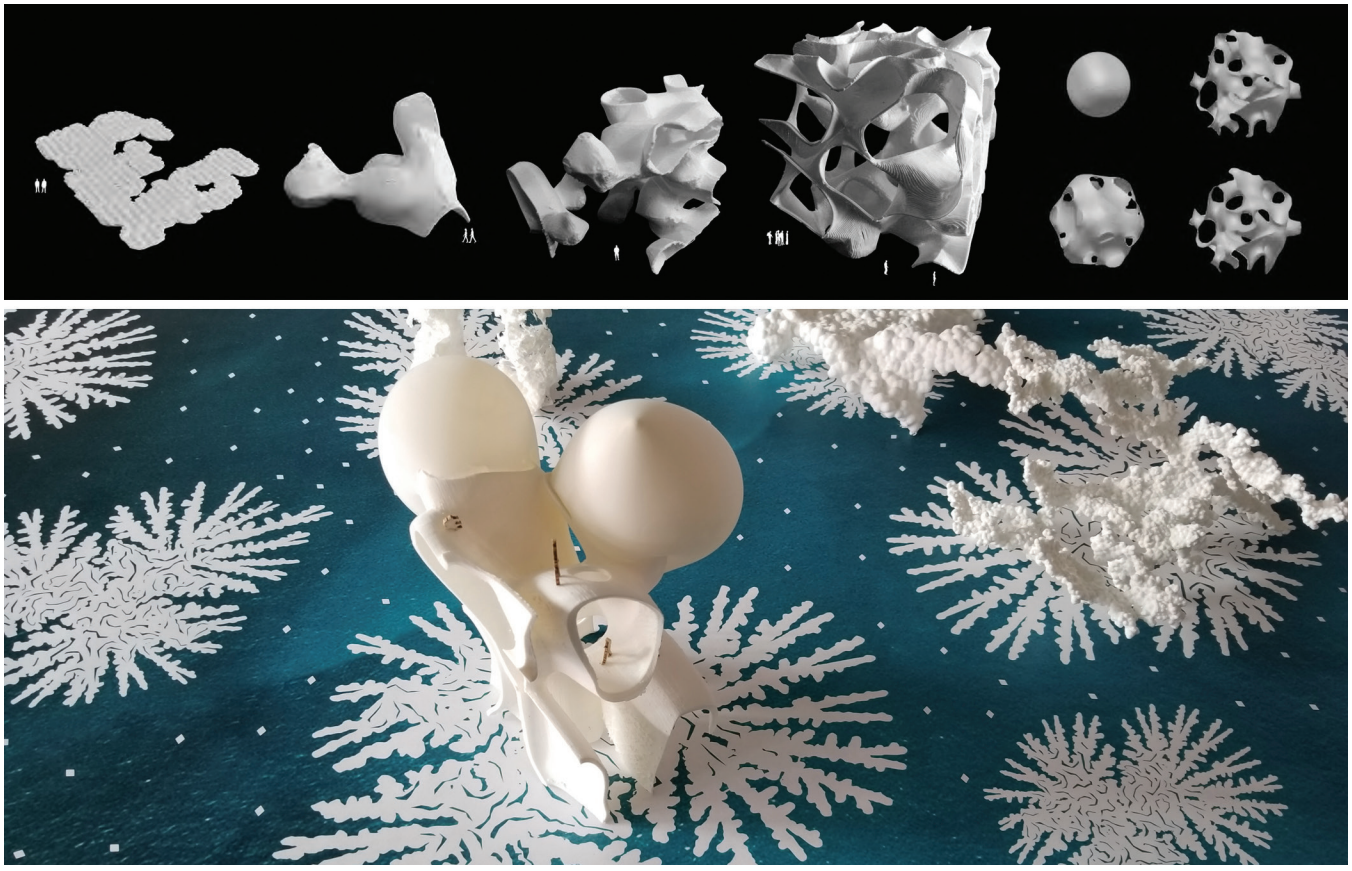

Figure 8. This project worked with the growth of programmable biological matter with artificial cell systems that communicate with each other using catenoid structures. Images: a project by Albert Giraldo (Alfredo Andia Design 8 Studio, FIU, Spring 2019).