Emergence *"Deep Star"*

By Lisa Moren, Artist
University of Maryland Baltimore County (UMBC), lmoren@umbc.edu

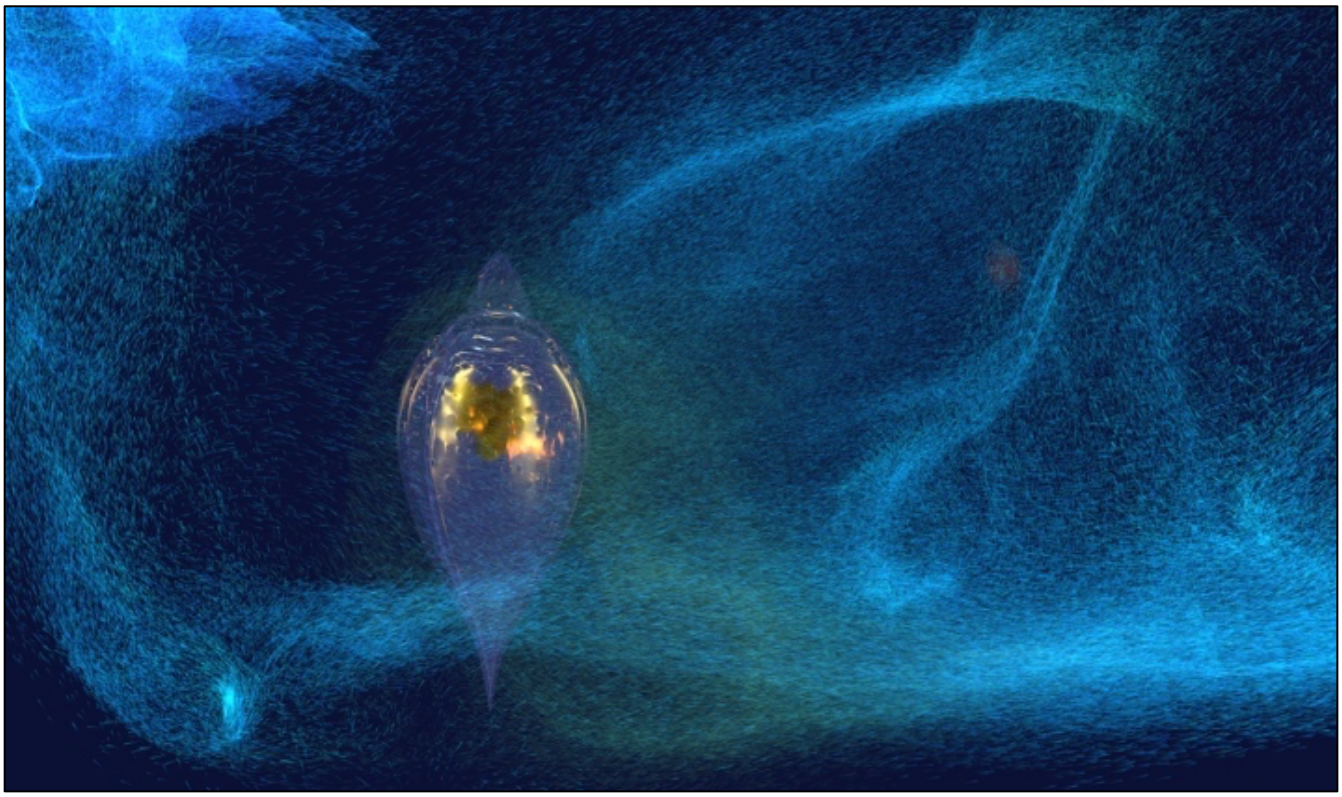

Figure 1. *"Under the Bay"* augmented reality (still) by Lisa Moren with Dr. Tsvetan Bachvaroff. Scene 03 \\ Chalky Faeries, 2022. Image shows a cropped Bay Nettle jellyfish with coccolithophores (the microbes responsible for chalk). The app allows the user to click and drag on the microbe to draw in chalk. Courtesy of the artist.

"Water is life" (Mní wičhóni) Lakota
"Water is the softest thing, yet it can penetrate mountains and earth." Lao-Tzu

Abstract

From water's ability to create and sustain life to its impact on the current global ecological crisis, its significance cannot be understated. I work with marine biologists who know how to solve marine ecological problems, but require a public who cares about our waters to fund their research projects. In my collaborations with marine biologist, Tvetan Bachvaroff, and computer programmers we create projects that engage the public with water, relative emergence, and the "umwelt" of marine species.

"Deep Star" is a multi-channel video and audio installation in live conversation with the Chesapeake Bay. In this work-in-progress the public is a complicit witness with Bay water, its patterns, flows, blooms and their significant influence on marine wildlife. In September, the Fells Point docks are teeming with scores of ignored bioluminescent ctenophore jellyfish that have co-developed in form and movement passively revealing the waters currents. "Deep Star" creates unique video, animations and sounds from critters both invisible (microbes) and visible, but are all often unnoticed.

To deepen the connection of marine forms interweaving with the complexity of water patterns, the project will stream in live data from sensors already in the Bay to the project. I'm working with the MD DNR and a software

engineer, where we transfer the live pH, oxygen, temperature, saline (salt), chlorophyl (microbes) and turbidity (clarity) data from sensors already in the Bay to the project. For example, working specifically with data from the Inner Harbor, the high oxygen levels will display a large *deepstaria* jellyfish. But when the oxygen is low, the jellyfish becomes small, or if it's really low or anoxic, the animation transforms into a plastic bag. In this way, many aspects of the video, 3d animation, and sound are affected by temperature, salt conditions, number of critters, etc. making *Deep Star* an undulating multi-channel story that changes over time and seasons.

Related projects discussed here include "What is the Shape of Water?" (2020), the experiential reality and augmented reality (AR/XR) "Under the Bay" that includes the "Chamber of Wonders" installation (2022). These are part of a series of cross-species artworks aimed at diminishing human-centered exceptionalism. The marine collaborations began in 2019 when I was the inaugural Artist-in-Resident at the Institute for Marine and Environmental Technology (IMET). There, I met researcher and marine biologist, Dr. Tsvetan Bachvaroff, where he and I immediately shared a like-minded vision to develop a project that exemplified phenomenal exceptionalisms in micro-organisms.

Figure 1. *"Under the Bay"* augmented reality (still) by Lisa Moren with Dr. Tsvetan Bachvaroff. Scene 03 \\ Chalky Faeries, 2022. Image shows a cropped Bay Nettle jellyfish with coccolithophores (the microbes responsible for chalk). The app allows the user to click and drag on the microbe to draw in chalk. Courtesy of the artist.

Keywords

bio-art, data-driven narrative, live-data, senors, emergent strategies, emergence, Tao Te Ching, water, symbiosis, sentience, dinoflagellates, Chesapeake Bay, estuary, marine biology, microbes, media art, Lynn Margulis, Kathryne Hayles, Jane Bennett, Theodor Schwenk, data-driven music, philosophy.

Introduction

Figure 2. *"Under the Bay"* AR by Moren/Bachvaroff. Left: demonstration of AR in Fells Point, Baltimore; right: Beta testing of AR on Pier V, Baltimore's harbor, 2022. Courtesy of the artist.

For "Deep Star", the idea of "emergence" and "emergent strategies" has three influences. First it considers strategies in nature (including physics) that describe water phenomena that drives new emerging forms. Inspired by Octavia Butler, Adrian Maree Brown coined the term *"Emergent Strategy",*[1] as *"a framework for resistance that is rooted in the miracles of nature, decentralized, collective leadership, and personal, relational, organizational, and movement-wide transformation."*[2] The strategic focus was based in part on Brown's idea that anomalous strategies in nature can be a model for the benefit of human communities, from species longevity to social change. Secondly, two philosophers place the environment as the significant influencer from which human-made matter emerges. Jane Bennet details the vibrancy of inert matter that emerges symbiotically from its environment. She calls this "thing power." And in her argument towards the post-human, Katherine Hayle's describes that scientists have proved the existence of matter that's imperceivable to humans, but influential to human consciousness.[3] She describes this limitation of understanding through the "umwelt", a species-specific world view that is locked in by limited biological capacities. What humans intellectualize and the stuff we make is both extraordinary but also limited through the mechanics of our fixed biology. because our consciousness is influenced by our environment, the more stuff (matter) we make, the more we

[1] Brown, Adrienne Maree. *Emergent Strategy: Shaping Change, Changing Worlds.* Edinburgh: AK Press, 2017.

[2] Ritchie, Andrea. *Invisible No More: Police Violence Against Black Women and Women of Color*. Beacon Press; Reprint edition, 2017)

[3] Hayles refers to Ignacios Provencio's 1998 discovery of melanopsin, a photoreceptor found in certain amphibians, some mammals (especially nocturnal ones) including humans, but mostly found in reptiles, where species who possess this gene can perceive non-visual forms without being consciously aware of it. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC18217/

slip into a virtual existence that she calls the post-human. Therefore, species with a distinct, or overlapping "umwelt" may offer a glimpse into an objective world view not available to humans. The connections between environmental emergence, organic differentiation, and the umwelt, became the basis of this art, philosophy and science project.

Emergence, Emergent Strategies

Tsetso and I focused our creative research on three types of speciments. First, the eukaryote dinoflagellate, who are the ancestors to all plants and animals. With more than 20,000 dinoflagellate variations, and along with diatoms, they produce most of the world's oxygen, including more than the contributions from the Amazon rainforest. Secondly, species who's evolutionally emergence, directly or passively display attributes of the water's behavior. And finally, marine species who's biology or behavior displays non-human "umwelt."

The flexibility and diversity of Dinoflagellates have survived hundreds of thousands of years and will clearly outlive humans. Some energy-consuming examples include a 'gardening' dinoflagellate, the *Ornithocercus*, a single-cell organism who will host cyanobacteria in its upper basket-like shape, a strategy that not only stores nutrients for on-going consumption, but the chains of cyanobacteria itself re-produces creating a "fruit-on-the-vine-like garden." *(fig. 6)*

Diverse reproduction strategies also assist in species longevity. The dinoflagellate *Ceratium* can both cell divide and mate for optimum reproduction benefits. However, an identical *Ceratium* — of the same species — has two flagella because they had two parents that mated *(fig. 5)*

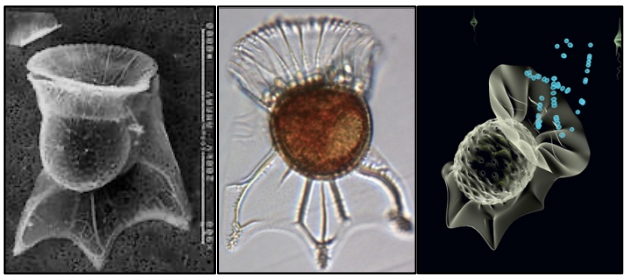

Figure 6. Left to Right: *Ornithocercus* SEM, *Ornithocercus* with a visible cyanobacteria 'garden.' *"Under the Bay"* AR (still) by Moren/Bachvaroff. Images courtesy of Dr. Tsvetan Bachvaroff and the artist.

Using these reproductive, and energy consumption strategies for hundreds of millions of years, will undoubtedly allow dinoflagellates to outlive humans.

Other strategies explored include uses of "organic differentiation"[4] in the structure of the cell walls of dinoflagellates (and many other species mostly notably exoskelatons and turtles). These complex organic forms, such as Voronoi patterns use less matter to produce structures that are lighter in weight than any objects human engineering could produce based on Cartesian principles in 20th c. manufacturing. Differentiation is best exemplified in the repeating hexagon pattern of a turtle shell, where the shapes repeat, but not perfectly. It's in that imperfection, crookedness, or wobble, that creates the greater strength with less matter. Organic differentiation influenced the largest 21st-century algorithmically designed and digitally fabricated architectural form in Seville, Spain, the Metropol Parasol.[5] The aerial view of architecture appears as a mushroom blooming throughout the grided city. This demonstrates how human behavior and movement shifts from meandering through the traditional city. The significance of human-made organic differentiation placed in the psyche of humans at a fairly large scale is interesting in this context because, according to Hayles, when we change our environment, we change human consciousness. *(fig. 7)* Just like the microbes the algorithms are mimicking, these crooked curves are stronger using less matter. More bluntly to this point is another architectural example is in Stuttgart, Germany where one of the algorithmic pavilion's is based on the exoskeleton of a beetle where the outcome was so strong and lightweight, it blew away.[6] *(fig. 7)*

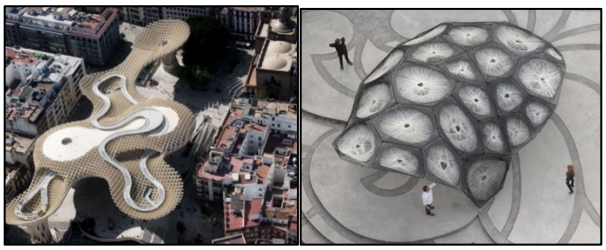

Figure 7. Left: Metropol Parasol, Seville Spain (aerial view), 2012. Photography by David Franck.[7] Right: ICD ITKE Research Pavilion, Stuttgart Germany (aerial view) 2013, Photograph by Roland Halbe.[8]

[5] https://www.setasdesevilla.com/

[6] https://www.itke.uni-stuttgart.de/research/icd-itke-research-pavilions/

[7] https://www.floornature.com/j-mayer-h-metropol-parasol-in-seville-7540/

[8] https://www.itke.uni-stuttgart.de/research/icd-itke-research-pavilions/ and, https://vimeo.com/99712339

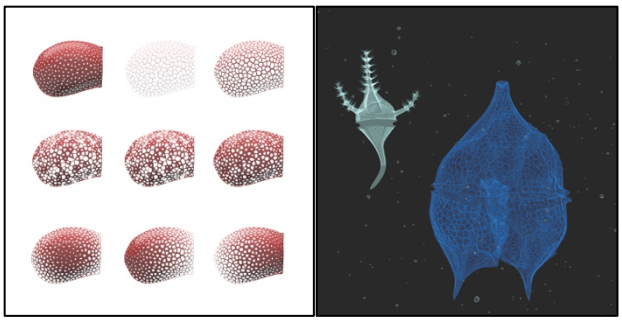

Figure 8. *"Under the Bay"* AR by Moren/Bachvaroff. Left: Voronoi tests, work in progress; right: Voronoi application, still from Scene 04 \\ Crooked Shelters. Courtesy of the artist.

Water Projects

To create a public project for an open house at IMET, Tsetso and I demonstrated the microbial strategy of making light through the bioluminescence of the dinoflagellate (*Pyrocystis*). Eventually, the public display was set up as a ceiling tank (hooked up to a Max/MSP, Arduino, and AV system) for the Light City Festival in Baltimore's Inner Harbor. The system worked with a voice-activated trigger so that when a participant spoke into a microphone, for example, *"What is the Shape of Water?"*[9] the millions of microscopic organisms in the ceiling tank answered the question in turbulent shapes of blue bioluminescence. Originally, this was influenced by the mesmerizing organic order and differentiation in the murmuration patterns of starling birds[10]. *(fig. 9)* However, Tsetso's colleague, Dr. Al Place who studies the motion behavior of dinoflagellates, says that the flocking behavior of the dinoflagellates will unlikely look as organized as the starlings. Instead, the water agitation produced turbulent patterns more akin to the wobble, the crookedness or what philosopher Jane Bennett calls *murmuring messiness*.[11]

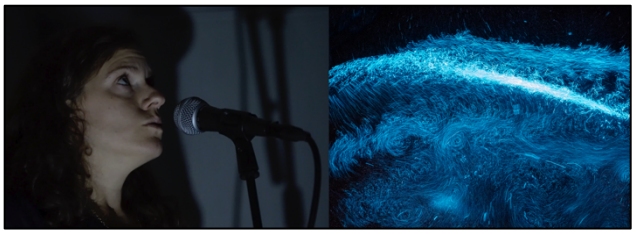

Figure 9. *"What is the Shape of Water?"* Left: vocalist Bonnie Landers, Light City, Nov. 2019. Right: Photograph (detail), Moren/ Bachvaroff. 16x16", 2019. Photography by Lisa Moren. Trailer.

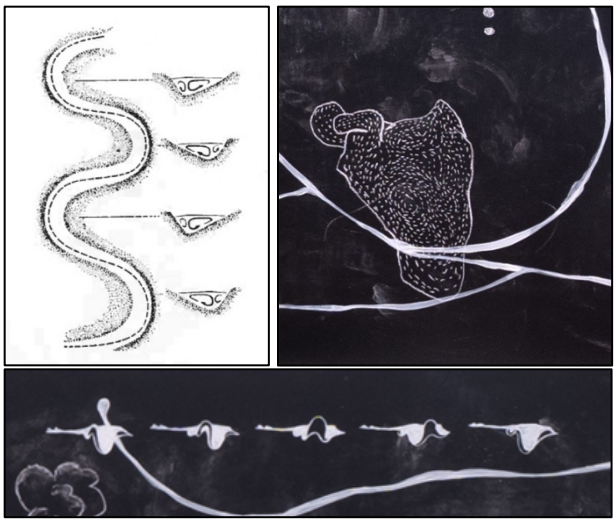

Figure 10. Above left: Illustration of a river with cross-sections displaying diverse piping attributes (such as temperature). Note how the attributes flip when the river undulates side to side. Image from Theodor Schwenk, *"Sensitive Chaos: The Creation of Flowing Forms in Water and Air"* 1967. Above right and below: *"Under the Bay"* (details), by Lisa Moren, Chalkboard installation, mixed media with AR. These show how water flow influences the shapes and movements of animal bones, cartilage and motion (see human scapula above right; and below the movement of rays mimicking the movement of waves they swim in). Images after Schwenk and courtesy of the artist.

After creating the AR project "Under the Bay" (trailer) [12] I began working on "Deep Star." This work in progress continues to work with the Maryland Department of Natural Resources (MD DNR) and the data from sensors already installed in the largest estuary in North America, the Chesapeake Bay. The 36 parameters potentially stream into the project from six Bay locations. While locations are from the Delaware border to Washington DC, the Eastern Shore of Maryland, and Baltimore City *(fig. 11),* I focused on Baltimore's Inner Harbor conditions of the Bay. The parameters pH, temperature, oxygen, salt, etc., effect the animation's color, speed, sound and scale. For instance, when the oxygen levels in the Bay are of good quality, the deepstaria jellyfish becomes large and inflated. When the oxygen levels dip, the critter deflates and is small, but if the water is anoxic, the images flips into a plastic bag. In this way, the story, images, and sounds change from day to night and season to season for an ongoing story influenced by the Bay water. The unpredictable variability of the incoming data becomes an authentic wobble created by the water.

[9] https://vimeo.com/372235650
[10] https://www.youtube.com/watch?v=LAQwEWqg0ug
[11] Bennett, Jane, and Connolly, William. "The Crumpled Handkerchief." *Time and History in Deleuze and Serres*, Bloomsbury, London, UK, 2013. Pp. 155.

[12] "Under the Bay" trailer by Lisa Moren with Tsvetan Bachvaroff, 2022. https://vimeo.com/796868197

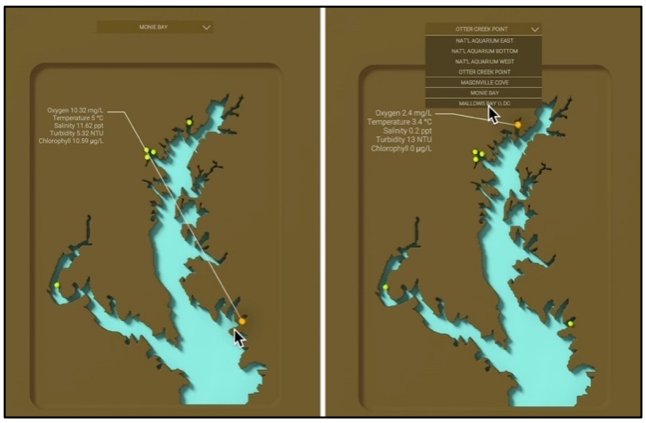

Figure 11. *"Under the Bay"* AR Moren/Bachvaroff. UI showing locations in the Chesapeake Bay where sensors allow water parameters to stream into the project. Courtesy of the artist.

Emergence and Water

The project propaganda in the trailer claimed the ambition of cross-species communication specifically "*What if we could hear what the water is saying?*" The project is focused on the life and consciousness emerging from the one's environment. For marine life, this is water. To imagine the significance of water, I'm borrowing from water physicist Theodor Schwenk, as I do in the AR "Under the Bay" project, but also Jane Bennett[13], who references Graham Harmon, Bruno Latour, and Michel Serres's *The Birth of Physics*.[14]

If we look at water as an object, we can argue that water is the largest object in the world. On the one hand, the ocean contains essential elements, H2O, saline, and other matter on the periodic chart. We know that water and gravity work together to form currents like pipes that braid in distinct patterns and that these flowing pipes separate into differing physical data such as speed and temperature. *(fig. 10)* These differences become visible when encountering an obstacle, like a rock in a river, where we observe differentiation in the water shapes bulging around the rock. Similarly, in the ocean, large and *"long waves travel faster than short waves"* [15] and overlap until the larger waves envelop the smaller ones, repeating the pattern endlessly. But these patterns are not perfect or predictable waves, their equilibrium billows, and exhales asymmetrically, and it's in that asymmetry that they wobble. Or, what Bennett calls an *"irregular bombardment of circumstances,"* especially when new physical elements act as an obstacle such as a rock. Here, the current billows and exposes its diverse temperatures, causing what Serres names a *"cauldron of turbulence that thickens into lumps of phenomena, and the bubbling swirl keeps those shapes upright… while the wobble produces variances of noise."*[16] A vortex is shape derived from the swirl that is both form and vibratory. To Serres, he calls this vibratory noise *"the fluctuating ado that is the strange substance of any discrete, differentiated shape,…* (where) *the multiplicity of the possible rustles in the midst of the forms that emerge from it… It is restless matter…*(a) *perco-lation."*[17] While much of this noise dies like seedlings that don't spawn, the intermingling currents and swirls that overlap with enough force allowing forms to sometimes emerge from it.

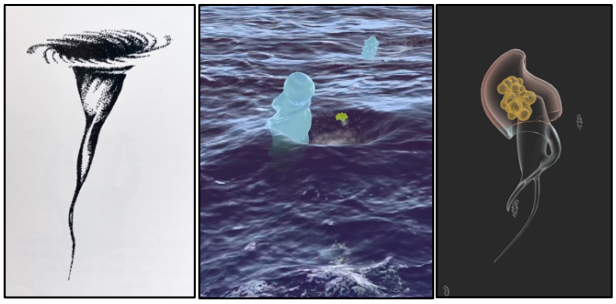

Figure 12. Left: Vortex funnel drawing by Theodor Schwenk,*"Sensitive Chaos: The Creation of Flowing Forms in Water and Air"* 1967, pp 44; center and right: *"Deep Star."* Stills of microbes expressing the negative spiraling shape of the vortex. Courtesy of the artist.

While we do not think of water as having agency, free will, or decision-making abilities or even that its elements are alive, in complex natural events, water does cause a multitude of events to happen, and is therefore an actant (Latour).[18] One of the most significant events that water enacts is sustaining and creating new life, but also emerging shapes, and unique forms. In this way, water will begin by initiating an abundance of events, such as a vortex or a whirlpool effect. Any time these elements react or effect one another, there is the potential for something to emerge, including new life.

The animated microbes that reflect Schwenk's organisms taking on the negative space of the vortex shape traveling in a reverse corkscrew spiraling up is animated in "Deep Star" *(fig. 12)*.[19] Therefore, when I say, "What if we can hear what the water is saying?" It's not that the water, as pure physical compounds, produces a will or agency that desires to be heard. However, water's natural environment has reactions, interactions, and relationships with other

[13] Ibid, Bennett, Connolly.
[14] Serres, Michael. *The Birth of Physics*. Rowman & Littlefield International, Ltd., 2018.
[15] Schwenk, Theodor. *"Sensitive Chaos: The Creation of Flowing Forms in Water and Air"*. Sussex: Rudolf Steiner Press, 1996. Pp 33.
[16] Ibid, Bennett, Connolly. Pp 157.
[17] Ibid, Bennett, Connolly. Pp 157.
[18] Latour, Bruno. "On actor-network theory. A few clarifications, plus more than a few complications." *Philosophical Literary Journal Logos*, vol. 27, no. 1, 2017, pp. 180.
[19] Ibid, Schwenk. Pp 44.

phenomena and other physical materials where unique consequences emerge as shapes, forms, beings, and blooms. Moreover, if we consider the incoming parameters of the Bay water and its data as a kind of alphabet the data does arrange itself to describe a story of the Bay water's emerging behaviors and forms. This communication is so hard for humans to understand, especially to predict — that when the data reflects the formation of an algae bloom, it's often too late to hear the water saying: *we are out of balance.* Perhaps we can imagine the data acting like a Google knowledge engine, an algorithmic code anticipating the user's thoughts when typing a partial phrase into the search bar while we wait for it to display our presumed burning questions. However, in this case, the data coming in from the Bay anticipates the presumed thoughts of the Bay water. The success of this water-communication system is so significant that the scores of MD DNR sensors we use to siphon the water-communication by the US Federal Government are funded solely to predict the emergence of algae blooms in the Chesapeake Bay. "Under the Bay" observes how the Bay ebbs and flows over time to create an emerging narrative driven by what the water is enacting as an emergence. I call this *murmuration messiness,* listening to what the water is saying.

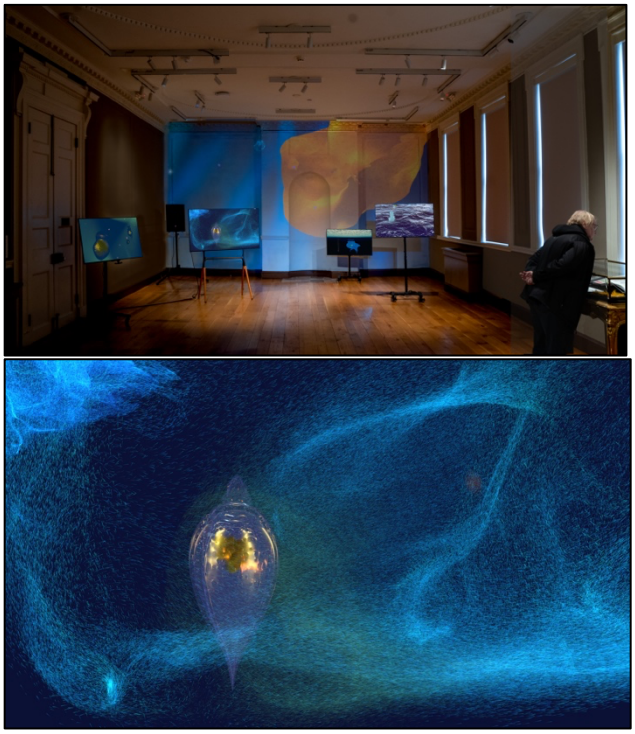

Figure 17. *"Deep Star"* by Lisa Moren. 5-channel installation, with live incoming data from Baltimore's Inner Harbor, original music by Dan Deacon, dimensions variable. Peale Museum, Baltimore MD, 2023-2024. Below: (detail) Still from monitor. Animated microbe that teeters, or wobbles, based on a low or high pH in the Harbor.

Production Team

Lisa Moren, Artist, Producer, Art Director; Dr Tsvetan Bachvaroff, Marine Biologist, Researcher and Data Anaylsis; Dan Deacon, Electronic Composer; Dr. Marc Olano, Co-Principal Investigator, Lead Programmer; John Boutsikas, Programmer and Developer.

Acknowledgements

This project is generously supported by the Saul Zaentz Innovation Fund at Johns Hopkins University and the R.W. Deutsch Foundation. This project originated during an artist-in-residence supported by the Institute of Marine and Environmental Technology (IMET), the Center for Innovation, Research, and Creativity in the Arts at the University of Maryland, Baltimore County (UMBC). We're grateful for the support from Maryland Department of Natural Resources; John Boutsikas for his API and AR development, Danielle McPhatter and Harvestworks DigitalMedia Art Center, and CAHSS. The exhibition at the Peale Museum was made possible by the Maryland State Arts Council.

Bibliography

Bennett, Jane, and Connolly, William. "The Crumpled Handkerchief." *Time and History in Deleuze and Serres*, Bloomsbury, London, UK, 2013.

Brown, Adrienne Maree. *Emergent Strategy: Shaping Change, Changing Worlds.* Edinburgh: AK Press, 2017.

Fishel, Stefanie R. *The Microbial State: Global Thriving and the Body Politic*. University of Minnesota Press, 2017.

Gibbs, Sarah P. "The chloroplasts of *euglena* may have evolved from symbiotic green algae." *Canadian Journal of Botany*, vol. 56, no. 22, 1978, pp. 2883–2889.

Hayles, Nancy Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics*. Univ. of Chicago Press, 2010.

Kahn, Douglas. *"Energies in the Arts"*. Cambridge and London: MIT Press, 2019, pp. 2–46.

Lao-Tzu; translated by Stephen Addiss and Stanley Lombardo; introduction by Burton Watson. *"Tao Te Ching"*. Boulder: Hackert Publishing Company, 1993.

Sagan, Lynn. "On the origin of mitosing cells." *Journal of Theoretical Biology*, vol. 14, no. 3, 1967, pp. 225–274, https://doi.org/10.1016/0022-5193(67)90079-3.

Schwenk, Theodor. *"Sensitive Chaos: The Creation of Flowing Forms in Water and Air"*. Sussex: Rudolf Steiner Press, 1996.

Spuybroek, Lars. *Sympathy of Things: Ruskin and the Ecology of Design*. Bloomsbury Academic, 2016.

Artist's Biography

Lisa Moren is a multi-disciplinary artist who works with emerging media, bio-matter, public space, AR and works-on-paper. She has exhibited at the Chelsea Art Museum, Creative Time, Drawing Center (New York, USA); the Peale Museum and Cranbrook Art Museum (USA); Ars Electronica (Austria), Akademie der Kunste (Germany), uShaka Museum (South Africa), and the Artists Research Network (Australia). She received the National Endowment for the Arts award, is a Senior Fulbright Scholar; a multi-year recipient of the Maryland State Arts Council, CEC Artslink International, and a Saul Zaentz Innovation Fellow in Film and Media at Johns Hopkins University. Lisa is also a Ruby's R.W. Deutsche Award recipient.

Lisa Moren's writing has appeared in Performance Research; Visible Language; Inter Arts Actuel; New Media Caucus for *"Algorithmic Pollution: Artists working with Dataveillance and Societies of Control"* and *"CYBER IN|SECURITY"*; and her books on *"Intermedia"*; and Issues in Contemporary Theory for *"Command Z: Artists Working with Phenomena and Technology."* Lisa Moren is a Professor of Visual Art at the University of Maryland Baltimore County (UMBC); and an Affiliate Faculty at the Imaging Research Center (IRC).