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# EMERGING STRATEGIES “UNDER THE BAY” IN AR/XR

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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 all the chalk in the world). The app allows the user to click and drag on the microbe to draw in chalk. Courtesy of the artist.

## Abstract

“*Under the Bay*” is an augmented reality project where anyone can use their cell phone like a microscope and reveal invisibilities in our world and marine life. When they do a series of animated stories between humans and non-humans emerge. Images, sounds, and stories are affected by live data streamed in from sensors located in the largest estuary in North America. Sensors in the Chesapeake Bay relay live pH, oxygen, temperature, etc. (figure 9). Similar to the water itself, color, speed, audio fluctuate with the water and marine life, making “*Under the Bay*” a data-

driven narrative with eight scenes that tell a story of a world beneath the marine surface, and the exciting but frail health of estuaries and oceans worldwide.

The two projects discussed here, “*Under the Bay*” (2022) and “*What is the Shape of Water?*” (2020), are part of Lisa Moren’s series of cross-species artworks aimed at diminishing human-centered exceptionalism.

The collaborations began in 2019 when Lisa was the inaugural Artist-in-Resident at the Institute for Marine and Environmental Technology (IMET). There, she

met researcher and marine biologist, Dr. Tsvetan Bachvaroff (Tsetso) and the two immediately shared a like-minded vision to develop a project that exemplified phenomenal exceptionalisms in micro-organisms. In this paper we argue that novel strategies in nature emerge when a complexity of matter is intermingled with conditions of differentiation. We explain and identify differentiation in art and architecture, symbiosis in biology, and the “wobble” in physics as core principles for new forms and creative strategies to emerge. The outcome is focused on the unusual and significant diversification of dinoflagellate microbes in the Chesapeake Bay and oceans worldwide.

Tsetso directed the live organisms, science and data analysis for the augmented reality project. Stories are written and told by Lisa, who produced and art directed the animation and AR scenes. The sound score is by electronic composer Dan Deacon. Dr. Marc Olano led the software engineering and development with John Boutsikas, for the AR app in IOS and Google Play.

### Keywords

Augmented Reality, AR, bio-art, data-driven narrative, emergent strategies, Tao Te Ching, water, symbiosis, dinoflagellates, Chesapeake Bay, estuary, marine biology, performance, microbes, media art, podcast, experimental narrative, bio-architecture, Lynn Margulis, Ted Nelson, Jane Bennett, Theodor Schwenk, data-driven music, philosophy.

### Introduction

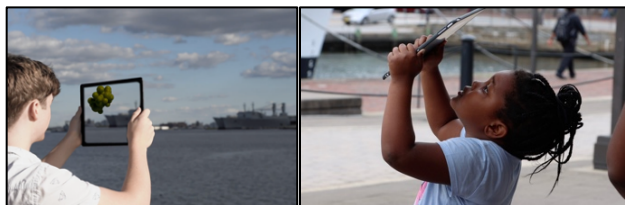


Figure 2. “Under the Bay” AR by Moren/Bachvaroff. Left: demonstration of AR in Fells Point, Baltimore; right: Beta testing of AR on Pier V, Baltimore’s harbor. Courtesy of the artist.

In our collaborative work, we borrow the idea of “emergent strategies” to consider strategies in nature that describe

<sup>1</sup> Brown, Adrienne Maree. *Emergent Strategy: Shaping Change, Changing Worlds*. Edinburgh: AK Press, 2017.

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

phenomena driving new emerging forms. Inspired by Octavia Butler, Adrian Maree Brown coined the term “Emergent Strategy”,<sup>1</sup> as “a framework for resistance that is rooted in the miracles of nature, decentralized, collective leadership, and personal, relational, organizational, and movement-wide transformation.”<sup>2</sup> We focused our strategies 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. Lisa’s second influence was her participation in a Taoist meditation group where she studied and meditated on the Tao Te Ching.<sup>3</sup> These meditations blended with her observations of nature, primarily [starling bird murmurations](#) described in **Scene 05 \\\ Lava Lamps in the Sky**. The connections between emergent strategies, organic differentiation, and a Taoist social order became the basis of this art and science collaboration.

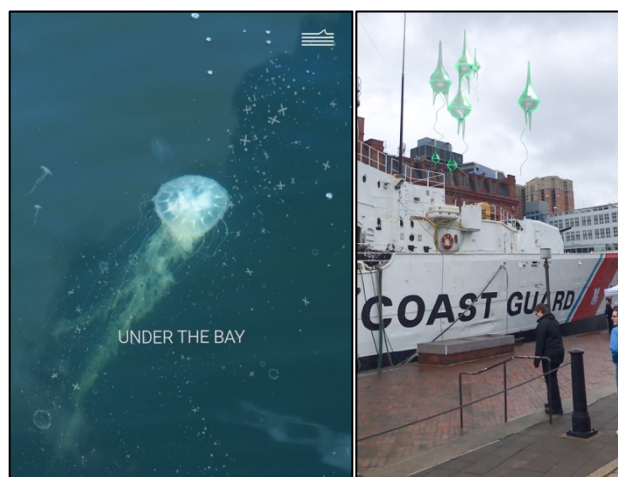


Figure 3. “Under the Bay” AR by Moren/Bachvaroff. Left: Still from splash screen with user interface (UI); right: still from AR **Scene 02 \\\ Water Moving Around My Fingers** at Pier V, Baltimore. Courtesy of the Artist.

### Emergent Strategies

We find the origin of strategic emergence by looking at gene evolution in early microbes. The Darwinian idea of natural selection has been combined with genome inheritance from two parents into what is now called the ‘modern synthesis’. While this synthesis has excellent explanatory power, some observations are not a perfect fit to this synthesis. For example, photosynthesis is scattered across multiple kingdoms, but the process of photosynthesis itself is unlikely to have been invented

<sup>3</sup> Lao-Tzu; translated by Stephen Addiss and Stanley Lombardo; introduction by Burton Watson. “*Tao Te Ching*”. Boulder: Hackert Publishing Company, 1993.

multiple times. The solution to this paradox required two steps (figure 4). First, Lynn Margulis in 1967 proposed that eukaryotes are a combination of two cells from different bacterial lineages. The first lineage is the archaea bacteria which engulfed another bacteria cell that contributes the mitochondrion. Mitochondria are responsible for the exchange of oxygen and carbon dioxide, eventually this will be the foundation for breath itself. The mitochondrion is then a ‘cell within a cell’<sup>4</sup>. This symbiotic combination of two previously distinct cells into eukaryotes created a new complexity of features (figure 4). The first scene in our project **Scene 01 \ Origin Stories**, describes that before Margulis, any scientific reference to a symbiosis hypothesis was taboo. To accept symbiosis, science had to imagine a scenario where a species swallows a giraffe’s eye to acquire longer eyelashes successfully, but then, they pass those eyelashes onto their offspring. Symbiosis was once a faery tale.

But once the formation of eukaryotes via symbiosis of two lineages was accepted then the symbiosis concept was extended to include photosynthesis in plants and algae. In this scenario, a previously free-living cyanobacterium was engulfed by a eukaryotic host (figure 5). The host now contains both mitochondria and photosynthetic chloroplasts. This new host obtains energy from sunlight via the chloroplast and exploits that energy in the mitochondria. This innovation ultimately leads to land plants and nearly all photosynthetic eukaryotes (figure 4).

Sarah Gibbs extended the idea of symbiosis to explain why photosynthesis is scattered across multiple kingdoms. In this third scenario, one cell with chloroplasts is consumed by a second, but only the chloroplasts are retained.<sup>5</sup> This provides access to photosynthesis and explains how photosynthesis could have spread across many diverse eukaryotic groups.

Therefore, an individual can be shaped by two patterns of evolution: the familiar and dominant expression of parental genes via vertical descent and a second, less familiar, pattern of horizontal gene transfer from endosymbiosis (figure 4).

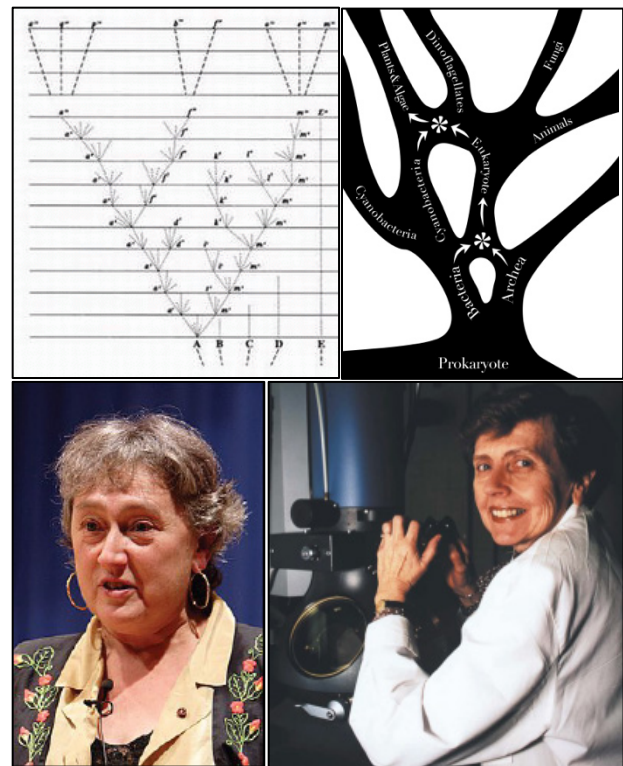


Figure 4. Left to right: Darwin’s original descent with modification figure from the ‘Origin of Species’; Phylogenetic schematic of symbiosis, Moren/Bachvaroff, 2023; Lynn Margulis, [https://en.wikipedia.org/wiki/Lynn\\_Margulis#/media/File:Lynn\\_Margulis.jpg](https://en.wikipedia.org/wiki/Lynn_Margulis#/media/File:Lynn_Margulis.jpg); Sarah Gibbs, Gibbs, *S Annu. Rev. Plant Biol.* 2006. 57:1–17.

The dinoflagellates are from the eukaryote kingdom and a perfect case study to demonstrate both symbiosis and the global importance of small eukaryotes to our planet. In global estimates of oceanic photosynthesis dinoflagellates are one of the top oxygen producers. The oceans produce oxygen at a scale similar to the contributions from the Amazon rainforest. This is underscored by modern sequencing which places dinoflagellates as second in abundance to animals and first in diversity in oceanic surveys. Dinoflagellates also include a wide array of life strategies such as [built-in harpoons](#) used to capture prey.<sup>6</sup> Other strategies include a symbiotic photosynthetic lifestyle as the algae found in coral reefs use internal and external types of parasitism, and consuming food for energy. The term mixotrophy describes the role of many photosynthetic dinoflagellates, which can be both photosynthetic (autotrophic) and [consume prey](#) (heterotrophic).<sup>7</sup>

<sup>4</sup> Margulis, Lynn. “On the origin of mitosing cells”. *Journal of Theoretical Biology*, vol. 14, no. 3, 1967, pp. 225–274.

<sup>5</sup> 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.

<sup>6</sup> Polikrokos harpooning prey  
<https://www.youtube.com/watch?v=BddN1LE1YZQ>



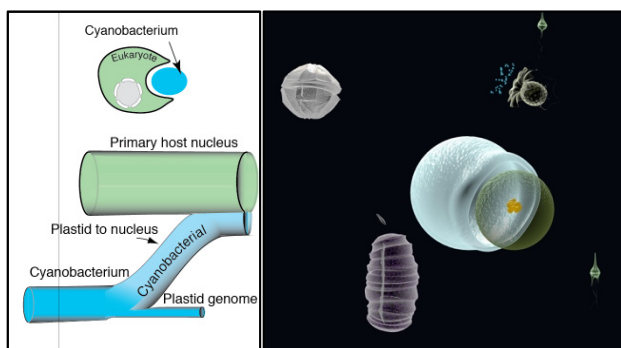


Figure 5. Left: Gene Flow Symbiosis chart by Tsvetan Bachvaroff; right: “Under the Bay” AR by Moren/Bachvaroff. Still from **Scene 01 \ Origin Stories** showing symbiosis. Courtesy of the scientist and artist.

Mixotrophy and diversity in the ocean combined with the concept of symbiosis represented by Gibbs and Margulis provides many instances of emergent strategies. For example, the dinoflagellate *Dinophysis* feeds on ciliates demonstrating how the chloroplast could be consumed intact from prey by injecting a built-in “[straw-like method](#)” to acquire, or suck, chloroplasts from its prey.<sup>8</sup> Roughly nine events have occurred where photosynthetic dinoflagellates contain chloroplasts borrowed or gained from essentially every available lineage. And this list does not include dinoflagellates with elaborate structural features that contain external symbiotes such as *Ornithocercus*.

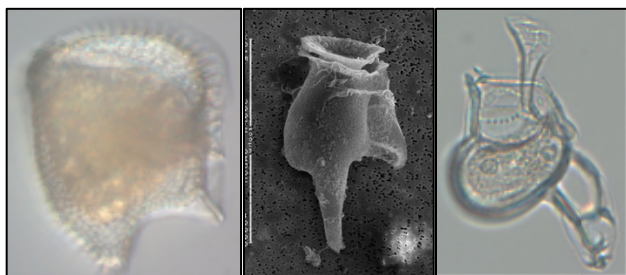


Figure 6. Three genera of dinophysoid dinoflagellates. Left to right: *Phalacrocoma*, *Dinophysis* SEM, *Histioneis*. Three genera contain intracellular photosynthetic organelles or symbiotes, each distinct from the other. Courtesy of the scientist.

<sup>7</sup> Photosynthetic *Fragilidium* consuming a large *Ceratium*  
[https://www.youtube.com/watch?time\\_continue=1&v=KFFsnHVIHyo&embeds\\_referring\\_euri=https%3A%2F%2Fmail.google.com%2F&embeds\\_referring\\_origin=https%3A%2F%2Fmail.google.com&source\\_ve\\_path=Mjg2NjY&feature=emb\\_logo](https://www.youtube.com/watch?time_continue=1&v=KFFsnHVIHyo&embeds_referring_euri=https%3A%2F%2Fmail.google.com%2F&embeds_referring_origin=https%3A%2F%2Fmail.google.com&source_ve_path=Mjg2NjY&feature=emb_logo)

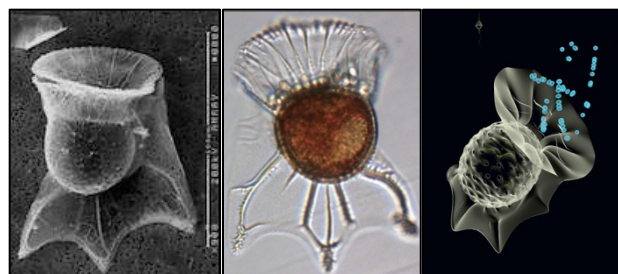


Figure 7. Left to right: *Ornithocercus* SEM, *Ornithocercus* with visible cyanobacteria; “Under the Bay” AR (still) by Moren/Bachvaroff. Courtesy of the scientist and the artist.

Within the *Dinophysis* group there are different types of photosynthesis or symbioses, including the ‘gardening’ *Histioneis* (figure 6) and *Ornithocercus* (figure 7), the ‘heterotrophic’ *Dinophysis* that sucks out chloroplasts, and at least two other types of internal symbiotes. *Ornithocercus* will host cyanobacteria in a birdcage-like crown, a strategy that not only stores nutrients for on-going consumption, but the chains of cyanobacteria reproduces itself creating a “fruit-on-the-vine-like garden” energy supply (figure 7).

Symbiosis has allowed these the single-celled dinoflagellates to diversify over hundreds of millions of years into thousands of species that will clearly outlive humans. Therefore, diverse reproductive, energy consumption, and other strategies assisted the dinoflagellates in obtaining longevity that humans can only dream of. For example, the dinoflagellate *Ceratium* can both cell divide and mate for optimum reproduction benefits. In **Scene 01 \ Origin Stories** the viewer will see images of the *Ceratium* that cell divide having only one trailing flagellum (a propeller-type tail). However, an identical *Ceratium* has two flagella because they had two parents that mated (figure 3).

Other strategies we named included organic differentiation in the structure of the cell walls of the dinoflagellates. These complex 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 manufacturing. Differentiation can be exemplified in the exoskeleton of a crab or lobster but is most visible in the repeating hexagon pattern of a turtle shell, where the hexagon shapes repeat, but not perfectly. It’s in that imperfection, crookedness, or wobble, that creates more strength with less matter. Dinoflagellates, diatoms, and other microbes also have this efficient design

<sup>8</sup> *Dinophysis* sucking the chloroplast from its prey  
<https://www.youtube.com/watch?v=cq3SBoCHPP4&t=3s>

principle of differentiation. **Scene 04 \ Crooked Shelters** (figure 8) describes how such differentiation influenced the largest 21st-century algorithmically designed and digitally fabricated architectural form in Seville, Spain, the [Metropol Parasol](https://www.setasdesevilla.com/).<sup>9</sup> The pavillion's aerial view appears as a mushroom blooming throughout the grided city. A similar architectural example is in Stuttgart, Germany where one of the algorithmic [pavilions](https://www.itke.uni-stuttgart.de/research/icd-itke-research-pavilions/) based on differentiation in nature was so strong and lightweight, it blew away.<sup>10</sup>

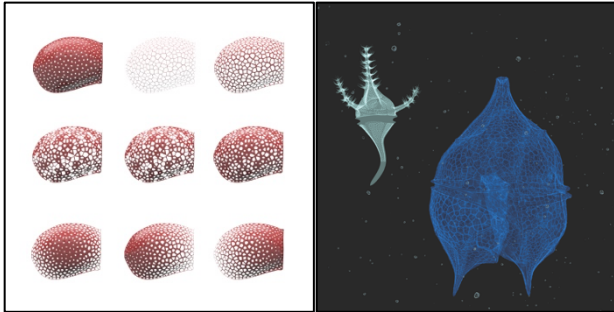


Figure 8. “Under the Bay” AR by Moren/Bachvaroff. Left: Work in progress; right: still from **Scene 04 \ Crooked Shelters**. Courtesy of the artist.

## Water Projects

In our first attempt to create a public project for an open house at IMET, we created an artwork demonstrating 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 audience entered a pitch-black room with a large ceiling tank holding millions of invisible dinoflagellates. 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?*” the microscopic organisms above them answered the question in turbulent shapes of blue bioluminescence (figure 9). Originally, this was influenced by the mesmerizing organic order and differentiation in the murmuration patterns of [starling birds](https://www.youtube.com/watch?v=LAQwEWqg0ug)<sup>11</sup>. 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*.<sup>12</sup>

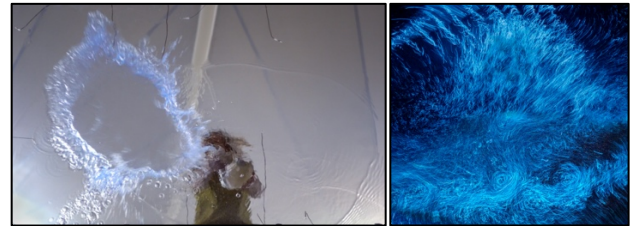


Figure 9. “What is the Shape of Water?” Left: Lisa Moren pouring biomatter in the ceiling tank; right: Photograph, Moren/ Bachvaroff. 16x16”, 2019. Courtesy of the artist.

“*What is the Shape of Water?*” began as a somewhat expedient strategy of displaying bioluminescence in an art project that took over a year to fully realize. It was an unrealistic approach to create art installations for the more than two dozen strategies we identified for potential exhibition. We instead turned to story-telling and produced an augmented reality (AR) project with eight scenes, approximately 10 minutes per scene. Lisa took the strategies we identified for the project and built narratives that meandered through purposefully fragmented topics related to microbes, water, Taoist meditation, architecture, monuments, and politics..

The AR project became “*Under the Bay*” and it’s [trailer](#)<sup>13</sup> illustrates the animation, narrator, and incoming data. For the data, we worked with the Maryland Department of Natural Resources (MD DNR) to siphon data from sensors already installed in the largest estuary in North America, the Chesapeake Bay. In total 36 parameters stream into the project from six locations in the Bay. Locations are from the Delaware border to Washington DC, the Eastern Shore of Maryland, and Baltimore City (figure 10). The parameters pH, temperature, oxygen, salt, chlorophyll, and turbidity (clarity) are updated every 15 minutes. These parameters then affect the animation’s color, speed, and scale, along with the narration and music composition. For instance, when the oxygen levels in the Bay are of good quality, the narrator’s voice sounds normal. However, when the water is anoxic, with little or no oxygen, the voice becomes choppy, fragmented, as if choking. In this way, the story, images, and sounds change from day to night and season to season for an ongoing collaborative narrative with the Bay water. The unpredictable variability of the

<sup>9</sup> <https://www.setasdesevilla.com/>

<sup>10</sup> <https://www.itke.uni-stuttgart.de/research/icd-itke-research-pavilions/>

<sup>11</sup> <https://www.youtube.com/watch?v=LAQwEWqg0ug>

<sup>12</sup> Bennett, Jane, and Connolly, William. “The Crumpled Handkerchief.” *Time and History in Deleuze and Serres*, Bloomsbury, London, UK, 2013. Pp. 155.

<sup>13</sup> “*Under the Bay*” trailer by Lisa Moren with Tsvetan Bachvaroff, 2022. <https://vimeo.com/796868197>

incoming data becomes an authentic wobble created by the environment.

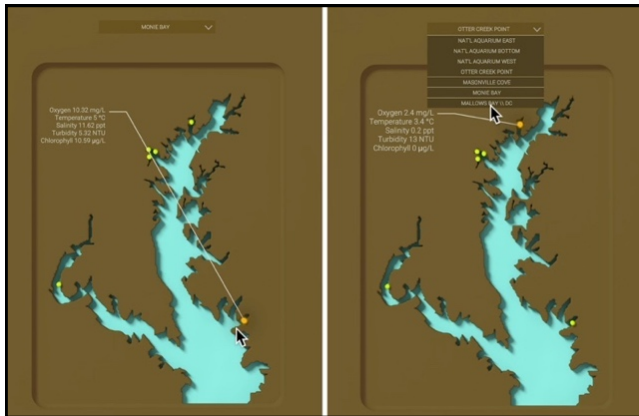


Figure 10. “*Under the Bay*” AR Moren/Bachvaroff. UI showing locations in the Chesapeake Bay where sensors allow water parameters to stream into the project. Courtesy of the artist.

## Listening to the Water

The project propaganda claimed the ambition of cross-species communication specifically “*What if we could hear what the water is saying?*” To address skeptics to these claims, we’re borrowing from water physicist Theodor Schwenk, as we do in the AR project, but also Jane Bennett<sup>14</sup>, who references Graham Harmon, Bruno Latour, and Michel Serres’s *The Birth of Physics*.<sup>15</sup>

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, H<sub>2</sub>O, 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. 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*” and overlap until the larger ones envelop the smaller ones, and the waves repeat the pattern endlessly.<sup>16</sup> But unlike early CGI waves, the real ocean’s 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, they produce a

*vibratory noise*, where the force of repetition starts to create a surge, 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.”<sup>17</sup> A shape derives 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) percolation.”<sup>18</sup> While much of this noise dies like seedlings that don’t spawn, the intermingling currents and swirls, overlap with enough force allowing forms to emerge from it.

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. 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 affect one another, there is the potential for something to emerge, including new life (figure 11).

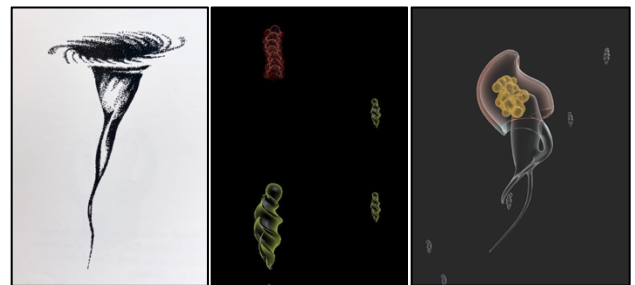


Figure 11. Left: Vortex funnel drawing by Theodor Schwenk, “*Sensitive Chaos: The Creation of Flowing Forms in Water and Air*” 1967, pp 44; center and right: “*Under the Bay*” AR by Moren/Bachvaroff. Courtesy of the artist.

In **Scene 02 \ Water Moving Around My Fingers**, the microbes reflect Schwenks organisms that take on the negative space of the vortex shape traveling in a reverse

<sup>14</sup> Ibid, Bennett, Connolly.

<sup>15</sup> Serres, Michael. *The Birth of Physics*. Rowman & Littlefield International, Ltd., 2018.

<sup>16</sup> Schwenk, Theodor. *"Sensitive Chaos: The Creation of Flowing Forms in Water and Air"*. Sussex: Rudolf Steiner Press, 1996. Pp 33.

<sup>17</sup> Ibid, Bennett, Connolly. Pp 157.

<sup>18</sup> Ibid.



corkscrew spiraling up (figure 11).<sup>19</sup> Therefore, when we say 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 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 as a kind of alphabet — to use a human metaphor — 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 telling us *we are out of balance*. Perhaps the data acts like a Google knowledge engine, an algorithm anticipating the user's thoughts when typing a partial phrase into the search bar and displaying our presumed burning questions. However, in this case, the data anticipates the thoughts of the Bay water. This concept is so significant that the scores of MD DNR sensors we use to siphon data 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. We call this *murmuration messiness*, listening to what the water is saying.

## Conclusion

Once we name this process of emergence, we can apply it to the other scenes in the AR project, addressing issues of differentiation and emergence not only in nature but also in creative ideas, forms, art, architecture, monuments, and also politics, protests (we discuss emerging protests including BLM, the beheaded Columbus statue ending up in the Bay, or the #metoo flocking of women in a bloom of pink hats — figure 12). This brings Brown's term *emerging strategies* full circle where strategies in nature can be a model for social change. Again, our stories meander through these topics and phrases, like symbiotic waves engulfing one another leaning on influences from the Tao Te Ching as much as science.



Figure 12. “*Under the Bay*” AR by Moren/Bachvaroff. Left: **Scene 08 \ Turnover [I Can’t Breathe]** (still); right: **Scene 07 \ Vaccine Blooms with Pink Hats** (still with UI). Courtesy of the artist.

“*Under the Bay*” will be exhibited at the Peale Museum, in Baltimore, Dec 14 to Feb 1, 2024, for “*Chamber of Wonders*”, with a public panel on Jan 18. While “*Under the Bay*” is freely available to download,<sup>17</sup> the XR installation will include iPads interacting with paintings, drawings, and assemblages for a unique museum experience. “*What is the Shape of Water?*” and related works will also be on display.

“*Under the Bay*” Scenes 01-08 include: Origin Stories \ Water Moving Around My Fingers \ Chalky Faeries \ Crooked Shelters \ Lava Lamps in the Sky \ Instrumental \ Vaccine Blooms with Pink Hats \ Turnover [I Can’t Breathe]



Left: “*Under the Bay*” AR by Moren/Bachvaroff, 2022: Apple IOS; Google Play; right: “*Under the Bay*” (podcast), 2022: Spotify, Google Podcasts and Apple Podcasts.

<sup>19</sup> Ibid, Schwenk. Pp 44.

<sup>20</sup> An eight-episode podcast version of “*Under the Bay*” is available on Spotify, Google, and Apple podcasts. Links to podcasts and more information can be found on the project website : <http://lisamoren.com/underthebay>.

<sup>17</sup> Download the AR from [Apple IOS](#) or [Google Play](#):

<https://apps.apple.com/app/id1641553491>

<https://play.google.com/store/apps/details?id=com.lisamoren.underthebay&pli=1>



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## Production Team

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

Samson Modeler and Animator; William Forrest, Modeler, Animator, UI and Technical Artist; Woody Lissauer, Voiceover Engineer and Male Narrator 1; Ruskin Nohe-Moren, Male Narrator 2; Aliyah Baruchin Copy Editor and Fact Checker.

## Author'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 her work at the Chelsea Art Museum, Creative Time, Drawing Center (New York), Cranbrook Art Museum (Michigan) and Ars Electronica (Austria), Akademie der Künste (Germany), uShaka Museum (South Africa), and the Artists Research Network (Australia). She received the National Endowment for the Arts award, is a Fulbright Scholar; a multi-year recipient of the Maryland State Arts Council and CEC Artslink International, is a R.W. Deutsch Award recipient and a Saul Zaentz Innovation Fellow in Film and Media at Johns Hopkins University.

Her 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 INSECURITY"; 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); is an Affiliate Faculty at the Imaging Research Center (IRC) UMBC; and taught at FAMU and AVU in Prague; and the University of California San Diego (UCSD).

[Dr. Tsvetan Bachvaroff's](#) research is focused on dinoflagellate evolution with special emphasis on the parasitic dinoflagellates, using large scale sequencing and phylogenetic methods to describe the evolutionary history of different types of genes in dinoflagellates. He uses DNA sequence analysis from data collection, assembly, annotation and phylogeny; has received numerous academic awards, including the William Trager Award from the Journal of Eukaryotic Microbiology, International Society of Protistologists, culture independent methods such as single cell PCR, sequencing, and sequence analysis; Establishing dinoflagellate cultures. He received the Marsho award, Mid-Atlantic Section of the American Society for Plant Biology, University of Maryland College Park, and the Chemistry Prize, Trinity School, New York.

Tsvetan Bachvaroff received his B.A. degree from Johns Hopkins University and Ph.D. from the University of Maryland College Park. He was a Post-doctoral Fellow at the Center of Marine Biotechnology and subsequently with the Smithsonian Institution. He is an Associate Research Professor for the Institute of Marine and Environmental Technology (IMET) at The University System of Maryland.