Remediate

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It is difficult today to conjure up an image that *isn't* related to the environment when we use the word "remediate." Warnings of eroding coastlines, diminishing species, polluted oceans, and toxic waste sites are omnipresent in every news forum. They have also been rallying cries for many designers as they try to slow, stop, and even reverse the negative impacts of our human footprint on the planet. Their actions express an opportunity for renewal and realignment with nature, and their projects reveal how they have chosen to rehabilitate, reform, and regenerate for future generations.

Rehabilitate

Experiencing nature in a tangible way has physical and mental benefits. When spending time in nature is combined with daily exercise, people have fewer diseases, lower blood pressure and cholesterol levels, and overall less stress.[1] Popular in Japan is forest bathing (*shinrinyoku*), a slow and meditative walk through the woods with participatory interventions along the way, which reduces stress by promoting the natural killer cells, a part of the immune system that fights cancer.[2] The United States Department of Agriculture reports that "breathing in antimicrobial compounds found in the essential oils of trees increases relaxation and improves stress management, resulting in increased vitality and less anxiety."[3]

With clear evidence indicating the positive benefits of spending time in nature, "the medical field has begun to adopt a biopsychosocial model in which mind and body are viewed as inextricably linked."[4] As landscape architect Ulrika K. Stigsdotter explains, "This changing view is encouraging for designers who seek to integrate patient, family, and community-centered care into design."[5]

Stigsdotter's project Nacadia Therapy Forest Garden (2011–ongoing) is a research- and therapy-based garden and an example of how the biopsychosocial model can be used to promote mental rehabilitation. "Entering Nacadia is like entering into another world; it is like a refuge with no demands. You forget time and place in Nacadia," explains a patient who suffers from post-traumatic stress disorder. Designed by Stigsdotter, with input from researchers in landscape architecture, architecture and environmental psychology, as well as medical doctors, psychologists, and therapists with expertise in nature-based therapy, Nacadia shows how designers carefully construct an experience within and using nature to provide healing opportunities for patients suffering from stress-related illnesses.

Nacadia is open year-round and is situated within the Hoersholm Arboretum, forty miles north of Copenhagen, Denmark. It covers two acres of land and is a forest garden of outdoor rooms with plant material creating the floors, walls, and ceilings to encourage immersion in nature and promote healing. The design has six built components: the hut, a wooden elevated deck in a tree, the main wooden walkway, an entrance gate with a pergola, a greenhouse, and an office building (transformed from an existing gardener's cottage) surrounded by a large wooden terrace. Approximately two-thirds of the garden is covered by tree canopies, with the remaining area comprising grass meadows. Water features are also included: a spring, stream, pond, and lake with an island. One of the major goals of Nacadia is to conduct as much therapy as possible outdoors—very different from traditional therapeutic methods.[6]

Stigsdotter and her group designed five outdoor rooms with certain constant conditions—shape, size, and direction—but with fluctuating content. Some rooms have walls of shrubs or green fences, floors of grass, stone, or wood, and ceilings of treetops, pergolas with flowering climbers, or the open

sky. Each choice of material and spatial placement relates to the patient's needs and ability, which can change over time and are accounted for in the overall design. Nacadia addresses the mental state initially in an effort to improve physical well-being.

In a project where the situation is reversed, designers have worked to improve compromised motor functions in an effort to enhance mental well-being. The Soft Robotic Grip Glove (2015–ongoing), designed by Conor Walsh's Harvard Biodesign Lab, represents an important new area of soft robotics in assistive devices, using flexible and lightweight materials instead of rigid and heavier components for functionality. It was developed to assist individuals who have limited motor skills in their hands, caused by muscular dystrophy, stroke, and partial spinal cord injury. According to research conducted by the Biodesign Lab, approximately four million chronic stroke survivors with partial paralysis exist in the United States and another six million are found in developed countries globally.[7] In most of these cases, partial or entire loss of motor functions in the hand has occurred, severely reducing basic daily activities. The glove allows the user to perform daily activities, promoting independence and a sense of well-being.

The base glove resembles the dimension and weight of a common padded wheelchair glove and has modular, independent finger actuators comprised of three fabric layers and two airtight bladders placed between each fabric layer. Sensors are used to control the actuators and, when activated, inflate the bladders, causing the gloved hand to open, close, grasp, pinch, and hold an object. The control system, which includes electronics, battery pack, electric air pump, exhaust, and fill air manifold, is contained in a compact box lightweight enough to wear on a belt or attach to a wheelchair. Because user functionality was the primary focus of the design, prototypes were tested on potential users at every step of development. Users discussed the comfort of the glove—that it felt good to have fingers extended—when it was impossible to do this without the glove.[8]

Reform

No other manmade material has had such a longstanding impact on designers and our world than plastic. With a worldwide production of plastic close to three hundred million tons per year, plastic objects are choking the life out of our planet.[9] Plastic has also become a remarkable catalyst for designers, who are collaborating with marine biologists, environmentalists, and concerned citizens to find alternatives that replace it, invent ways to collect it, and thereafter repurpose it (some of which are explained in Salvage, pp. 88–107).
One of the largest and most recent (as well as controversial) endeavors for collecting ocean plastic is the Ocean Cleanup, a multimillion-dollar project aiming to clean up the largest accumulation of ocean plastic in the world, the Great Pacific Garbage Patch. Years in development, the Ocean Cleanup uses passive floating cleanup systems to collect marine debris. The first cleanup system was launched in October 2018.

Equally as concerning as the enormous garbage patches are minisculе plastics that pollute our rivers and oceans. Referred to as microplastics, a term introduced in 2004, they are less than 5 millimeters (3/16 inch) in size and result from the breakdown of plastics in the ocean and other bodies of water. They are typically found as pellets, fragments, or fibers. They account for 92 percent of all marine plastics floating in the world's ocean.[10] Microplastics hover like smog on the surface of water and in sediment. The most hazardous characteristic of microplastics is their ability to absorb chemicals.[11] This can render microplastics toxic and, when absorbed by marine life, they become part of the food chain. In order to research microplastic pollution, Max Liboiron, a professor in Geography at Memorial University of Newfoundland, invented BabyLegs (2017–19), "a do-it-yourself monitoring tool for marine microplastic pollution."[12] BabyLegs was "born" at the Civic Laboratory for Environmental Action Research, a "feminist, decolonial, marine science laboratory that studies plastic pollution in Newfoundland and Labrador."[13] Made from babies' tights for a net, plastic soda bottles for pontoons (this insures that costs

1. The dark forest room
2. The scent and color site
3. The bonfire site
4. The heart of the forest garden site
5. The small lake

Nacadia Therapy Forest Garden, 2011-ongoing; Hoersholm Arboretum, Hoersholm, Denmark; Ulrika K. Stigsdotter (Swedish, b. 1971); University of Copenhagen (Copenhagen, Denmark, founded 1479)

Soft Robotic Grip Glove, 2015-ongoing; Conor Walsh (Irish, b. 1981), Diana Wagner (American, b. 1986), Megan Clarke (American, b. 1995), Dorothy Orzel (American, b. 1958), Yu MengZhou (Canadian, b. 1994), and Ciarán O'Neill (Irish, b. 1991), Harvard Biodesign Lab (Cambridge, Massachusetts, USA, founded 2012); Knit textile, compressed air

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Variety of microplastics

Babylegs, 2017-19; Max Liboiron (Canadian, b. 1980), CLEAR (Civic Laboratory for Environmental Action Research) (St. John's, Newfoundland, Canada, founded 2015); Plastic bottle, nylon stockings, rope; 45.72 × 20.32 × 7.62 cm (18 × 8 × 3 in.)

stay low), and other inexpensive, off-the-shelf materials, BabyLegs attaches to a boat, which drags it along the surface to collect bits of microplastic for study and, if lucky, identification. The design mimics the much more expensive Manta trawler ($3,500, as opposed to BabyLegs' less than $12 solution). BabyLegs is open source, as is its larger version, LADI (Low-tech Aquatic Debris Instrument, pronounced "lady").

Liboiron's research on microplastics focuses on the area around Labrador, which is home to indigenous and aboriginal communities who rely on fish for sustenance. Plastic toxicity, according to Liboiron, results when microplastics are ingested into a hot and acidic climate like the gut, at which point chemicals can leach out of the plastic and move into tissue at crucial times of development in fetuses, children, and women.[14] For Liboiron, this has become an issue of equity, which recognizes that when people start from fundamentally different social, economic, educational, and political positions, treating everyone equally does not overcome those differences.[15] This makes microplastic pollution, especially in communities whose livelihood depends upon fishing, a major crisis economically, socially, and environmentally.

BabyLegs offers an important example of open-source scientific research, where it lives in social space, and of how such research can encourage the development of low-cost community projects for environmental monitoring and assessment. When designers provide the tools and the road map for creation, and allow users to make specific choices with regard to materials and construction, knowledge and empowerment follow, which can change the behavior of an individual and a community.

Similarly research-driven is Charlotte McCurdy's After Ancient Sunlight (2018), which offers an alternative to how we think about our relationship to the sun so that it is in the present rather than focused on the captured carbon from what she refers to as "ancient sunlight." She uses this term in her 2018 master's thesis to describe "everything made from the fossilized remains of the chemical storage of ancient photosynthetic activity."[16] Over millions of years under high pressure and high temperature, the remains of algae, coral, and plants are transformed into today's fossil fuels. McCurdy states that we need to free ourselves entirely of petroleum products and find alternatives. As a proof of concept, McCurdy created a petroleum-free, algae-based (in order to harness present sunlight) plastic to replace traditional waterproof materials. She labelled it Solene™, and described it as a material that uses "young sunlight" because it is made from quickly grown and harvested plant matter (algae).[17] The Solene™ raincoat McCurdy designed underscored the extreme weather events that are linked to climate change.

McCurdy also has created two books that document her research. She printed the first with traditional petrochemical-derived black ink on conventional paper and bound with petroleum-based glue. McCurdy produced the second publication by reading the first book aloud into a double-valve container that splatters bubbles of plant-based soaps and salvaged wood charcoal on vegan watercolor paper. The beauty and creativity in all of McCurdy's elements comprising her thesis—the books, raincoat, ceramic studies, and more—derive from her methodical research and desire to communicate the possibilities, as she explains, of "what it would mean—what it would feel like—to live in a present-tense relationship with the sun."

Even in death, we are polluters. Our bodies emit toxins during decomposition and, when cremated, these ashes continue to release toxins into the soil and water. Studio Nienke Hoogvliet is collaborating with the Dutch Water Authority to introduce a new type of biodegradable alternative to a traditional cremation burial. Several years ago, the Dutch Water Authority produced the first polyhdroxyalkanoate (PHA) using sludge, the leftover material from wastewater treatment. PHA, a type of bioplastic, is made by bacteria as an energy-storage medium (like fat in mammals). The Dutch Water Authority realized that instead of cultivating bacteria to produce PHA, they could use the bacteria already present at wastewater treatment plants, which accumulate PHA and are abundantly available.[18] Hoogvliet then combined PHA with cremation ashes to create Mourn (2017–ongoing), a cone-shaped object that can be buried in soil or water in its entirety. It releases nutrients

and toxins gradually, as opposed to the immediacy of scattering ashes, thereby having little impact on the soil and groundwater.

Designer Jae Rhim Lee, founder of the company Coeio, proposes a different way of thinking about death that "moves us toward death acceptance . . . a critical aspect of protecting our environment."[19] She created the Infinity Burial Suit (2016–ongoing), an organic cotton suit with a built-in mix of mycelium and proprietary natural materials that the designer refers to as biomix. Lee's research initially focused on mycelium, and she studied with Paul Stamets, a renowned American mycologist, professor, and author of several books on the extraordinary benefits of mycelium for human and planetary health. One of the super biomaterials of the twenty-first century, mycelium is a network of fungal threads—those fuzzy, cobweb-like growths under rotting logs—which at some point in its life cycle fruits mushrooms, like an apple tree produces apples.[20] Mycelium is fast growing—from ¼ to 2 inches per day—and more than eight miles of these cells can permeate one cubic inch of soil. According to Stamets and other scientific sources, mycelium can absorb or eliminate toxins from the soil—called mycoremediation—while enriching the soil during biodegradation.

From thousands of species of mushrooms, Lee made her selection after consultation with mycologists, who recommended specific types of fungi for the various stages of decomposition and for absorption of chemicals.[21] Lee reports on the Coeio website that according to the Centers for Disease Control and Prevention in the US, there are 219 toxic chemicals in the human body, including tobacco residues, dry-cleaning chemicals, pesticides, fungicides, flame retardants, heavy metals, preservatives, and more. Mycelium can assist in breaking down these toxins. Lee is currently on her third design iteration, all three created in collaboration with zero-waste fashion designer Daniel Silverstein. Lee has designed a shroud version for pets and humans and is working on other mycelium-based products for the funeral industry.

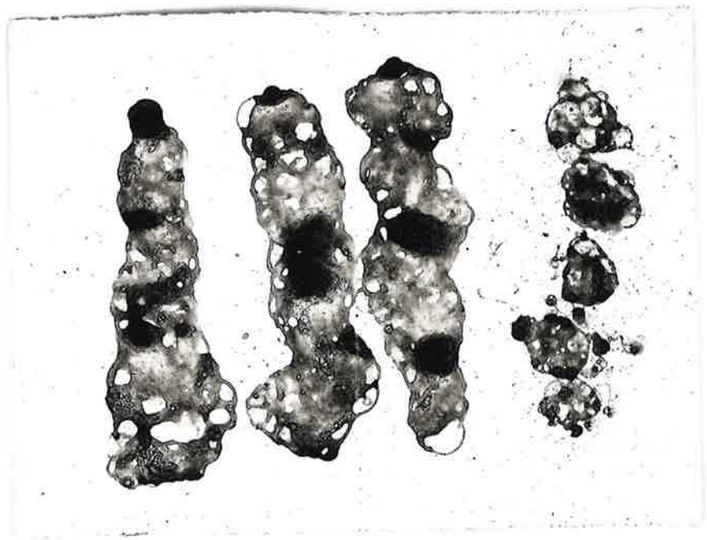
Regenerate

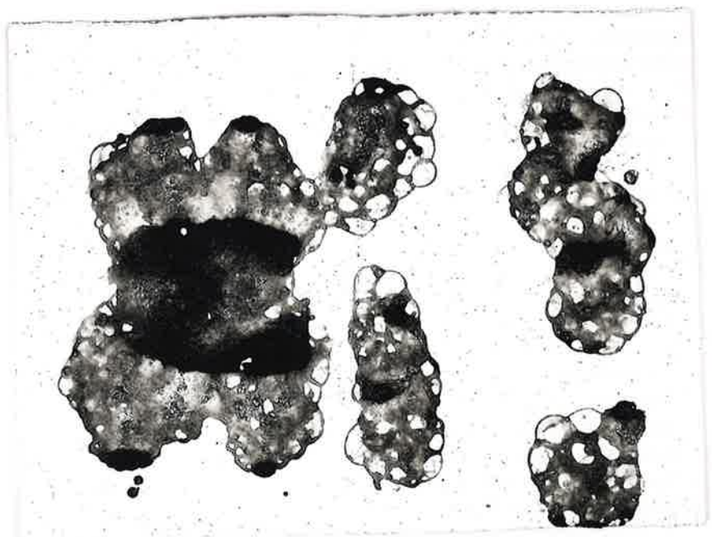
When Dellarobia Turnbow, Barbara Kingsolver's protagonist in *Flight Behavior*, stumbled upon the hibernating grounds of monarch butterflies, she had a transformative experience:

"Unearthly beauty had appeared to her, a vision of glory to stop her in the road. For her alone these orange boughs lifted, these long shadows became a brightness rising. It looked like the inside of joy, if a person could see that."[22] Butterflies are loved by everyone, and within the order Lepidoptera, monarchs are the most famous and popular in North America. They are easily recognizable with their bold orange and black coloring. Although it is still unknown how widely they pollinate, monarchs are a barometer for the sustainability of North America.[23] Their susceptibility to agricultural pesticides, temperature changes, land development, and habitat loss has made them a rallying cry for changes in government policies around the use of pesticides and for the preservation of their native habitats.

New York City is located on one of the migratory paths of the monarch, which travels northward from its winter hibernation in the mountains of Mexico to the Midwest and Northeast United States during spring and summer. Important to the survival of the monarch is milkweed, on which adult females lay their eggs, larvae feast throughout larval metamorphosis, and the pupal form dangles as a chrysalis. Milkweed is especially critical for monarchs during autumn migration, when they require a sustained habitat with nectar and resting spots.[24]

Terreform ONE's Monarch Sanctuary (2018–ongoing), designed for the façade of a commercial building in New York City, is a thirty-thousand-square-foot refuge for the renewal of the local monarch butterfly population. Architect Mitchell Joachim, who founded Terreform ONE as a nonprofit organization, wanted to create a multipurpose façade that contributes to the well-being and diversity of life in the city. He describes his design for the Monarch Sanctuary as "a vertical meadow behind a glass façade that contains living plants and flying butterflies in an environment highly regulated for





After Ancient Sunlight, 2018; Charlotte McCurdy (American, b. 1989)

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Pages from a petroleum-free book; Vegan watercolor paper, cotton thread, charcoal, and plant-based soap

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Raincoat: Solene (a novel 100% marine-algae-derived polymer), rayon thread, brass fasteners; 91.44 × 63.5 × 30.48 cm (36 × 25 × 12 in.)

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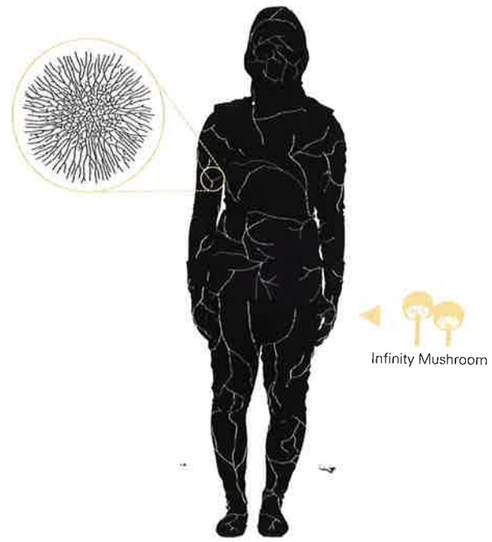
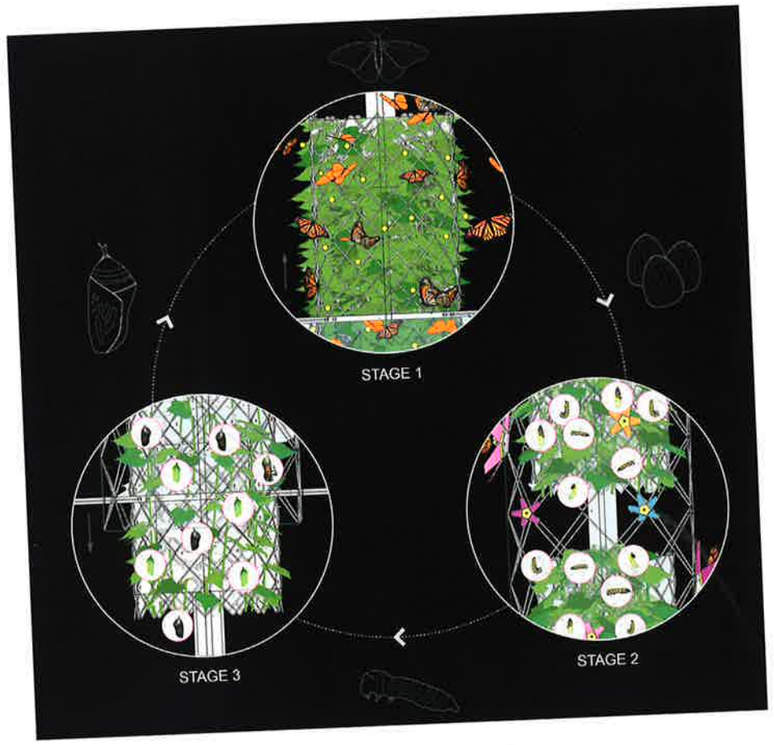
Three species of live marine algae, salt water

Mourn, 2017-ongoing; Nienke Hoogvliet (Dutch, b. 1989), Studio Nienke Hoogvliet (Hague, Netherlands, founded 2013); Ashes, PHA bioplastic made from waste-water; 30 × 15 cm (11 13/16 × 5 7/8 in.)



Infinity Burial Suit, 2016-ongoing; Jae Rhim Lee (Korean, b. 1975), Coeio (Mountain View, California, USA, founded 2015); Mycelium spores, organic cotton, microorganisms; Dimensions variable



Monarch Sanctuary, 2018-ongoing; Mitchell Joachim (American, b. 1972) and Vivian Kuan (American, b. 1966), Terreform ONE (Brooklyn, New York, USA, founded 2006); Glass, metal, plastic, milkweed, Monarch butterflies and larvae

For full caption information, see page 239.

temperature and humidity." By planting milkweed and nectar flowers throughout the exterior of the building (roof, façades, and terrace), he hopes to provide more breeding grounds for wild monarchs, while colonies in the façade will also increase monarch population. Joachim sees the building as an "object lesson in enhancing the urban environment with green technologies, including plant life and other creatures, in designing for other species, and in conveying images of new possibilities for the urban environment. This project alone will not save the monarch, but it will crucially raise awareness about our much-loved insect residents."[25]

Stabilizing shorelines against erosion has been accomplished by building jetties and inserting boulders, which are artificial defenses that have to be maintained and replaced over time. Designer Sheng-Hung Lee invented TetraPOT 2.0—The Evolution of Greener Sea Defense (2015–18), a module that works with the surrounding ecosystem. Inspired by the solid concrete water breakers or tetrapods scattered along the shores of Taiwan, Lee adapted this design to contain a mangrove seedling inside the concrete pod. In his prototype, Lee constructed a three-part mold with a central chamber for the mangrove that includes three primary openings. The holes allow the root system of the gradually maturing mangrove to connect to both the adjacent TetraPOT and mangrove roots from other TetraPOTS, creating an interlocking system of roots that will remain long after the pod itself has deteriorated.

Lee also sees this natural breakwater as regenerating mangrove forests, which, according to Smithsonian scientists, are among the most productive and biologically complex ecosystems on Earth. They cover approximately fifty-three thousand to seventy-seven thousand square miles globally, providing essential habitats and feeding grounds for thousands of species.[26] They have also been disappearing at an alarming rate. Data shows that between 2001 and 2012, the world lost between thirty-five and ninety-seven square miles of mangrove forest per year due to coastal development, aquaculture, and industrial activities.[27]

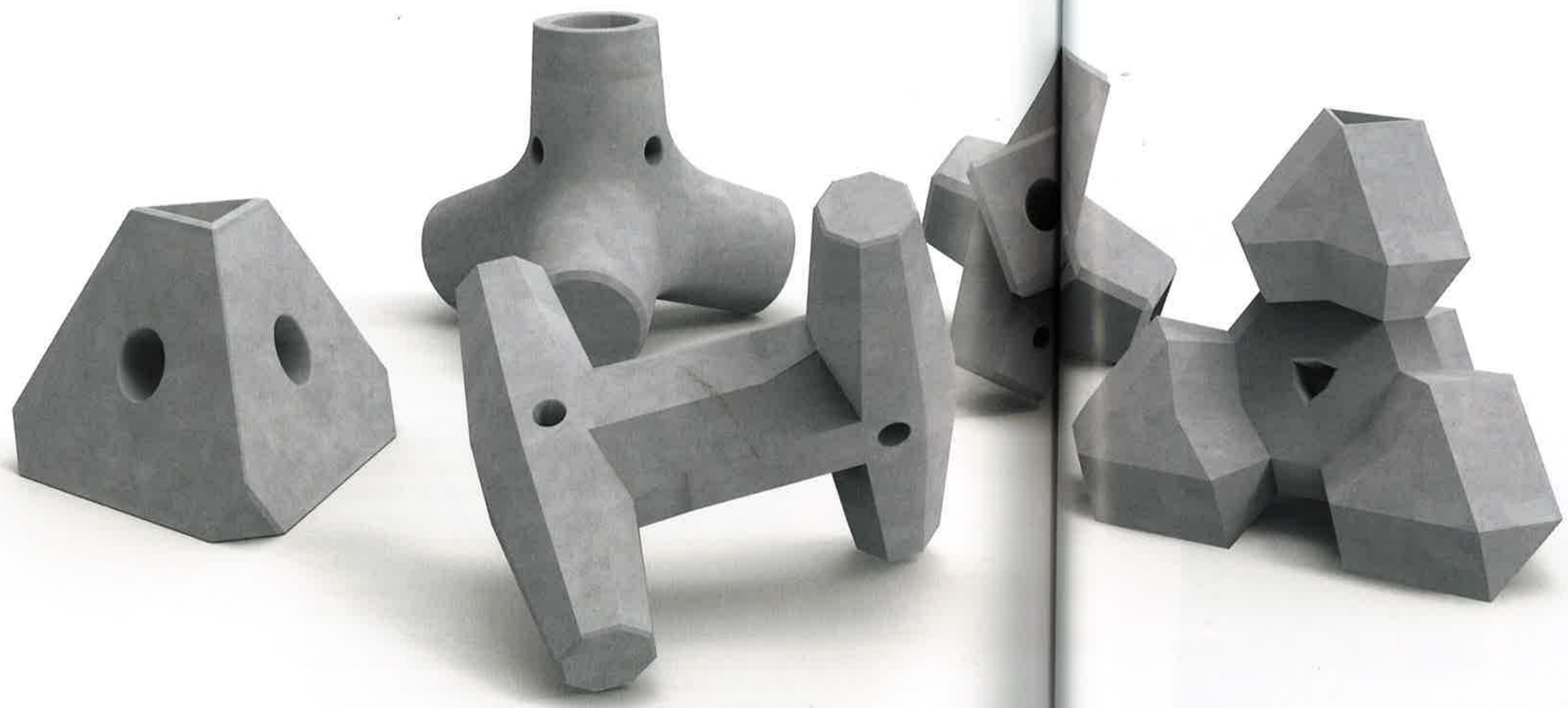
Preservation of native species is the essence of Fernando Laposse's project called Totomoxtle (2017–ongoing), or "corn husk," referring to the brilliantly colored veneers made from native Mexican corn that he uses for marquetry in wall coverings, lighting, and furniture. Laposse, who was born in Paris, France, and grew up in Mexico, made a trip when he was six years old to Tonahuixtla to visit Delfino Martinez, a friend of his family.[28] Returning every summer until he was fifteen, Laposse learned farming practices from the Mixtec, an indigenous community inhabiting present-day Oaxaca, Guerrero, and Puebla, where Tonahuixtla is located. He remembers being drawn to the beautiful black, purple, and pink colors of the ears of corn, which also translated into the leaves. This native corn reflected the diversity of maize in Mexico. When Laposse returned to this community thirteen years later, as a product designer and to participate in a residency in Oaxaca related to the corn husks, he could not find native corn in the city markets or in Tonahuixtla. It was a rare commodity, having been replaced with hybrid corn that was industrially grown with herbicides and genetically modified seeds. The land was useless for farming and the community had all but evacuated the town. Laposse found Martinez, however, who was part of a small group of farmers starting a cactus reforestation project to stop erosion on the now barren land. They were also creating an earthworm composting center to fertilize the land with the ultimate goal of replanting their native corn. It was at this point that Laposse, who was so moved by the farmers' plight and determination, decided to expand the scope of his project to achieve Martinez's goal.

Important to Laposse and Martinez's story is the seed. Traditionally when farmers harvested the native corn they would choose the best variety from which to keep the seeds to use for the next growing season. This permitted growth of the native species. These seeds were lost when industrialized farming took over. Fortunately, Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), the germplasm bank in Mexico, holds the largest seed collections of maize in the world, with more than twenty-eight thousand unique varieties. Laposse and the farmers collaborated with CIMMYT scientists to carefully select seeds that would work with the soil and altitude of

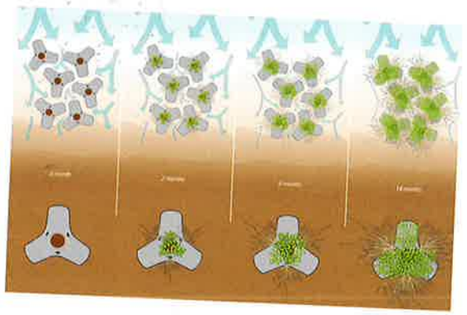
Tonahuixtla. The organization is also training the farmers to preserve the best seeds in the hope that Tonahuixtla will start its own seedbank.

With money received from grants and awards, Laposse moved his studio to Tonahuixtla in order to accelerate the project. In the meantime, the farmers had cleared two hectares of land and planted twelve different types of corn using bull-drawn plows and sowing the seeds by hand. To ensure success, Laposse had two agronomists working with him to monitor growth for the first harvest in 2018. He also designed a system for die-cutting the husks with a manually operated press that uses no electricity. Leftover trimmings are fed to the goats.

What excites Laposse is not only the work that his studio is producing from the native corn husks, but how it is spawning other initiatives related to indigenous farming practices. Restaurants are rescuing traditional recipes and including native corn in the ingredients. Laposse continues to document and quantify the positive impact that the project is having in the community with the hope of replicating this model in other indigenous communities.



TetraPOT 2.0—The Evolution of Greener Sea Defense, 2015-18; Sheng-Hung Lee (Taiwanese, b. 1987); PLA; Special thanks: Tasos Karahalios, LUNAR; Elyssa He, IDEO; Ji Ke, HAX; Terrence Zhang, Boio; and Shu-Yan Wang and Lin Shun Kuang, Puten Model Company



Totomoxtle, 2017-ongoing; Fernando Laposse (Mexican, b. 1988), with Delfino Martinez, Lucia Herrera, and Noë Leon; Corn husks; Dimensions variable

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Delfino Martinez with Fernando Laposse (left) and Sophia Laposse (right)

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Die-cutting husks