

ADVANCING REGENERATIVE SOLUTIONS FOR PEOPLE & PLANET



We're supporting a deep redesign for planet Earth by empowering people to learn and apply nature's blueprints.



BIOMIMICRY
INSTITUTE

ANNUAL REPORT
2019

WELCOME

"The countries, communities and companies that most closely [and] consciously mirror Mother Nature... are the ones that are going to thrive in what I call the Age of Accelerations. I'm a big believer in biomimicry."

- THOMAS FRIEDMAN

New York Times columnist and author



A MESSAGE FROM THE EXECUTIVE DIRECTOR

If the core purpose of biomimicry was distilled to one sentiment, it would be this: "how can humans fit in on this planet?" Our answer, of course, is to emulate nature in form, process, and systems. But biomimicry is more than emulation, and this is where we differ from other nodes in the bio-inspired design world: it also includes a deep ethos of sustainability, premised on a reconnection to nature.

In 2019, we saw the growth of all three elements of emulation, ethos, and reconnection. Design submissions from students ages 12 - 30+ presented us with concepts that were not just disruptive, but filled with genuine love for seed pods, beetles, redwood trees, and their habitats. Our Biomimicry Youth Design Challenge grew from a small pilot of a few hundred students in 2018 to reach over 4,000 middle-school and high school students last year. Our Biomimicry Global Design Challenge + Launchpad program have participants from over 50 countries. Top Challenge teams join our 8-week long Launchpad and travel for a week into the rainforest, deepening their biomimicry knowledge and gaining skills to help make their ideas become a reality.

Once they are a reality—a pre-commercial, viable entity—we join the Ray C. Anderson Foundation in awarding the \$100,000 Ray of Hope Prize®. In 2019 this went to Watchtower Robotics, a promising startup with a goal of ensuring water security by eliminating leaks from water utility pipes.

Looking forward, the easiest and most straightforward test of our work may simply be this: are our students and entrepreneurs creating new solutions that are compatible with all surrounding living systems, not just serving humans? It's this explicit commitment to creating designs that are well adapted to our ecosystems that sets biomimicry apart.



Beth Rattner
The Biomimicry Institute
Executive Director

A MESSAGE FROM THE BOARD CHAIR



Given these unprecedented times and the challenges we face on a daily basis, it is paramount for us to come together as a singular community. We have respect for the unknown, gained introspection within each of our lives, and have learned to create a new normal within our given parameters. Perhaps our immense respect for nature, as well as our own fragility, has established a new appreciation, respect, and reverence for the natural world we live in.

The Biomimicry Institute has provided opportunities and perspectives for students, teachers, scientists, researchers, and industry professionals to come together and learn about nature. Perhaps the silver lining amidst the chaos is the unification we all have through our natural world and where we as humans fit in. As we continue to navigate and explore this new normal, there is comfort that we do this together as humans.

Thank you for being such an integral component of our initiative, our work, and our environment. We look forward to overcoming these new challenges we face together and continuing to grow while providing stability through the turbulence. We stand together, unified in creating new pathways for teaching, learning, and education in the world in which we live!

Respectfully and with gratitude for all you do,



Lauren Birney
President
The Biomimicry Institute
Board of Directors

"Humans can contribute positively to the planet's cycles. Rather than take from the carbon, nitrogen, and water cycles, we can preserve, replace, and regenerate. We can stand in the middle of the carbon cycle and be a regenerative force for good."

JANINE BENYUS

co-founder The Biomimicry Institute

MISSION

WHY BIOMIMICRY?

Joe Pugar, a 2019 Launchpad participant, was an undergraduate student at the University of Pittsburgh when he discovered that nature uses a simple mechanism to keep surfaces clean—dynamic wrinkling. Dolphins, for example, use active wrinkling to keep their skin free of bacteria and algae. Our arteries use the same transition from smooth to wrinkled and back to smooth to keep our blood flowing freely, without blockages.

"The survival of our species is at a critical juncture. And yet we have the wisdom to design and redesign a future for life to thrive. Biomimicry is the roadmap, the framework for innovation."

LYNELLE CAMERON

Vice President, Sustainability,
Autodesk, and CEO, Autodesk Foundation

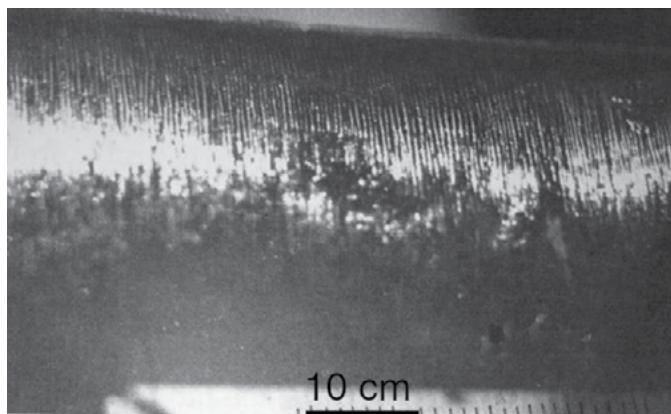
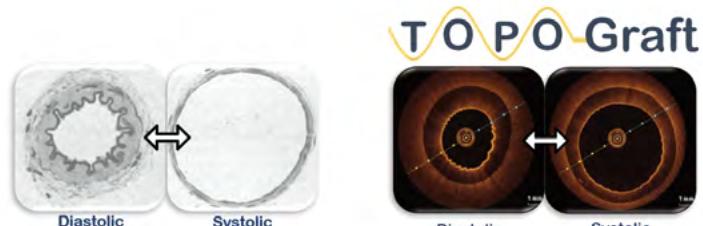


Photo credit: Pocivavsek, L., Pugar, J., O'Dea, R. et al. Topography-driven surface renewal. Nature Phys 14, 948–953 (2018). <https://doi.org/10.1038/s41567-018-0193-x>

After publishing their research in the prestigious journal *Nature*, Joe and his colleagues set about creating a company, Aruga Technologies, and developing a platform technology with applications for everything from self-cleaning roofs and industrial hoses to anti-fouling in aquaculture and medical devices. As a first application, Aruga is focused on developing an artificial blood vessel that resists clotting for use in cardiovascular surgeries and dialysis.

As with many nature-inspired technologies, Aruga's vascular graft has many secondary benefits beyond better health outcomes. Because it resists clotting, the grafts last much longer and greatly reduce the need for replacement surgeries, which cost the global healthcare industry \$2 billion annually. This also saves energy and materials, including the single-use items that are standard in operating rooms and become medical waste.

Following the Launchpad, Aruga Technologies won the \$25,000 second place prize in the 2019 Ray of Hope Prize® competition. Aruga has gone on to secure additional funding, as well as continuing the testing necessary to become an approved medical device.



The native arteries we're born with create this changing surface pattern every time our heart beats between two pressures

And Aruga's completely synthetic TOPO-Graft mimics this surface pattern under the same physiologic conditions.

"From materials and products to business models, biomimicry offers a fresh lens for all the dreamers and doers remaking the human-made world."

ANGELA NAHICKIAN

Former Director of Global Sustainability, Steelcase

This is what biomimicry makes possible—a radically different approach to solutions for a rapidly changing planet. We need more innovators like Joe, who know how to create new materials, products, systems, and communities that are regenerative, circular, and generous to all species. This is the mission of the Biomimicry Institute.



How can biomimicry help us?

By infusing biological strategies in design, we can transform sustainable innovation. Many are already leading the way:



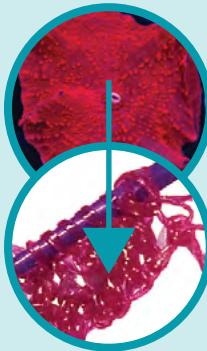
NexLoop's AquaWeb is creating more resilient food systems by harnessing water from rain and fog and distributing it for local urban food production. This passive, modular, decentralized technology is inspired by the strategy epiphytes use to wick moisture from the air and the way mycelia transport water to plant roots.



Diverse forests are a stabilizing force in balancing our changing climate. Inspired by bromeliads and forest leaf litter, **Nucleário** dramatically reduces the need for post-planting maintenance of seedlings by accumulating rainwater, creating a physical barrier against leaf-cutter ants, and permanently controlling invasive grasses without the need for pesticides.



The textile industry relies heavily on petrochemicals — and water throughout the value chain. **Werewool** emulates the functional proteins of discomycete coral and other organisms to create biodegradable textile fibers with vibrant color and desirable performance characteristics without the damaging impact of synthetic fibers and dyes.



BIOMIMICRY YOUTH DESIGN CHALLENGE

*Encouraging students to
think in wild new ways*

Teachers say students who participate in our Biomimicry Youth Design Challenge (YDC) are more creative, more connected to nature, and enjoy science in a personal, experiential way.

The YDC provides a framework for middle and high school educators to teach STEM and environmental science using biomimicry. Students connect what they learn to the real world by designing a nature-inspired solution to a local climate change problem.

What started as a small pilot program in 2018, grew last year to reach 4,000 middle and high school students in the United States. Through the YDC, we are fostering a different relationship with the natural world—one of learning from nature, not only about nature—and helping the next generation of designers see that solutions are right outside their window.

LEARN MORE:
youthchallenge.biomimicry.org

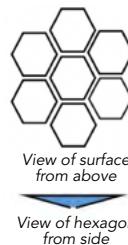
"We were absolutely amazed by the rapid growth of this new program. It really speaks to the demand for meaningful and relevant project-based learning experiences and the power of biomimicry to captivate students and teachers alike."

GRETCHEN HOOKER

Interim Director of Youth Education

If you've never heard of Hottentot bread and think it comes from a bakery, think again! It's actually a plant in the yam family, and its large underground tuber inspired the middle school winners of the 2019 YDC. Team Futuristas, from Rhinebeck, NY, designed a permeable tile to limit the amount of water pooling on the hardscape surface of a courtyard in their village, emulating the corky tuber of the plant.

At the high school level, the winged seeds of the Javan cucumber inspired the winning team, RHS Biomimicry from Larkspur, CA. They devised a passive control system for tidal kites, a type of underwater energy generator, based on the aerodynamics of the gliding seeds. Other innovations honored in the 2019 YDC were inspired by the unique traits and strategies of hagfish slime, Namib beetles, oyster reefs, prairie dogs, and Saharan silver ants. The award panel that reviewed the students' work was impressed with the quality and creativity of the projects. Judge Jenji Henson of EcoRise remarked, "We would be wise to add these (and other) smart kids to the brainstorming table for countless issues we currently face. Their creativity, enthusiasm, ability to look to and be in awe of nature, and refusal to be daunted gives me hope for a more sustainable world!"



Another judge, Colleen Mahoney of Mahoney Architects, admired the teachers' initiative in incorporating biomimicry into the students' curriculum: "The kids who participated in the Youth Design Challenge are experiencing the wonder of nature and the ability to have 'Aha' moments of discovery. I hope that they continue to be inspired by the billions of years of nature's research and development for years to come."



YOUTH DESIGN CHALLENGE IMPACTS

193
teachers registered

4,200
students impacted

37
states

Teachers from **24** countries used our curriculum

STUDENTS REPORTED THE YDC HAD A POSITIVE IMPACT IN:



Learning about science



Thinking critically



More interested in nature and sustainability



Knowing how to use scientific information to solve problems



Being more creative



Learning about engineering



Excitement to learn

BIOMIMICRY YOUTH DESIGN CHALLENGE

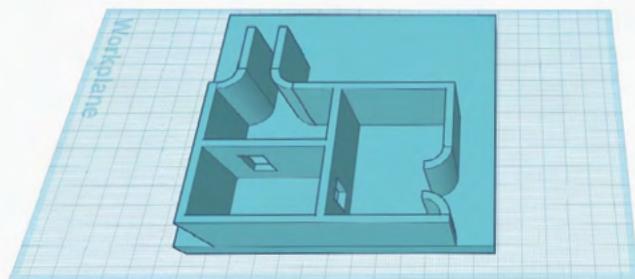


TEAM PRAIRIE DAWGZ

Passive Ventilation System

The Harley School, Rochester, NY

Passive building ventilation can greatly reduce heating and cooling loads and costs for a building. Team Prairie Dawgz took inspiration from how prairie dog burrows generate a Bernoulli effect for ventilation. They built prototypes to demonstrate and test the effect over multiple iterations of their design for a passively ventilated house.



"Biomimicry is one of those rare hopeful notes in the modern chorus of environmental warnings. Perhaps the best thing about this 'quest for innovations inspired by nature' is that it is more than just a theory. It is already underway."

JONATHON PORRITT

Chairman, Chair of the UK Prime Minister's Sustainable Development Commission



TEAM ROOFLECTION

Reflective Roof Design,
Homeschool, Edmonds, WA

Team ROOFlection wanted to help communities decrease the urban heat island effect and reduce the need for air conditioning. Taking inspiration from the highly reflective hairs on the Saharan silver ant, they came up with a system to retrofit existing buildings with retractable curved panels that reflect sunlight off of roofs. The team developed a concept, pursued further research, and consulted with an architect to improve upon their initial design.



"I was able to use my creative abilities to effectively create a design that can benefit the world. I felt that I could actually make a difference in the world, despite my age and experience."

YDC STUDENT PARTICIPANT



TEAM AIR2WATER

Fog Collection Roofing Tile

Wilbur Wright Middle School, Munster, IN

Team Air2Water was inspired by the Namib beetle and the honeybee to create a roofing tile that harvests fog from thin air. The tiles mimic the shape of honeycombs for strength and the superhydrophobic back of the Namib beetle to collect fog for residents of the Atacama Desert, one of the driest regions in the world.



TEAM SLIME FIRE

Water Absorbing – Water Releasing – Fire Retardant Balls

Nichols School, Buffalo, NY

Team Slime Fire focused on helping to stop the spread of wildfires. They were inspired by the properties of spiders, hagfish slime, and broom bush plants. They showed great creativity in their proposed fire retardant system of water-filled pods hung on trees like outdoor Christmas tree lights. The pods absorb and store water that is then released when exposed to extreme heat.



BIOMIMICRY GLOBAL DESIGN CHALLENGE + LAUNCHPAD

*Nurturing a new species
of entrepreneur*

What if every design problem was approached with the well being of all creatures in mind? Our annual Biomimicry Global Design Challenge encourages just that, asking teams of students and professionals to address critical global issues with nature-inspired solutions that contribute to the health of the planet. Finalist teams are invited to join the Biomimicry Launchpad, where they continue to develop their designs and business models. The program accelerates the development and commercialization of biomimicry startup innovations and helps support the next generation of sustainability entrepreneurs.

LEARN MORE:
challenge.biomimicry.org
biomimicry.org/launchpad

"This program, through teaching, connecting to resources, and coaching, taught our team that we could do something inspiring that we've never done before—develop an idea and make a difference. The Biomimicry team also helped me think about how to create a product, a business and a life that can exist in balance and harmony with ecological needs as well as support other human efforts."

ELENA JUODISIUS

Team Instabuff, BGDC & Launchpad Participant

In its fifth year, the BGDC used the United Nations Sustainable Development Goals as a framework for selecting meaningful focus areas related to climate change and human and environmental health. The Challenge also offered two specific prompts: addressing plastic pollution in the ocean and reducing food waste.

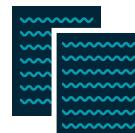
Following BGDC judging, the Biomimicry Launchpad welcomed 12 teams to its new cohort, with 46 participants from 13 countries. In 2019 we piloted a new 10-week virtual program that combined biomimicry with startup basics training. Teams from diverse backgrounds and sectors tackled a range of issues, from flooding and other water-related problems to the fashion and textile industries. They valued learning startup skills such as customer discovery, testing assumptions, developing value propositions, and how to build a strong and diverse team.

"The Biomimicry Global Design Challenge encourages participants to hone the critical skills they'll need in our rapidly changing world. They are challenged creatively and learn to adapt to a new way of thinking and collaborating in interdisciplinary groups. All are invaluable assets in the 21st century."

REBECCA CARLSON

BGDC Program Manager

2019 BGDC + LAUNCHPAD HAD:



98
entries



455
participants



19
countries



12
finalist teams

SOLUTIONS FOR 7+ SECTORS:

Including:



20%
ocean plastic
pollution



13%
coastal zones,
flooding, water
management



13%
GHG
emissions



8%
food
waste



5%
drinking
water



5%
agriculture



5%
air pollution/
public health

PARTICIPANT FOCUS AREAS:

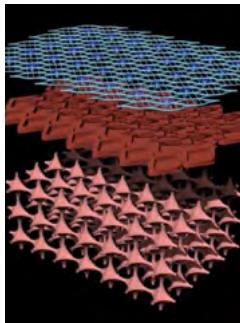


- Design (25%)
- Life sciences (23%)
- Engineering (22%)
- Architecture (12%)
- Business (7%)
- Physical science (5%)
- Technology (3%)
- Environmental Studies (2%)



BRYOSOIL

Pontificia Universidad Javeriana, Bogotá, Colombia



Bryosoil is a modular, multi-functional soil system (that emulates three geometric patterns found in bryophytes) to help prevent floods and mitigate the heat island effect. It catches water from a flooding event and manages it according to the risk. The system is composed of three layers that can perform five functions: slowing down the water's flow, redirecting it, infiltrating the water into natural soil, harvesting stormwater, or evaporating it. These layers replace the existing paradigm of water management that is based on pipe systems.



RICE AGE

California State University, Long Beach

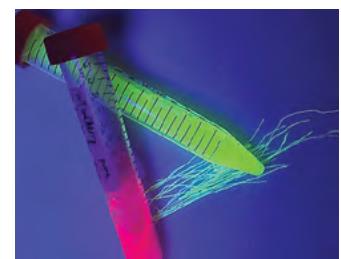
Rice Age is aiming to solve the problems with plastic use, water loss, and methane emissions in the rice industry. By emulating the hexagonal shape of the honeycomb and the circulatory system of termite mounds in a closed-loop system, Rice Age is able to maximize land use, oxygenate the soil, and preserve water in rice production.



WEREWOOL

New York, NY

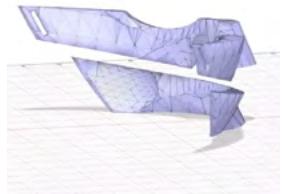
Werewool emulates the inherent performance properties that nature achieves through proteins in corals, jellyfish, and oysters—such as color, stretch, and waterproofing—to create performance textiles.



FOOTHILLS FLOW

Calgary, Canada

As wildfires, smoky days, and the prevalence of smog increase, this team looked to the particle-trapping strategies of bees, mammalian eyelashes and nose hairs, and flower stigmas to design a surface for a mask filter that can capture fine airborne particulates.



Ocean Plastic
Pollution



Coastal Zones, Flooding,
Water Management



GHG
Emissions



Food
Waste



Drinking
Water



Agriculture



Air Pollution/
Public Health



ATL SOLUTIONS

**Utrecht University,
Netherlands**

By increasing the connectedness and redundancy of existing drainage networks, this team modelled a more dynamic response to floods based on how various ecosystems manage water.



INSTABUFF - SUNY

**College of Environmental
Science and Forestry, NY**

Inspired by the giant lobelia, this team's layered mat filters nutrients, holds water, collects sediment, and promotes plant growth.



UNDULA TECH

New York, NY

The undulating fin motion of cuttlefish inspired this small-scale energy-producing turbine, which harvests the energy of flowing mediums like air and water.



BIOMIMETIC LAND OCEAN TREATMENT SYSTEM (B.L.O.T.S.)

**USA, New Zealand,
and Germany**

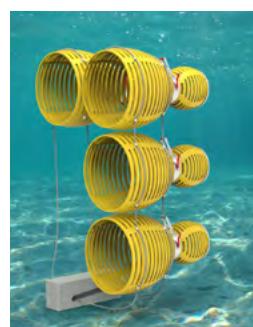
This team looked at mangrove roots, ferns, and lymph vessels for inspiration to develop a system that absorbs, redirects, filters, and stores flood water.



FLOATING COCONET

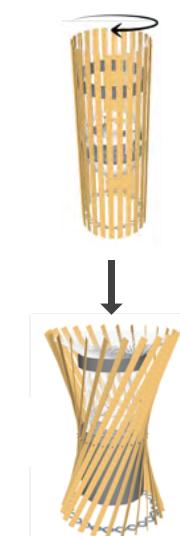
**The Hague University of Applied Sciences,
Netherlands**

Floating Coconet aims to capture plastic pollution in rivers before it has the chance to enter the oceans. Mimicking the way organisms like manta rays and basking sharks filter food from water, their design mechanism consists of rows of adjustable, angled fins. Water flow is directed based on the position of the fins. Their design is able to direct and collect free-flowing plastics of various sizes while allowing water to pass through.



H2U (HYDRATION TO YOU)

**California State University,
Long Beach**



H2U collects water from fog to address the lack of available clean water. Their design mimics fog-condensing plants and the motion created when ducks paddle their feet.



MILK AND JUICE

Monterrey, Mexico

Inspired by the nanostructure of cicada wings and sounds generated by caterpillars and queen ants, this team's solution damages bacteria in order to prevent spoilage in the collection, storage, and transport of milk, as well as fruit juice and pulp.



RAY OF HOPE PRIZE®

*Celebrating
nature-inspired
solutions*

The Ray of Hope Prize® celebrates and accelerates nature-inspired solutions addressing the world's environmental and sustainability challenges. Supported by the Ray C. Anderson Foundation, this \$100,000 prize sparks the next generation of businesses that will lead us to a circular and regenerative future.

LEARN MORE:
biomimicry.org/rayofhopeprize

WATCHTOWER ROBOTICS



Twenty percent of the world's water is wasted due to leaky pipes. That's enough water to serve an additional 1 billion people and comes at a huge cost in terms of energy and excessive infrastructure repair. Watchtower Robotics set out to address the problem of assessing water utility pipes for leaks, looking to nature to inform their solution.

The team had the idea of developing a soft-bodied robot to inspect city pipes for leaks. They took inspiration from blind cave fish and the lateral line system they use to detect changes in water pressure in order to develop new leak sensing technology. When Boston-based Watchtower ran into challenges fitting their robots through narrow-

diameter pipes and branching junctions, they looked to the octopus to enhance the compressibility of their robot (which can compress to 50% of its original size). They also took inspiration from the propulsion system of jellyfish, allowing their robots to take advantage of the energy available from water flowing through the pipes.

"The blind cave fish, octopus, and jellyfish all deserve our thanks," said Tyler Mantel, CEO of Watchtower Robotics. "Our experience...revolutionized our robot. At Watchtower, we care about saving water, and with the \$100,000 Ray of Hope Prize, we will commercialize our production to make a serious impact around the globe."

"When entrepreneurs turn to nature as their teacher, they remind us of life's brilliance and how much more we have to learn. These startups prove that biomimicry offers a better pathway to success."

JOHN LANIER

Executive Director of the Ray C. Anderson Foundation

Aruga Technologies' platform for keeping surfaces clean took home the \$25,000 second-place prize.

Other startups that made it through to the pitch round of the competition included teams from India, New York, the Netherlands, and California. Among the solutions were ECOSTP's zero-power small-scale sewage treatment unit, inspired by the cow's stomach; UPOD, a mechanical mosquito control device inspired by bladderwort plants; and an architectural cooling solution inspired by cacti, Saharan camels, and wheat.



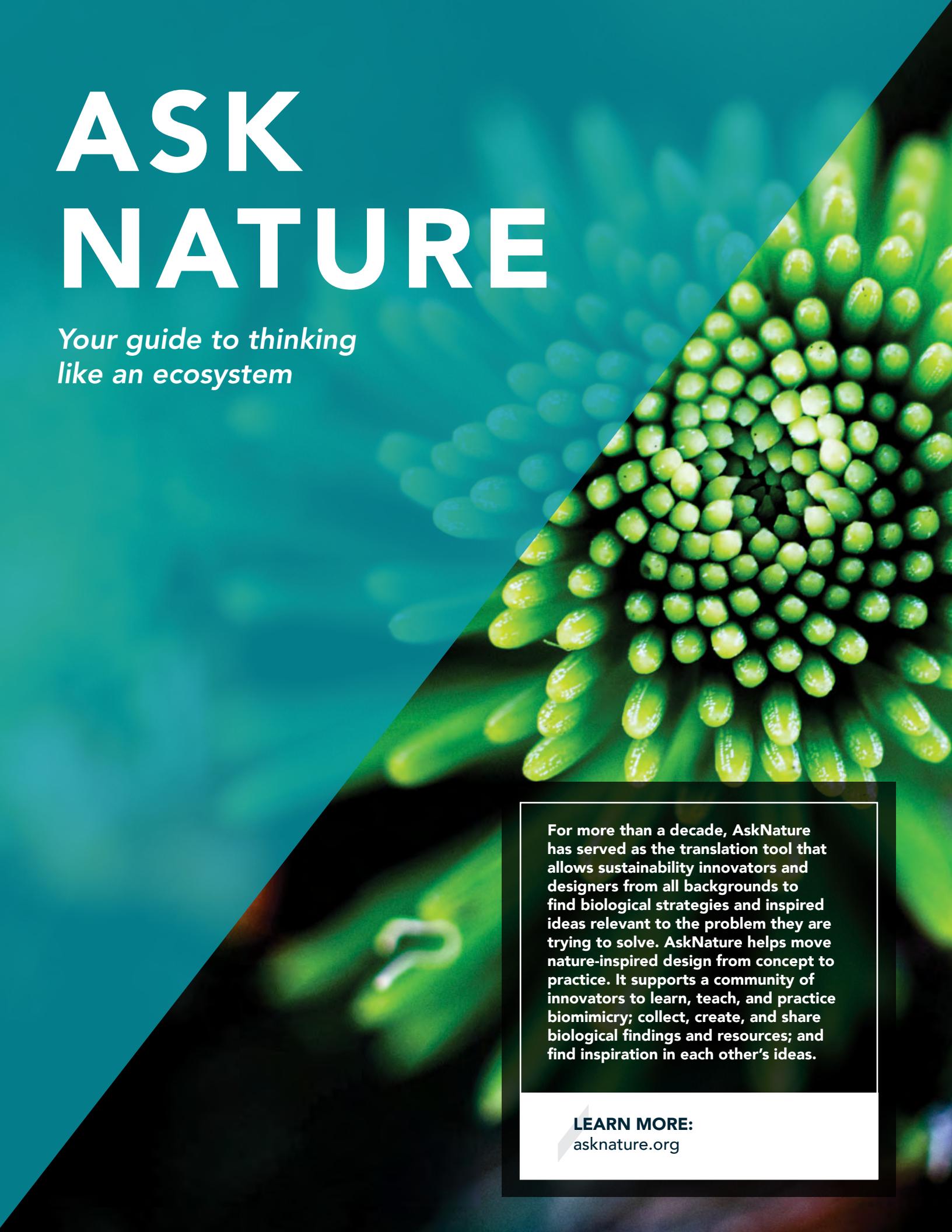
"There are no words to express how fulfilling and enriching this experience was, from having a nature walk that completely changed how I see and value nature, to being able to meet and work with people from all over the world, to finding ways to help our environment heal. This experience has opened my eyes and made me realize that we can all contribute, even if it is in small ways, to make this world a better place."

PAULINA VILLACRECES

UPOD, 2019 Ray of Hope Prize Finalist

ASK NATURE

*Your guide to thinking
like an ecosystem*



For more than a decade, AskNature has served as the translation tool that allows sustainability innovators and designers from all backgrounds to find biological strategies and inspired ideas relevant to the problem they are trying to solve. AskNature helps move nature-inspired design from concept to practice. It supports a community of innovators to learn, teach, and practice biomimicry; collect, create, and share biological findings and resources; and find inspiration in each other's ideas.

LEARN MORE:
asknature.org



"It's an exciting time for AskNature. We've grown significantly in the amount and types of content we're producing, which will help us reach a new audience of innovators and accelerate the growth of biomimicry across disciplines."

ALEX RALEVSKI

Science Director

In 2019 we finalized a strategy to update, expand, and enhance AskNature. The first phase began with a pilot on automated content generation and improvements to the Inspired Ideas content. These projects will make AskNature more accessible to those without a biomimicry background, make it a centralized tool for scientific information that was previously dispersed or behind a paywall, and accelerate the number of solutions inspired by the natural world.

AUTOMATED CONTENT GENERATION

Until now, AskNature's biological resources have been manually curated by our science writers and community of volunteers. To more rapidly grow the volume of resources available to our audience we are testing how to tap into a much larger pool of biological and scientific information. Last year we did a pilot to test the technology that will grow the number of biology resources from 1,700 to 10,000.

"AskNature is a great tool for learning, for ideation, and for fulfilling personal curiosities. Not only does it show you how we should be working together with nature, but also how we can learn to work better with each other."

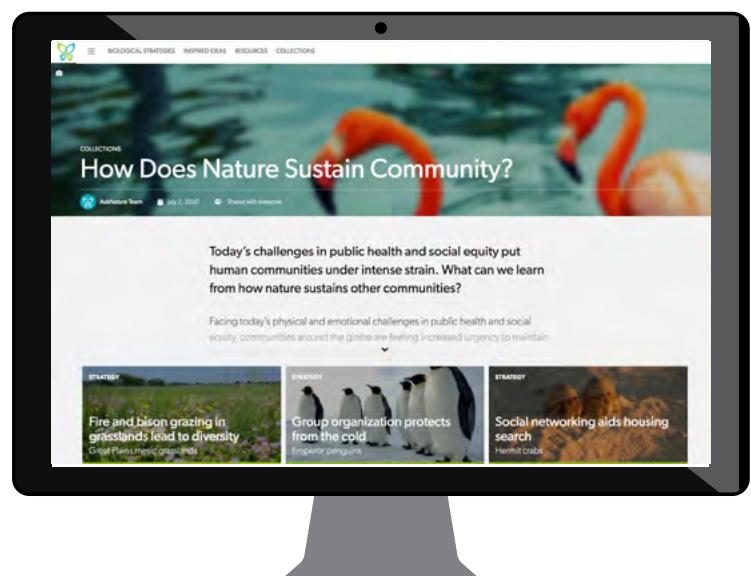
JORGE ZAPOTE

Biomimicry Launchpad alumnus, Windchill

700,000
visitors in 2019

6 MILLION
total visitors

1,900+
pages inspired
by nature



INSPIRED IDEAS

Inspired Ideas pages contain examples of biomimicry in application. AskNature is the only place to find a consolidated, searchable list of bio-inspired innovations and technologies, from both academia and industry. In 2019, we grew our curated list to 400 solutions, with an ultimate goal of at least 2,000 solutions available on the site.

EXPLORE  **ASKNATURE**

Weave your own path through thousands of profiles of living things and the human innovations they've inspired.

FINANCIALS



2019 FINANCIALS



■ Biomimicry Education & Outreach	27% (\$360,518)
■ Entrepreneurship	25% (\$338,797)
■ AskNature	18% (\$234,647)
■ Biomimicry Global Design Challenge	8% (\$104,024)
■ Fundraising.....	12% (\$161,090)
■ Admin & Finance.....	10% (\$136,604)



■ Grants.....	59% (\$975,218)
■ Major Donors	22% (\$364,000)
■ Individual Supporters.....	2% (\$37,757)
■ Corporate Sponsorship.....	4% (\$60,550)
■ Earned Income	12% (\$191,513)
■ In Kind Donations	1% (\$13,593)

STATEMENT OF FINANCIAL POSITION

ASSETS	12/31/2019	12/31/2018
Cash and cash equivalents	\$715,680	\$595,523
Investments	301,482	99,172
TOTAL	1,017,163	694,695
Receivables and Prepaid	90,125	23,143
Property and Equipment, and Other Assets	5,702	6,018
TOTAL	1,112,990	723,856
LIABILITIES AND NET ASSETS		
Total Liabilities	152,278	83,569
Net Assets	960,712	640,287
TOTAL LIABILITIES AND NET ASSETS	\$1,112,990	\$723,856

SUPPORTERS



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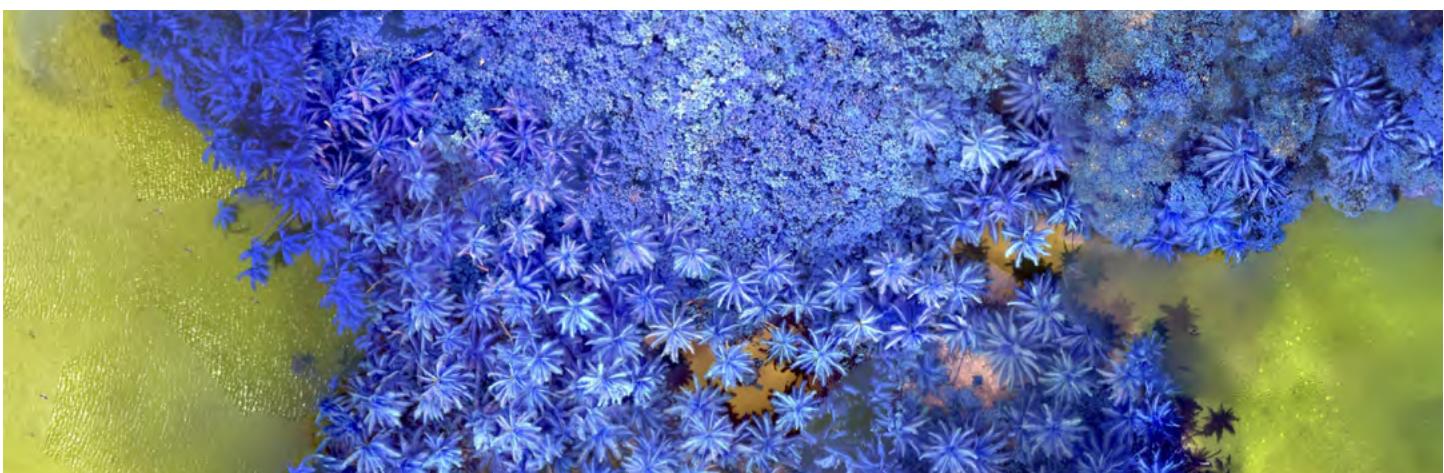
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