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About Zygote Quarterly

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Cover: Kiyooka Ohe House Vessel Installed | 11.5”x11” Unglazed Stoneware | Installation image of *Portraits of Time and Place* Exhibition - Herringer Kiss Gallery - February, Kristine Zingeler | pp. 2-3/pp. 86-87: Quaking aspens (*Populus tremuloides*) | Photo: Zion National Park, 2007 | Wikimedia Commons

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Quaking aspen (*Populus tremuloides*) leaves with aspen serpentine leafminer (*Phyllocnistis populiella*) | Photo: Robert Flogaus-Faust 2006 | Wikimedia Commons

Editorial

If there is a theme that runs through our articles this issue it might be "inspiration". Often inspiration from nature and the cleverness and intelligence of our fellow humans are what draw us to bio-inspired design. That combination is evident in many of our writings here.

Associate Professor Brook Kennedy of Virginia Tech writes about using macro lens attachments for cell phones as an aid to finding that inspiration. Moreover, he argues that open discovery of the details of nature should be the starting point for design innovation and advocates the use of journals to begin the process of bio-inspired design.

Our Heidi Fischer presents an homage to all the biologists that she has trekked, climbed, hiked and paddled with in order to be guided by their knowledge. She honors the wonder of nature and the people who help us know it better.

Ryan Church gives us an update on the progress of his company, Biome Renewables, since his interview and article on the PowerCone in *ZQ16*. He gives an account of lessons learned that informed his process for technological development in the commercial market.

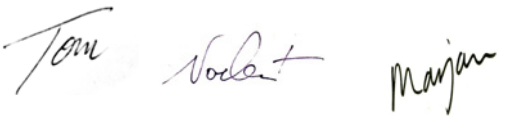
Artist Kristine Zingeler shares her beautiful art assemblages and ceramics in our portfolio section. Her inspiration stems from her deep appreciation of the preciousness of life: the open wonder of her children and the fascinating artifacts in a nearby natural history museum. Learn how she has turned two-dimensional photography into a component of three-dimensional sculpture.

Shoshannah Jacobs talks with Director of Business Alan Finney and Executive VP Anne Kania of Floating Island International, a company that is using natural plant constructions to improve the quality of freshwater lakes and reservoirs. Finney was inspired on a Wisconsin fishing trip and later reflected on how the conditions that were good for fish could be employed to benefit all of us.

Finally, we memorialize biologist Nicolay Bogatyrev, who was continually and unabashedly inspired by nature (particularly bumblebees) and how it accomplished work. We follow with a reprint of his 2012 opinion article from *ZQ2*. His article is a rejoinder to ten popularly held assumptions about nature that, as a biologist and engineering educator, he could not countenance. His rational and thought-provoking piece still has resonance today.

We hope you are inspired to get out into nature and find your own spark of peace, wonder or innovation. Happy reading!

Happy reading! ×



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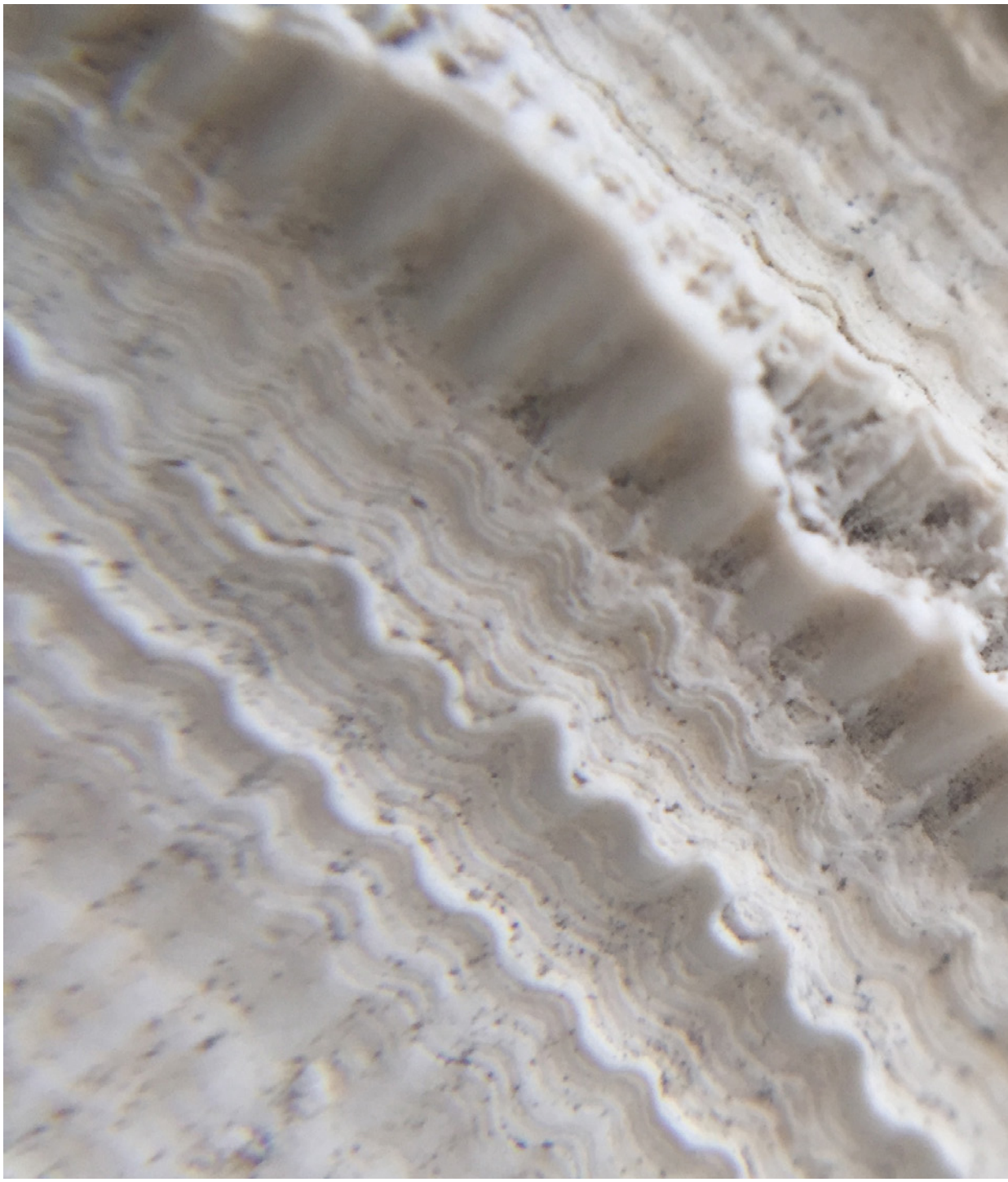

Magnified view of ocean clam shell construction
Photo: Brook Kennedy

Article

Looking Closer: Cultivating Bio-Inspired Design (BID) with Macro Photography

Brook Kennedy

Looking Closer: Cultivating Bio-Inspired Design (BID) with Macro Photography

Brook Kennedy

How do researchers comb through natural phenomena to discover areas of potential BID research in the first place? Macro photography journaling using open source, low-cost macro lenses designed for ubiquitous camera-equipped smartphones to stimulate BID research questions can engage newcomers into this transdisciplinary field and lead veteran researchers to new areas of inquiry.

Macro photography has often been undervalued in BID. Observing overlooked, seemingly mundane natural phenomena and materiality, sometimes nearby one's home, workplace, or school, can encourage a sense of surprise, curiosity, and discovery. The central aim of the Macronaut 2 journaling toolkit is to help draw attention to natural phenomena that are otherwise taken for granted. Macronaut is a low-cost clip-on macro lens for common models of smartphones, making it accessible to a larger audience. The companion journaling exercise with reflection sections helps structure these macro-photography activities and encourages building connections between the act of seeing and the creative contemplation of design, material, and engineering possibility. Above all, these tools can cultivate enduring curiosity in natural phenomena and thereby make a significant contribution in 'growing' the BID discipline.

Brook Kennedy

Unlike "problem-based" bioinspiration methods where a defined brief guides problem-solving, macro-photography journaling begins with open ended observation exercises. Participants explore "solutions", namely biological specimens and artifacts, and reflect upon how these specimens integrate with their ecosystems and how their apparent "design" might prompt analogous ideas and approaches to human challenges. Sometimes the rationale for phenomenon in nature might not be obvious, but its characteristics might still be relevant and justify closer investigation. One of the more famous BID innovations born of close observation is the hooked, cane-shaped spines of

Magnified view of water droplet on leaf | Photo: Brook Kennedy

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Brook Kennedy

burdock seeds. This phenomenon informed the idea behind VELCRO®, which inventor Georges De Mestral later developed into a global franchise.

The original Macronaut lenses were first developed in 2015 with optical-grade acrylic plastic optics and a 3D printed resin frame that could flex around the body of an Apple smart phone to hold the lens in place. Existing lens options at the time, such as the Olloclip, were more expensive and tended to be focused on fitting specific phone models. Two projects inspired by the Macronaut were Corlayer3d[1] from macro photography observation of Atlantic coast clam shells (many of which corrugate to increase their strength, figures 1 and 2), and Fog Harps[2,3] from observations of plants and pine needles in the foggy context of our research university and those of the mighty California coastal redwoods (figures 3 and 4). Both have current US patents granted or pending. The Fog Harps project has resulted in numerous scientific and design publications and has received external industrial R&D funding.

In 2016, macro-photography journaling was first piloted in university-level biochemistry lab classes at Virginia Tech. Examples of unusual biological specimens were gathered from departmental collections in Horticulture, Material Science, Biology, Ornithology, Entomology, and other departments. Over time, the following themes emerged that helped improve the experience and output of the seminars:

1. Introduce an outdoor activity where participants can search for biological specimens themselves and observe them in their natural context.

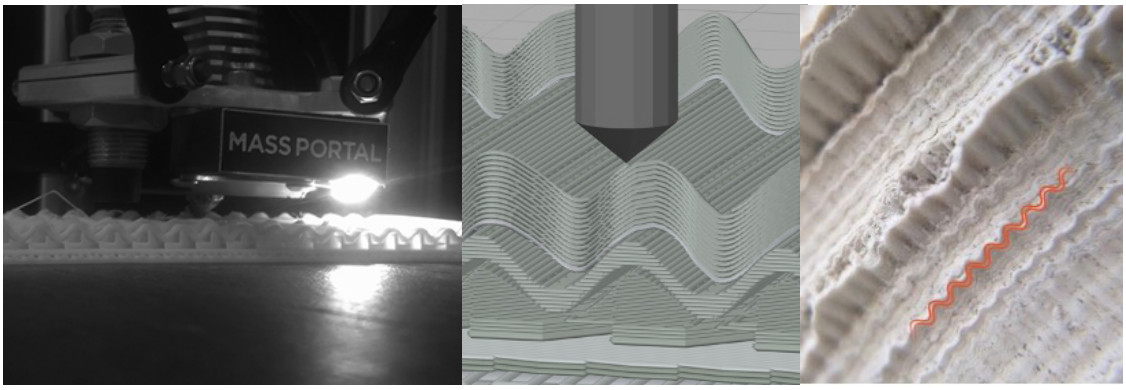


Figure 1a: An image in a lab test printing corrugated layers for increased shear strength in lateral forces. Figure 1b: A computer aided manufacturing simulation of corrugated layering. Figure 2: An image of an inner prismatic layer of a mollusk shell showing interlocking corrugated layers.

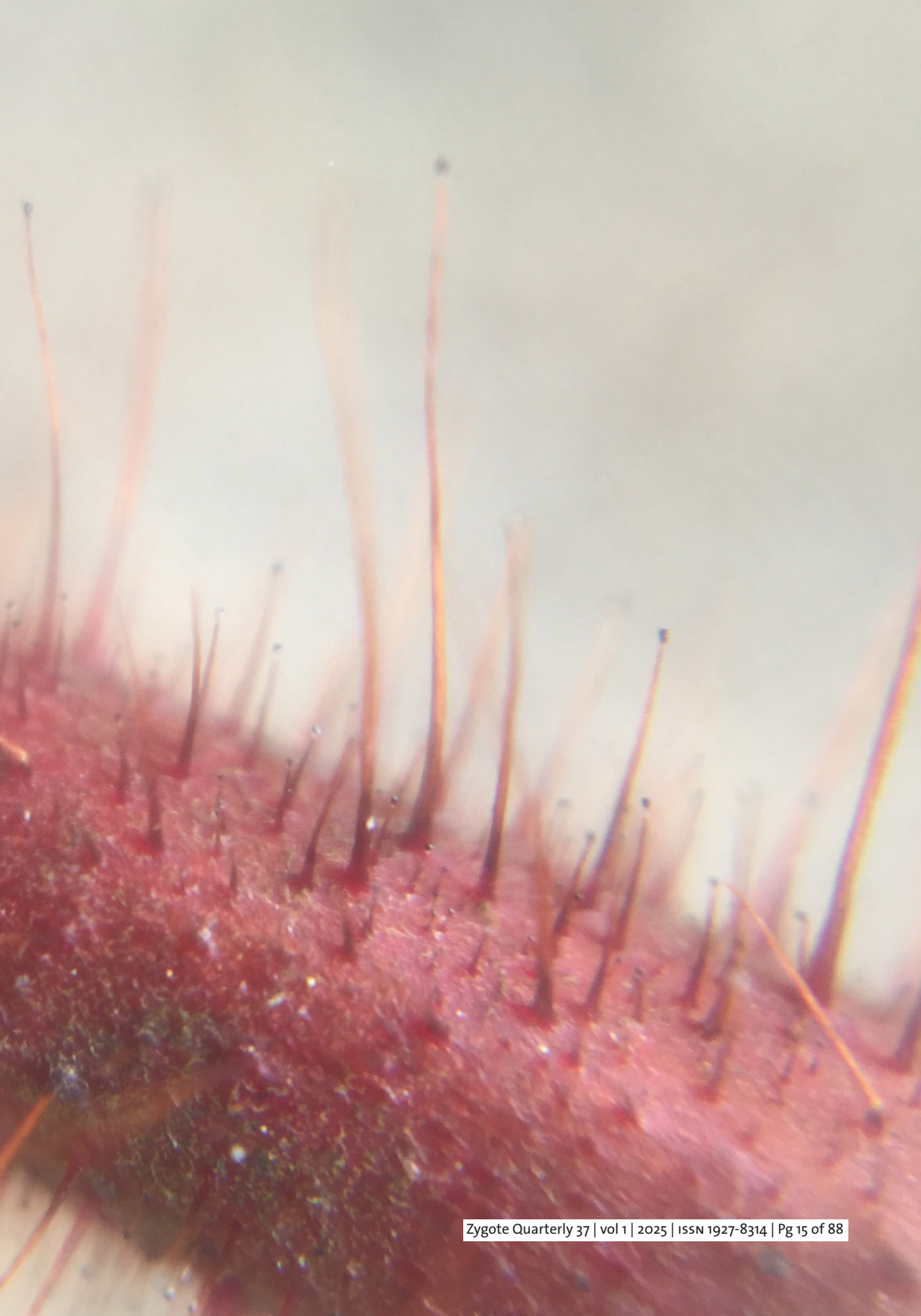
2. Provide more time: conduct the workshop over at least two days to allow more time for observation, analysis, and creative speculation.

3. Select bio-specimens where there are salient visual features that can be explored visually with photography. Avoid objects or objects with features that are smaller than a few millimeters across and that are uniform in quality at the 15x magnification of the Macronaut lens.

4. Improve the design of the smartphone macro lens frame itself. Identify ways to make it attach to the widest variety of smartphone models where the cameras are in different places. Use materials that won't scratch phones or protective screens.

Figure 3 (top). A proof-of-concept image in a lab test of fog harp fog water harvesting material. The material gathers on average 3-5X more fog water than conventional fog harvesting meshes. Figure 4a and 4b (bottom). An unidentified reed with a macro photograph of collected fog water droplets in the author's university's town. This plant's linear reeds helped fog collect and roll off onto the ground where the water is consumed by trees and other organisms in the ecosystem.

Magnified view of Trichomes | Photo: Brook Kennedy

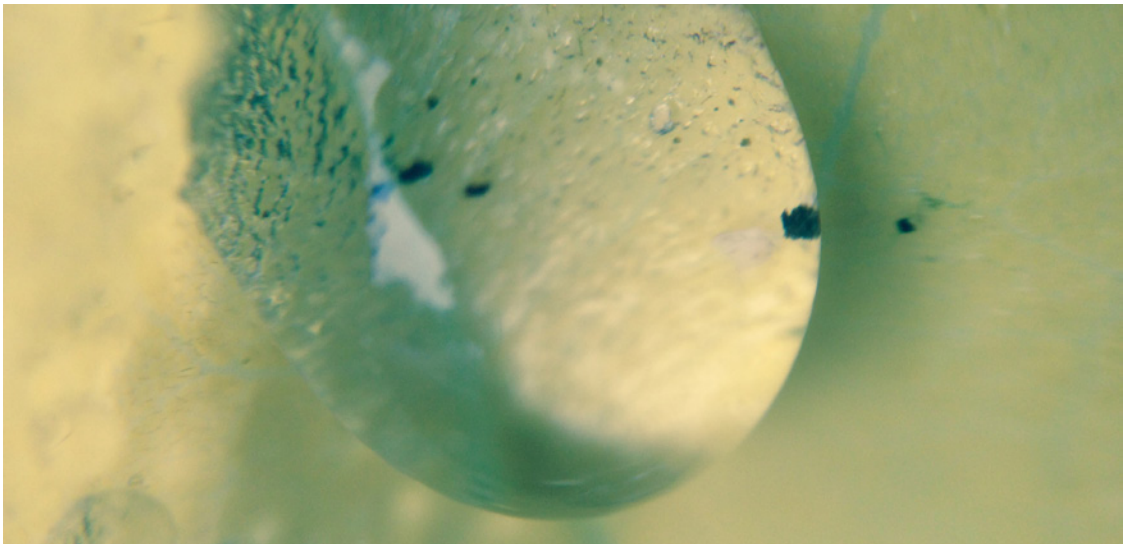


Looking Closer: Cultivating Bio-Inspired Design (BID) with Macro Photography
Brook Kennedy

The Macronaut 2 lens frame (figures 5 and 6) was developed in 2023 using 3D CAD software and printed by the 3D printing service Shapeways, using a newer, soft thermoplastic polyurethane (TPU) to avoid scratching phones and cases. Some Macronauts were colored with a reddish-orange natural dye so that they could be easily found if dropped. The lens and frame overall measures 40mm X 17.5mm X 16.5mm, stretches around phone cases, and fits more phone models. The design is meant to be open source for anyone to print at cost to maximize accessibility; about USD $8 for the frame. There is a small channel inside the frame into which an optical grade acrylic plastic macro lens can be inserted. The acrylic optics from an online bulk supplier cost about USD $0.03 each. These Macronaut 2 lenses, or any other commercially available macro lenses ranging from USD $10-$100, can work for the journaling exercises, although the roughly 15x magnification of the Macronauts is optimal because it visualizes enough novel detail to stimulate curiosity. When magnification is too high, the imagery ceases to be identifiable, whereas if magnification is too low, the resulting imagery loses intrigue.

In the spring of 2024, a structured journal was developed and incorporated into a graded assignment for a general Bio Design/BID research seminar with 10 undergraduate research assistants from Industrial Design and Architecture majors. Although the main thrust of the class was to explore biomaterial composite design with an industry sponsor, the Macronaut journaling exercise was assigned to situate this activity in a broader BID context. Students were provided with either a second generation Macronaut 2 lens prototype, or store-bought comparable design (figure 7). This exercise enabled them to explore the university's botanical garden and find biological

Figure 5. An image of Macronaut 2 prototypes used for the De Mestral Macronaut journaling in March 2024. Figure 6. An image conveying the level of detail provided by 15x magnification.



specimens to photograph and reflect upon more intimately. Specifically, students were asked to photograph any plant they found, both with and without magnification, to document the contrast between the images (figure 8). Afterwards, the students were provided with a journal document and asked to fill out a section to capture what they discovered and learned about the specimen and then reflect creatively about potential practical design opportunities stemming from their observations and discoveries.

Figure 7. A computer-generated image showing the Macronaut 2. Figure 8. Avery Gendell, a graduate student researcher in the Hahn Horticulture Center at Virginia Tech, photographing ground covers in March 2024.

Magnified view of Dandelion pod attachment | Photo: Brook Kennedy

Looking Closer: Cultivating Bio-Inspired Design (BID) with Macro Photography

Brook Kennedy

The journal was broken into two main sections:

1. Background: A visual explanation of macro photography and its potential to help discover new biologically based phenomena of potential interest and research value. This context is explained through examples, such as Georges De Mestral examination of Burdock seeds and the invention of Velcro.

2. A template to help guide the process of exploration and discovery of biological phenomena and traits that can be filled out digitally and then shared (figures 9-12.).

Figure 9. (Top left) The introduction page for the De Mestral Macronaut Journal. Figure 10. (Top right) An example of observation and analogy to human problems. Figure 11. (Bottom left) An image of the De Mestral Macronaut Journal template. Figure 12. (Bottom right) An image of a filled-out template showing examples of hydrophobia and ways it could be applied to human problems and challenges.

Photographed specimens and phenomenon ranged from mollusk shells, leaves, insects, tree sap and transpiration. Biospecimens and resulting creative design ideas are summarized in Table 1. Although feedback discussions revealed that some ideas were implausible, 90% of the student researchers found the exercise creatively inspiring and commented on its value in a separate written reflection paragraph. Some commented specifically about how the journaling exercise changed their perspective about natural systems, especially in relation to the built environment and sustainable design. Some mentioned how the exercise would be helpful in identifying good briefs for their undergraduate thesis/capstone design project.

Table 1. Macronaut journal results.

Bio specimen	Phenomenon	Creative Use
Gingko Tree Leaf	Transpiration (cooling)	Outerwear
Switchgrass	Hydrophobia	Umbrellas, shoes, Coatings
Lambs Ear	Bug repellant	Socks
	Sun protection	Outerwear
	Dew collection	Architecture
Lambs Ear	Insulation	Outerwear
Maple Tree Leaf	Non-tear structure	Woven fabrics
Orchid Leaf	Light reflectivity	Safety Equipment
Ant Feet	Grip	Climbing Equipment
Emperor Penguin Feathers	Insulation	Protective Outerwear
Tree Saps	Adhesion	Adhesives
	Protection	Coatings
	Binding	Material Binders
Alaskan Wood Frog	Cooling	Coolant
	Preservation	Organ Preservation
	De-icing	Aviation
Saltwater Clams	Impact resistant material	Consumer products

Looking Closer: Cultivating Bio-Inspired Design (BID) with Macro Photography
Brook Kennedy

More emphasis should be placed on helping BID researchers discover natural phenomena that encourage BID research activity. Macro photography and related journaling exercises could play a role in these efforts, especially for those without expertise in biology and natural science. Using macro photography can stimulate design and engineering research questions from otherwise overlooked day-to-day natural phenomena. Disseminating these optical imaging tools and using them alongside existing BID methods will help develop the discipline and support the kinds of inventive contributions this field has already achieved. ×

The Macronaut 2 lens is currently not available from Shapeways. If you are interested in the lens or journal, please contact me via https://design.vt.edu/faculty-staff/faculty/industrial-design/kennedy-brook.html.

Acknowledgements
A special thanks to the undergraduate research team, which was led by graduate student Avery Gendell: Will Baron, Hana Baiod, Maddie Haley, Hayden Battaglia, Aidan O'Driscoll, Wyatt Yates, Katie Deddens, Barbora Malikova, James Kim, Avery Gloyd and Jena Bae.

Adapted from:
Kennedy B. (2024). Look Again: Cultivating Curiosity with Macro Photography to Grow the BID Community. Cambridge Open Engage. DOI:10.33774/coe-2024-pwklg

Brook Kennedy is an award-winning multidisciplinary designer who also serves as an Associate Professor of Industrial Design at the College of Architecture and Urban Studies at Virginia Tech. There he pursues multiple research collaborations, including in bio-inspired design, with an eye on applied outcomes in social impact, human health and sustainability. Kennedy completed his graduate design work at Stanford University.

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Magnified view of water droplet on Tulip Tree leaf | Photo: Brook Kennedy

Snowflakes
Photo: Madison Inouye, 2016 | Pexels cc

The Science of Seeing
Spellbound
Adelheid Fischer

Spellbound

Adelheid Fischer

I recently heard a story that was simple enough in the telling but profoundly revealing in its implications. The story was from a friend and former colleague Clint Penick, and it went something like this.

In 1988, when Clint was a kid, his hometown of Tallahassee, Florida, was hit by a big snowstorm, a weather event that was—and still is—extremely rare in the Sunshine State. He and his buddies did what you might expect: they rolled in the snow, pitched snowballs, constructed a snowman. For Clint, however, one memory stood out from all the others. He recalled how neighbors set up sprinklers under their citrus trees in order to create a layer of insulating ice that would protect them from the bitter cold. As the water dripped off the branches and froze in place, it formed massive icicles as exotic as any Star Wars light sabers. Clint and his friends plucked the icicles from the trees and, after playing with them, carefully packed them away in their family freezers. So enthralled were the kids by the magic swords that for months after the storm, he says, they would regularly check on their treasures stashed among the frozen steaks and peas.

Fast forward 37 years to March 2025, when Clint experienced another freak snowstorm in the South, this time in Alabama, where he teaches entomology at Auburn University and is now raising two small kids of his own. Although his daughters could sing every song from their favorite Disney classic, *Frozen*, they had never walked into a real snow-covered landscape. So Clint was determined to make their first venture every bit as memorable as his own. He took them into the forest behind their house to listen to the muffled quiet that only fresh-fallen snow can create and then on to their favorite park where a topdressing of puffy powder transformed their playground into a place as fantastical as any wintry scene from a Hollywood movie. But he saved the best surprise for last. Clint stood in the swirling snow to catch a few flakes on a tray of ice cubes, a makeshift scheme that kept them frozen long enough to view their stunning filigree patterns under the microscope in his study. Snowflakes are nearly always hexagons, he explained to his kids as they peered through the lens and counted their six sides. Yet, no two designs are alike, he added. Like people, each snowflake is unique.

"The question is not what you look at, but what you see." This line from Henry David Thoreau could be the mantra for every biologist I know. Unlike many nonscientists, who too often view nature in broad brushstrokes and crude outlines, biologists never take the natural world at face value. Instead, they go deeper, expending

Snowtracks
Photo courtesy of Clint Penick

Spellbound
Adelheid Fischer

Microscope and snowflake
Photos courtesy of Clint Penick

Spellbound
Adelheid Fischer

considerable time and effort to actually see what they are looking at. They investigate why the world is the way it is, in the process, revealing how it works. They put snowflakes under microscopes and uncover a world that is infinitesimally more beautiful and wondrous than it appears on a superficial looking.

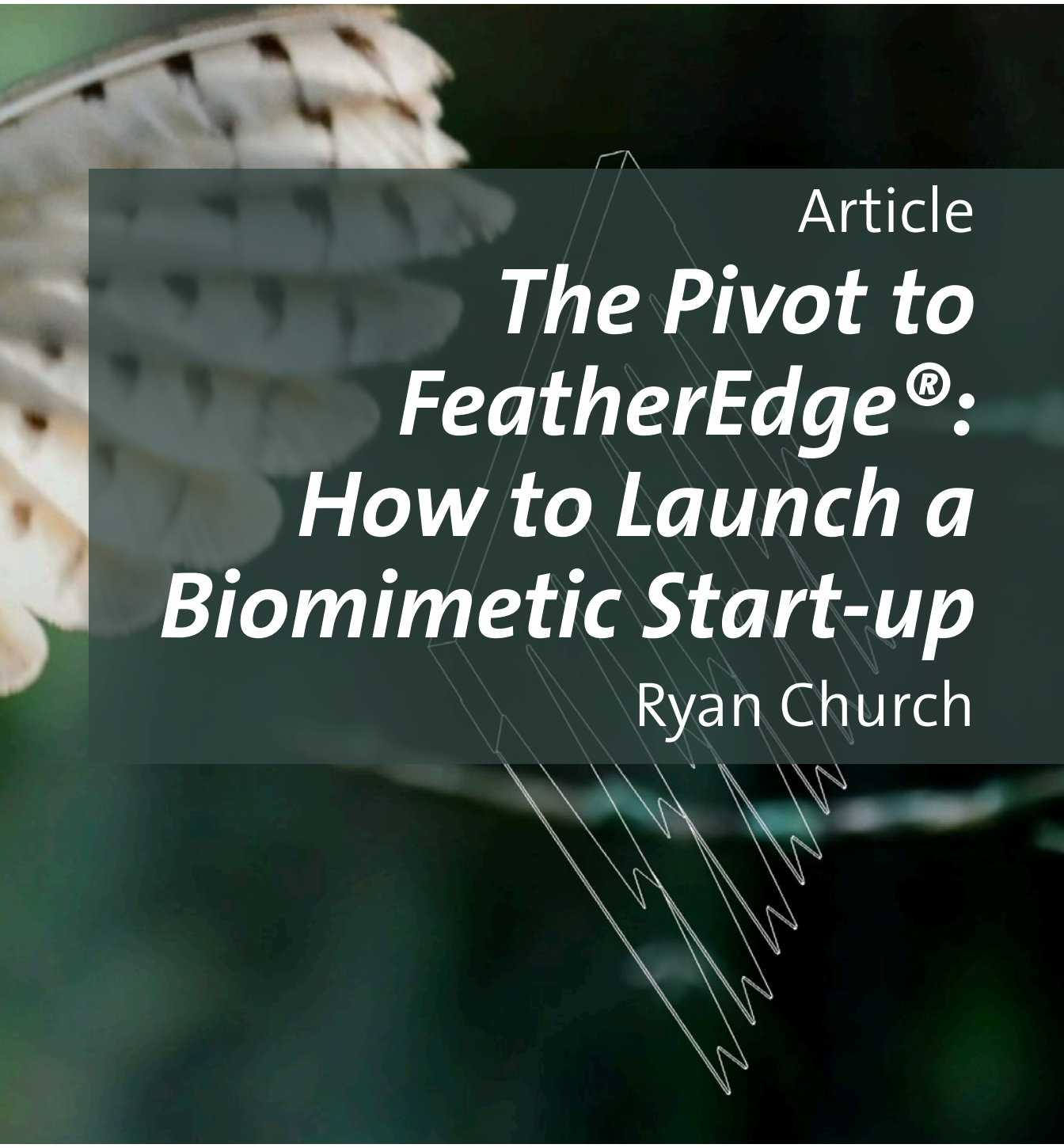
I regard scientists as nothing less than the masters of enchantment, a word that comes from the old French, *enchantement*, meaning to "charm," "bewitch," "to cast a spell." For decades now, I have followed spell-casting biologists into the field to learn about their research and to write about their discoveries. I've hiked with them along the base of volcanos for evidence of life flourishing in the aftermath of its destruction, turned over rocks in mountain streams in search of giant waterbugs, paced the desert floor to pick through the decaying remains of giant saguaro cactuses, teetered on a floating bog as it rippled under my feet so that I could experience the full landscape diversity of a northern forest, reclined belly down next to a red-rock pothole to make the acquaintance of mites no bigger than a pepper flake, looked up into the dim canopy of an old-growth forest as a mating pair of endangered owls peered back down at me. Their research findings are like incantations that conjure an astonishing world that is otherwise hidden in plain view. They have kept me spellbound for most of my adult life.

What I have learned from a lifetime of biological sorcery is this: we are surrounded by miracles but often cannot see them without a bit of help. Consider the snowflake, which begins its extraordinary life in the clouds as a meandering mote of dust or a microbial speck until water crystals latch onto their surface. Following a law of physics, the water molecules bond in hexagonal formations. When the crystals grow too heavy, they fall to earth to swirl around our heads as six-sided jewels each with its own distinctive lacey filigree.

We know this because a scientist once took the time and made the effort to see them for the wondrous things they are. ×

Clint and co in forest
Photo courtesy of Clint Penick

FeatherEdge® inspiration
Photo courtesy of Biome Renewables



Article

The Pivot to FeatherEdge®: How to Launch a Biomimetic Start-up

Ryan Church

The Pivot to FeatherEdge®: How to Launch a Biomimetic Start-up

Ryan Church

The tenet of biomimicry is that we take the complexity of nature, boil it down to the essentials, and then build it back up into technology, systems, or ways of interacting with our world. This process is complicated. When you pair this with the task of launching a company, starting a business, or developing a new technology, the task seems overwhelming. Very few startups reach across the Valley of Death (VoD), and even fewer are biomimetic start-ups. It doesn't help that many proponents of biomimicry are not businesspeople. The company I founded a decade ago, Biome Renewables, has crossed that valley. We just turned 10 years old, and business ... finally ... is booming. Readers of previous *Zygote Quarterly* articles may remember the series "Stories from the Trenches"[1,2,3]. Along with co-authors Rachel Hahs and Norbert Hoeller, we examined several case studies from different sectors and asked why innovation from the 'lab' either makes it or doesn't. We wanted to spark debate in the biomimetic community and see more success stories.

Ryan Church

Biome Renewables was known for its PowerCone® technology. While technically successful, it also suffered some engineering setbacks. In the post-mortem, we analyzed a key question: is *this* the technology to be commercializing *now*? The answer was no. Mainly this came down to capital. Coming out of COVID, the market wasn't ready for such a complex technological undertaking as the PowerCone. The investor market wasn't ready. Innovation does not need to involve 'new physics', but the PowerCone was proving some new physics. It was upending 100-year-old formulas that defined the wind industry, and not everyone was ready for that change – especially coming out of the uncertainty of COVID. Compared to other technologies we had in our quiver, the PowerCone would have a longer maturation cycle and be higher risk.

Biome Renewables was fortunate. We had several technologies and a treasure-chest of intellectual property (IP). Surveying the market needs and the technology we had, we made the critical decision to put the PowerCone back into 'R&D mode' and pivot to commercialising FeatherEdge®[4], Biome's trailing edge serration technology for wind turbine noise reduction. We crossed the

Flying Western Barn Owl | Photo: Mark A Jenkins, 2024 | Pexels cc

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Ryan Church

VoD from concept to revenue in 24 months, claiming the prize of the technical market leader in the process. And we did this in the wind industry, a slow and terribly risk-averse market, in the hardware segment, beating industry giants with 100 times our funding.

Back in 2014, I saw a David Attenborough documentary that explored how the owl flew silently. David watched and listened as different birds flew back and forth between two perches in a recording studio, their every wing flap recorded. First the pigeon flew, sending the audio needle gyrating. Then the owl flew - they had to check they were still recording... Owls use multiple strategies to fly silently. At the trailing edge of wind turbines, turbulent boundary layers of different velocities mix in an area of wild acoustic abandon. Homing in on what an owl's trailing edge was doing and how we could apply that physics to a wind turbine defined our core IP.

Fast-forward eight years, and the market forces that created the original problem statement had increased by an order of magnitude. As the team discussed which technology we should commercialize in place of PowerCone, we wanted an opportunity with a clear market potential that had not been fully exploited. Wind turbine noise and the trailing edge serrations market showed potential. Saw-tooth serrations to reduce leading edge noise had been in the market since the early 2000s, demonstrating that noise was important. They were implemented on nearly all new onshore wind turbines in Europe. But innovation had stalled with noise reduction around 1.5-2.0 dB(A). The demand for renewable energy squeezed larger and larger machines that made more and more noise onto less and

Noise Impact Contours without and with FeatherEdge®
Images courtesy of Biome Renewables

less land. Noise regulations in some jurisdictions were becoming stricter. Twenty-four months ago, we found a perfect storm of market forces driving the need for noise reduction to a head, and we had the IP and design concept - a huge head start.

With the market need hurdle cleared, we focused on the technology itself. The challenge is picking a business opportunity of the right size. The parameters are simple enough, yet slippery and somewhat undefinable. The opportunity needs to be large enough to be meaningful, yet small enough to be doable with the team and resources at your disposal. And if you do succeed, will anyone pay for it? For Biome Renewables, the question was: how meaningful was it to achieve another 1 dB(A) of noise reduction? The decibel scale is logarithmic, so that benefit is an order of magnitude in importance. We felt that 0.5 dB(A) would be the threshold: a measurable difference that would be believable. If we got to 1 dB(A), we had liftoff. We didn't just guess at these figures; we asked our soon-to-be customers and validated our assumptions. Customers told us that for every 1 dB(A) of noise exceeding regulations, they lose 3-5% of production, which is now supported by a recent market study that found an average of 5% across a range of turbines[5]. There were geographies that were more susceptible to noise losses, particularly in western Europe, where pro-wind policies stretching back decades had collided with large population masses and little undeveloped land. We now had figures to back up the opportunity. We also researched what the current incumbents paid to manufacture their solutions and how much they charged their customers. If we got the engineering right, we were onto something.

The last piece of puzzle before pressing ahead was to determine the innovation roadmap. Looking at the technology, one piece of it could fit in your hand. Was it possible to make a plastic part in the geometry we thought would work, and how many iterations would it take? How long was each turn of the prototype wheel, and did we have the team to pull it off along with the capital to get across the VoD? The importance of speed cannot be overstated. You are driving a car without steering headed for a cliff, and you must generate revenue or raise further funds before hitting the edge.

What was the minimum amount of capital (MAC) (time and money) needed to achieve a minimum viable product (MVP). This included a series of three important questions: does it work, how long will it last, and how easy is it to make? The first question took us six months to answer through a series of acoustic wind tunnel

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Ryan Church

tests on different design models. Then came the next evolution of that question: will it work *in the field*. Six months later, we had an answer. A further six months of in-depth accelerated lab testing allowed us to answer the durability question, and crucially, obtain independent certification. The lab testing also answered the last question, although we are still improving our manufacturing methods.

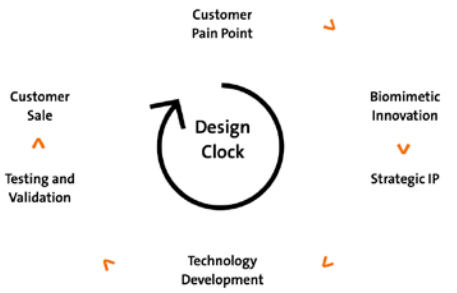
After 24 months we are revenue generating. Independent testing on turbines from 2MW to 6MW demonstrates our technology delivers on average an additional 3 dB(A) noise reduction above what is currently available, making our FeatherEdge-equipped turbines 50% quieter than the incumbents. The largest electric utility in the world, Iberdrola, called our technology a game-changer. We succeeded by asking the right questions and making a few correct calls. We also succeeded because we had the team to get it done. The idea was 1%, the execution was 99%.

Barn owl, Coaldale, Alberta
Photo: Alan D. Wilson, 2020 | Wikimedia Commons

In collaborating with our customers, Biome Renewables deployed an internal strategy that I developed years ago called the Design Clock that lives at the heart of Biome Renewables' innovation engine and is one of the foundations of our success. The design clock links all the questions and processes I have explored here and integrated them in the practise of biomimicry. To escape the VoD, you must make it around a full turn of the clock, like an entrepreneurship board game. The process is flexible and cyclical.

The design clock has six stages:

1. Customer Pain Point
2. Biomimetic Innovation
3. Strategic IP
4. Technology Development
5. Testing and Validation
6. Customer Sale



1. We start with a customer journey. Get in your customer's shoes and *empathize* with them. What pain are they feeling? What would they pay to make the pain go away? Call the customer and ask them. Perhaps even ask them what an ideal solution would look like. Problem solvers often exit this stage too soon. "If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions" (attributed to Albert Einstein).

2. With the problem well defined, look to the natural world and ask a series of probing questions to identify the appropriate analogy. This requires lateral thinking and associative memory - there are resources available like AskNature which can kickstart the process. For technical problems, scale and physics matter. But you rarely need to invent new physics.

3. When you believe you have identified strategic IP, do a quick market scan or literature review to see if someone else has beaten you to it. Depending on the scale and complexity of the defined problem and assumed solution, develop a first prototype. Get professional advice and file patents in a timely manner to protect your IP.

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Ryan Church

4. The fourth stage is technology development. If you haven't already, you ask the first in a series of four questions: will it actually work? Investors want the confidence that something works before funding you. You refine your IP by evolving your prototype - you may need to cycle back to the third stage. This is one of the most important chasms in the VoD.

5. In the fifth stage, you ask how long will it last and how easy is it to make? For hardware, this can be a long journey. For software, this is usually a short one, which helps explain why software startups are more likely to succeed.

6. The last stage is the customer sale. This is the ultimate test, or to quote Gandalf in *The Lord of the Rings*, "the most grave of enquiries." The questions pile up here: what is your business model, what is your go-to-market plan, what is your beachhead market? What is your insurance coverage? Quite often, you may be forced to 'give away' your first product when you are running on fumes. Again, hardware costs can be substantial compared to a software trial. Do not be satisfied with getting nothing for your first sale - your innovation matters. Even if that first dollar doesn't come your way immediately, get something of value: a future order on success can mean more than a one-time sale. At the point when the sale delivers revenue, you are across the VoD.

One aspect of biomimicry is that the solutions often have a myriad of permutations and applications - nature is multi-functional. Strategies found in the natural world are shape-shifted and re-aligned to fit evolution's arc. Let me be clear however: pick *one* permutation, pick *one* technology, pick *one* market, and one customer. Focus on that: nail it, and do everything to get it right. Never lose track of the fact that you are in a car with no steering wheel. You cannot afford to swivel around and look in the back seat wondering how many other opportunities you can fit in. At Biome Renewables, we focused on launching the rocket. With liftoff, we can now turn around and see how we can bring in other technologies to life, including the PowerCone. ×

Ryan A. Church is the Founder and CEO/ CTO at Biome-Renewables Inc. (https://www.biome-renewables.com), where they are developing biologically-inspired renewable energy technologies. They are launching in the wind industry with the PowerCone®, an enhancement technology that enables nine world-firsts in the wind industry with initial indications suggesting that this technology could break the Betz Limit. He has given university lectures and advised governments in both Canada and Europe as a thought-leader in the field of renewable energy and biomimicry. In 2019, Church was nominated as a Forbes "30 under 30" in Energy.

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Biome's FeatherEdge® serration on a 3MW turbine in Europe
Image courtesy of Ryan Church

Detail of Archean Vessel 19 Installed | 18”x16”
Glazed Stoneware

Portfolio

Kristine Zingeler

Portfolio
Kristine Zingeler

Kristine Zingeler was born and raised in Calgary, Alberta, and received a BFA with distinction from the University of Calgary in "Visual Studies with a Studio Concentration."

She has exhibited steadily since graduation in 2010. Awards include the Jason Lang Scholarship for academic achievement (2008, 2009, 2010, 2011), the Jack Wise Award for Excellence in Painting (2010), she was a BMO 1st! ART Nominee (2011) and a finalist for the Kingston Prize Finalist in 2013. Two of her paintings were included in Manifest Press' International Painting III, a catalogue of recent contemporary paintings from around the world in 2014. Kristine's work is in numerous private collections across Canada.

Ceramic sculptures act as monuments to the textures, colours and gestures of her research; a sort of reef that references specific place and vast history. The photographic collages become windows to this immense past and also the artist's own tiny history within it.

Kristine Zingeler

Could you tell us about how you are inspired by nature?

I have always loved finding beautiful things. When I was a kid I would collect rocks and shells and feathers and imagine little worlds in a tiny patch of moss and clover. I don't think much has changed. I still feel compelled to collect bits and pieces of the natural world and I can't help but be struck by the beauty that exists all around us. It sounds pretty cheesy but it is true. When you take a minute to look closely at something as seemingly mundane as a pinecone or a leaf, it is kind of mind blowing how complex it is. I tend to look at these things from the perspective of a maker and I think at the core of my practice I'm really just trying to learn how our natural world is constructed.

What kind of techniques do you use for your work?

I am an interdisciplinary artist, so basically I use a lot of different methods and materials

Settled Gathering detail | 3D Collage of archival print on bamboo papers, collected gull feathers, in birch box, 2023

Portfolio
Kristine Zingeler

to explore my ideas. I studied as a painter but for the last decade I have focused more on collage, photography, and most recently ceramics. The collages I am making right now are 3 dimensional and built in custom made shadow boxes.

The process is fairly complex and starts with a photographic research trip to the Royal Tyrrell Museum in Drumheller Alberta. I have traveled there to photograph their fossil collections on four occasions. I will spend the morning looking through the drawers and gathering specimens that interest me. Then the afternoon is spent photographing each specimen outdoors on film in natural light. I find those conditions to be the most ideal for getting an image that feels true to the actual object. Once I am back in my studio I sort through the images and try to make some preliminary decisions about composition so I can order prints at the right size and on the right kind of paper. I have printed on a variety of papers and choose them based on what I need the paper to do, whether it is sturdy enough to support itself, or be transparent, or be fibrous enough to tear in a beautiful way.

Once I have the printed photographs I begin building within the boxes, playing with different materials and combinations until I find what I am looking for. In comparison my process with the ceramic works seems pretty simple. I coil build a vessel with a general idea of what I would like it to be. Usually I am envisioning a particular surface texture that references a particular natural object or combination of objects. I leave plenty of opportunity for the clay to participate actively in this process and I embrace all the phenomena intrinsic to this material. Warping and cracking, expanding and blistering, it all feels a bit like magic when you place what is essentially a pile of earth into a kiln and see what happens.

Who/what inspires you creatively? What do you 'feed' on the most?

I think my kids are probably my biggest inspiration. They are four and seven and the way they see the world is just incredible. Kids are naturally curious and don't conform to the same rules and boundaries in their thinking that adults do. I think that the more I can try and embrace that in my own practice, the better it will be.

We spend a lot of time outside just kind of wandering around and I am always getting ideas while we are walking. We collect things as a family and the kids know when they found something that I will

definitely want in my studio, so it feels like they are a part of the process.

What are you working on right now? Any exciting projects you want to tell us about?

I have some ideas floating around about siphonophores. They are these massive colonies of individual animals that function as a single organism. They look a bit like a jellyfish and each animal or zooid performs a specific task for the good of the body as a whole. Some form stinging tentacles, some are feeders, some facilitate swimming, and all of them somehow work together in perfect harmony without a brain to coordinate their actions. I think this is just so beautiful. It is like a perfect model of how a society should function and is also just kind of mind blowing to imagine. I am in the early stages of exploring this through ceramics and I am pretty excited about the possibilities.

What is the last book you enjoyed?

A friend of mine, Kirti Bhadresa wrote a book called *An Astonishment Of Stars*. It is a collection of short stories that focus on the experiences of BIPOC women and immigrants living in Canada. It was such a joy to read and I really felt like I was given a beautiful glimpse into the lives of people who I could deeply relate to on a human level.

What are your favourite 3-5 websites, and why?

www.smittenkitchen.com for recipes

www.600sqft.com for design advice on living small and sustainable

www.art21.org for discovering new artists and new ways of thinking about my own work. ×

For more of Kristine's work, please see https://www.herringerkissgallery.com/kristine-zingeler

Masonic cavern | 23.75”x23.75”x3.75” | 3D Collage of archival print on bamboo papers, mason bee cocoons, in birch box, 2024

Childbearers Vessel | 24”x16” | Archival digital print of 35mm photograph, 2025

Doodle Vessel | 24”x16” | Archival digital print of 35mm photograph, 2025

ZQ37

Archean Vessel 21 | 16.5”x11.5” | Glazed Stoneware

Archean Vessel 19 | 18”x16” | Glazed Stoneware

Archean Vessel 21 Installed | 18”x16” | Glazed Stoneware

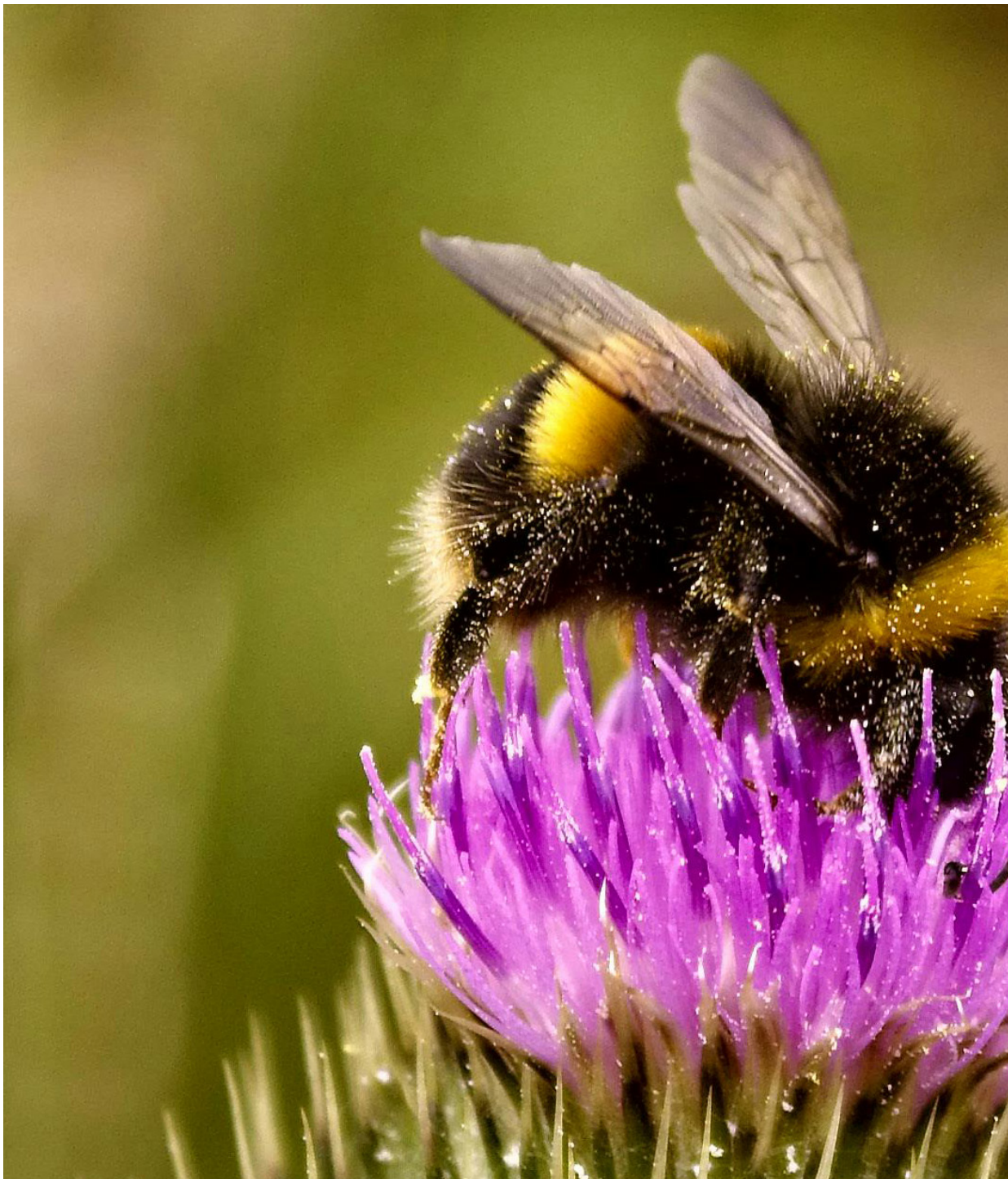
Archean Vessel 1 Installed | 13.5”x12” | Glazed Stoneware

Archean Vessel 6 Installed | 11.5”x8” | Glazed Stoneware

Ceramics at *Portraits of Time and Place* exhibition
Installation Image of Portraits of Time and Place Exhibition
Herringer Kiss Gallery - February, 2025

Detail of Brittle Branch Installed | 18”x16” | Glazed Stoneware

Installation Image of *Portraits of Time and Place* Exhibition - Herringer Kiss Gallery - February, 2025



Bumble bee on purple flower
Photo: Michelle Reeves, 2019 | Pexels cc

In Memoriam

Nikolay Bogatyrev

In Memoriam
Nikolay Bogatyrev

Nikolay Bogatyrev, who passed away on January 28, 2023, is remembered as a TRIZ expert, educator, author and consultant with more than 20 years of experience in the United Kingdom and Russia.

The Theory of Inventive Problem Solving (TRIZ) is a systematic method for creative problem-solving and innovation. Developed in the Soviet Union in 1946, the methodology is based on the analysis of patterns in inventions and technical systems evolution as an aid to a structured solution approach. The method focuses on identifying engineering contradictions, employing a set of inventive principles to overcome these contradictions, and reviewing evolutionary patterns of technical systems.

Olga and Nikolay Bogatyrev

Dr. Bogatyrev was awarded a PhD in Biology from Novosibirsk State University where he began a lifelong study of bumblebees. It was here that he was first introduced to TRIZ. Although a biologist, he was keenly interested in an engineering approach and ecologically sound architecture and design.

In 2002, he joined the mechanical engineering department at the University of Bath, where he employed the tenets of TRIZ to aid the transfer of mechanisms and effects in nature to technology. He produced more than 80 publications, ranging from popular science papers to research articles and books. During his teaching career at Bath he developed his own set of rules for eco-engineering and published them in the book *Ecological Engineering of Survival*.

Posthumously, his wife Olga has published two biomimetic books that he had been working on: *Living Things as Inventors: The Language of Living Nature* (https://www.amazon.com/dp/0995657882/), and *Laws of Living Nature: Biology for Innovators* (https://www.amazon.com/dp/0995657890/). ×

Bumble Bee | Photo: Chris Wakefield, 2018 | Flickr cc

Clump of Reindeer Lichen
Photo: Eva Bronzini, 2020 | Pexels cc

Opinion

Biomimetics: Ten Assumptions I Question

Nikolay Bogatyrev

Opinion

Nikolay Bogatyrev

We reprint here an opinion piece Nikolay had written for us in 2012 in Issue 2 of Zygote Quarterly.

Living nature is reliable, adaptable and sustainable. This has been proven by millions of years of evolution and is successfully applied today in the cutting-edge field of engineering, biomimetics.

Biomimetics is a relatively young branch of engineering methodology, but those who wish to trace its roots may find many historical attempts to copy nature. For example, Leonardo da Vinci observed animals and plants and foresaw the possibility of converting biological principles into technological ones. Later, more emphasis was placed on the need to increase the functional capability of engineering devices. Today, biomimetic ideas are also driven by the concepts of sustainability and nature-friendly engineering as we face the issue of the destruction of our planet's biosphere.

In recent years we have observed the growth in popularity of biomimetics. It has happened because of the wrenching changes which contemporary society faces now: ecological crisis, climate change, and health-threatening pollution of the environment. It has appeared that the conventional engineering approaches do not necessarily work as effectively and efficiently as we had expected. This is especially apparent if we take into account their global impact on our life. These issues have started to attract the attention of governments, media, architects, designers, engineers and the general public. No doubt science fiction books, films, Internet discussion forums, computer games, and other media have warmed the public's interest in copying nature and seem to have turned it into a kind of fashion.

Biomimetics takes ideas from biological systems and transfers them into technological implementation. Thus, the profession is in a mediatory position between biology and technology. There is clearly a need for cross-domain and cross-cultural knowledge transfer. Engineers and scientists in collaborative biomimetic projects face serious differences between their respective methodologies (scientists describe and model, while engineers prescribe and produce) and cultures (biologists study life, engineers design, build, and maintain machines).

Historically these two domains, biology and engineering, were very distant from each other, yet the biomimetic approach requires these two realms to be as close as possible. Ideally, they should both be present in the one head of the person who works on a biomimetic project. But this is not achieved easily, because it requires a large change in our education system. Biomimetic education is not so widespread

as we might wish: there are few teachers who are professionally qualified in both biology and engineering.

Often those who teach tend to keep the discussion either within biology or engineering. Moreover, to get a profound education (do not confuse education with training!), rather than "intellectual fast-food", I believe that one should spend twice as much time and effort to become a professional engineer and a professional biologist. This is not so easy in the current atmosphere of budget cuts and shortened matriculations. I believe that is why we have so many people involved in biomimetic developments that are excellent engineers,

Black ant on moss next to reservoir
Photo: Skyler Ewing, 2020 | Pexels cc

but have a school-level knowledge in biology or are highly qualified biologists with only a superficial understanding of what biological information is needed to develop a technology.

Finally, there is a large section of the public that is quite interested in biomimetics, but is educated in neither engineering nor biology. This section of the public believes sincerely in the promises of science fiction, and well they might. Glossy pictures, lovely urban legends and nearly plausible myths garnish the pages of the popular science press. Many have nothing to do with either engineering or biology. Still, many people expect the proffered miracles of this novel trend in science and technology.

As a result of the aforementioned, biomimetics remains a purely empirical discipline. It has no scientific methodology of its own and, therefore, uses just "good old" trial-and-error methods and inspirations. The living prototypes for biomimetic design often are chosen accidently and very often their functions are misinterpreted. Biological "paragons" often are found after the engineering device has been developed and the idea of biomimetic design is used mostly for marketing and advertising purposes. This is not a bad practice, in my opinion, as long as it is not confused with science and engineering. The frequent result is that the analogy between bio- and techno-systems is superficial, trivial or does not help to solve the engineering challenge. It is, very often, due to the lack of education in biology.

So, let us consider some of these popular assumptions that are suggested widely as the basis for biomimetic research and development. Let us see if they are solid enough to play the role of scientific or methodological guides for biomimetic design:

"Biomimetics is about copying and imitating nature".

We might discuss and dispute how to copy or what to imitate, but it would be besides the point, because direct and exact copying would be pointless, expensive, inefficient and possibly dangerous. Here is why I think so;

A copy is always worse than the original. Having an original object, why would we need its copy, which is always worse by definition?

We do not really need the complete copy: if we are going to produce an artificial biomimetic tooth, do we need caries and toothache also?

Life is poly-functional and is adapted to perform all of the functions, not just the one we need to copy. We do not need our vacuum cleaners to defend their territory

or migrate every winter to the warmer climates.

"Life is always perfect". Another popular asumption: "Nature is always wise".
Not always and not everywhere. Mind the millions of extinct species in the course of the history of our planet and those that are dying out now. Some of them were doomed due to morphology, others to behavioral peculiarities, still others due to physiological reasons. If you think about the imperfections of the human body you will realize that natural "paragons" are not so common. "Nobody is perfect!" is, therefore, a very apt phrase. The whole reason for the origin and development of technology itself (tools, transport, agriculture, medicine, etc.) is, I believe, to compensate for the deficiency of our embodiment of living Nature. By the way, technology is not the unique feature of humans; many animals also compensate for their weaknesses by building nests, burrows, shelters, accumulating food for themselves or their off-springs, and by using various objects as tools for their every-day needs.

"Living nature uses only the energy it needs."
Most organisms, however, accumulate and deposit excessive amounts of food and/or structural substances. Often rodents cannot consume all the accumulated food of their grain storages. Squirrels hide their food (nuts, seeds, cones, etc) and often just forget these places with the hidden food. Honeybee-keeping would be impossible, if bees accumulated only the exactly required amount of honey for their own needs. If we consider the ecosystem level of living systems, we can cite the example of a pond that is gradually silted with the excessive organic matter, which cannot be processed by the organisms inhabiting the pond.

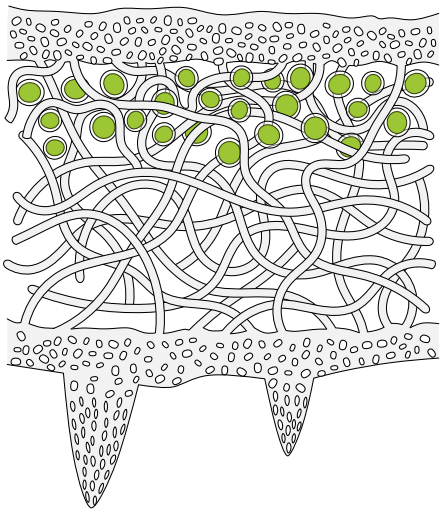
"Living nature recycles everything."
If this is so, why do we see surpluses so enormous that they cannot be processed, consumed, or digested and have to be deposited as coal, turf, oil, or limestone?

Green Lichen
Photo: Umberto Salvagnin, 2008 | Flickr cc

Opinion
Nikolay Bogatyrev

One can say that those deposits will also be recycled eventually, but this will happen in the geological (not biological) time-scale and mechanisms whereas we are considering living systems and the time-scale that corresponds with a human life – tens and hundreds of years, but not millions and billions.

"Living nature rewards cooperation".
I would urge the reader to remember the competition, parasitism, cannibalism, commensalism and ammensalism that exist alongside mutualism (symbiosis) and can even easily transit from one relationship to another. For example, lichen is the symbiosis of a fungus and an algae. When environmental conditions have deteriorated the fungus will digest the algae, thus transitioning from mutualism to cannibalism.



A lichen consists of a body (a thallus) formed mainly by a fungus, with unicellular algae (green) interspersed within the structure. The two species are mutually interdependent, like cells within a multicellular organism.
Chiswick Chap, 2024 | Wikimedia Commons

"Life relies on diversity".
Northern ecosystems exist at a very low level of diversity, as do some grassland ecosystems. In Africa we see a great diversity of species of savannah antelopes, but in the similar environment of the North American prairie the same herbivorous function is performed by just one single species, the bison.

While living prototypes are extremely complex, we need, typically, minimum complexity, maximum simplicity and reliability, ease of operation and predictability. Such features are not easy to guarantee in the case of copying the biological prototype.

"Living Nature runs on the energy of the Sun/sunlight."
This is largely indisputable, but I would also point out that Chaemobacteria run on the energy of chemical substances deep in the soil or ocean. So biomimetic systems seem to use any energy or every opportunity to extract energy from any available source or process.

"Biomimetics will provide sustainability."
This is not necessarily true, in my opinion. A natural tree is sustainable in the context

of the forest ecosystem. If we make an artificial "timber" mimicking the structure of natural fibers and their spatial arrangement and that material is made of carbon fibers and epoxy resin, it will be the perfect biomimetic product, but the manufacturing process and the after-use recycling will be far from sustainable.

"Living nature fits form to function."
This is true sometimes, I believe, but not universally. Very often the same function is provided with sufficiently different forms. Remember the shapes of fast-swimmers, whales and dolphins: the same effect is achieved with radically different shapes of the anterior part of the animals. Other cases could be even harder to approve: female hyenas give birth to their off-spring through a unique structure, an extremely narrow passage that passes through the clitoris. It is an amazing example of the total discoordination of sizes, forms and functions.

"Living nature optimizes rather than maximizes."
This depends, I believe, on what kind of biological system we consider. The number of baby-elephants is always one and the number of eggs that spawn fish can number in the six digits. The amount of spermatozoa, the number of pollen grains and seeds, the sizes of mammoth's tusks, the mass of dinosaurs appear, also, to be beyond the optimal. So, living nature seems to do it all: optimize, minimize and maximize , according to the given circumstances and available means.

Let me be clear: I am fully aware that all the principles listed above exist in nature, but, at the same time, the opposite statements are also true and similarly common in life. These principles represent just a smallest facet of the diverse strategies that Life as a phenomenon does possess.

There is one main feature of living nature that is omitted from this list: Life can possess totally and radically different features: it can be effective and inefficient, large and small, smart and stupid, slow and fast, adaptive and conservative... The professional biologist could easily fill the "space" of the continuum between these extremes with the full range of intermediary examples. This list would be very long indeed. This amazing multi-strategism of Life as a phenomenon is the feature that has allowed it to survive for billions of years in spite of all the changes and catastrophes in the history of our planet. ×

Caspian Tern (*Hydroprogne caspia*)
Photo: JJ Harrison 2011 | Wikimedia Commons

Interview

Floating Island International

Shoshanah Jacobs talks to Alan Finney and Anne Kania

Floating Island International

Shoshanah Jacobs talks to Alan Finney and Anne Kania

In 2013, I set up my research program in Biomimetics as a newly minted Assistant Professor at the University of Guelph. My first objective was to create a database of biomimetic technologies linked with interviews from the designers. I wanted to learn about the practical challenges of new technology development and transdisciplinary problems. Through this work, I met the folks at Floating Island International. I remember our conversation ended with a sincere invitation to visit the team to learn more about their work. Without a research penny to my name, I couldn't make it happen, but I remember the warmth and the kindness.

Now, in a very different career stage, I found myself reaching out again to Floating Island International. Their response was just as enthusiastic and warm as it was over ten years ago.

I sat down with Anne Kania and Alan Finney.

The team at Floating Island International has been collaborating on a technology inspired by nature, using the principles of biomimicry to restore health to water systems and expand habitats for both wild species or agricultural operations. Anne, who is married to founder Bruce Kania, has been with the company since she relocated from New Zealand to Montana in 2007. An experienced project manager (and, incidentally, professional singer), Anne's role as Executive VP is multi-faceted. Alan is the company's Director of Business.

Anne Kania and Alan Finney

Sho: It's wonderful to speak with both of you today about your inspiring work. I'm curious, what are your impressions of the current state of biomimicry or bio-inspired design?

Alan: Biomimicry right now is incredibly promising but also underappreciated. There's a practical beauty in learning directly from nature, but often, we're not fully leveraging its potential. In some ways, we're still at an early stage, still discovering nature's vast capabilities.

Anne: I'd add that biomimicry makes perfect business sense. More companies are starting to see the economic benefits—carbon credits, ecosystem services—but there is still much room to grow. Observing floating islands firsthand was pivotal for me. Understanding the biology behind these natural processes really opened my eyes. I

knew nothing about water quality issues when I moved here, but having our own research lake - and living with Bruce - gave me daily lessons. We would spend hours in the underwater viewing tank, watching fish grazing the roots of plants growing through our floating islands. We'd observe the water clarity improve over time and fish numbers grow, then morph into fewer, bigger fish. The bullfrog numbers went down as the largemouth bass numbers went up. We'd invite community groups of all ages to come and fish and take the "floating island tour", which was an education for me even as I led the tours! Over the years, I came to marvel at how complicated water quality is, and yet so simple when the system is in balance per nature's model.

Sho: What do you see as the biggest challenges?

Anne: Making biomimicry tangible and actionable on a local level. It's about creating accessible solutions and demonstrating clear, measurable benefits, especially financially. Natural solutions don't always fit neatly into conventional human accounting systems. And people with smelly lakes or too much algae want a "quick fix" with

Caspian Tern island at Sheepy Lake, CA
Photo courtesy of Floating Island International

Floating Island International

Shoshanah Jacobs talks to Alan Finney and Anne Kania

BioHaven Streambed (BSB)/Forced-Flow StreamBed (FFSB) and BioHaven Loon nests
Photos courtesy of Floating Island International

chemicals, so we have an educational issue when explaining that a natural approach over time is permanent and cost-effective - not to mention safe for the ecosystem.

Alan: Exactly. One of the biggest challenges is educating people about the value of investing in ecological solutions. We need a clearer message that highlights the practical financial benefits alongside ecological ones.

Sho: Which areas should we focus on to advance biomimicry?

Alan: Small-scale interventions at local levels. If we can demonstrate the clear benefits of biomimicry in local communities—such as making water healthy again using natural systems—we can really begin to scale those successes.

Anne: Yes, that local-to-global model is powerful. Financial access is key, so developing better communication around financial benefits is crucial. Partnerships with nature should also be emphasized as practical and financially viable.

Sho: How did each of you develop your interest in biomimicry?

Anne: Reading Janine Benyus's book, which Bruce handed me on my first day on the job! Floating islands and biomimicry came alive for me when we took a boat trip around Chippewa Flowage in Wisconsin. We visited natural floating islands in every stage of maturity, from a bare slab of peat, which may or may not stay afloat long-term, to a partially vegetated "young" island, to a fully mature, 30-acre floating island, complete with mature trees, underbrush, a "meadow" of perennial, wetland plants and a beautiful, tangled riparian edge where fish were hanging out (muskies, walleye, maybe a world-record size!). Then I understood our design's brilliance, what we were aiming for, and how it worked. And we kept learning, learning, adjusting, and learning until we became one of the few pioneers in aquatic methane abatement.

Alan: For me, it started with fishing in Wisconsin, noticing the effectiveness of natural floating islands—good fishing meant good water. Nature had already solved the problem; I just had to observe and learn.

Sho: What's your best definition of biomimicry?

Alan: It's understanding precisely what nature does, why and how, then trying to replicate that in an efficient, continually evolving way.

Floating Island International
Shoshanah Jacobs talks to Alan Finney and Anne Kania

Anne: For me, it's about developing human-made systems and designs based on how we observe nature doing it, then trusting and learning some more. We didn't know everything about how the islands worked before we started, but as we kept observing and measuring and talking with experts, we began to gain a deeper understanding of "why" they worked, of the incredible processes of nature. Then, we understood Oliver Wendell Holmes's "Simplicity on the other side of complexity" concept.

Sho: By what criteria should we judge biomimetic work?

Anne: By the "aha" moment when we see how brilliant nature is! In our case, it is by how effectively it repairs ecosystems and restores natural functions. Our key challenge is that natural processes don't translate easily into traditional human measurement systems. We can't always separate the impact of a floating island from the impact of the ecosystem regeneration as a whole, which does not always fit the research or remuneration protocols.

Alan: Exactly. We need measures focused on ecological repair, not just financial metrics.

Sho: Can you share any recent inspiration?

Anne: Learning more about how only natural solutions can really solve the problem of natural systems being overwhelmed - with a helping hand from humans. The climate crisis is a case in point. 40% of methane emissions are now coming from freshwater, which is increasing as the climate warms and freshwater systems are overloaded with nutrients. Algae blooms lead to oxygen depletion and then methane generation when the natural system is overwhelmed. Still, by restoring oxygen levels and recycling nutrients into a healthy food web, we can kick-start water recovery and methane mitigation. This is what our RAM system does (Removal of Aquatic Methane).

Alan: That's what we're working on next. The RAM system introduces another function into our technology. We're actively scaling up our RAM systems, collaborating with partners, and securing funding to extend this work globally, especially to developing countries.

Sho: On a personal note, what's the last book you enjoyed?

Anne: *Familiaris*. The stories of struggle and redemption were very human, funny, at times tragic, and very inspiring. The

Shoreline Protection and wastewater lagoon in Takaka, NZ treated with BioHaven technology
Photos courtesy of Floating Island International

Floating Island International
Shoshanah Jacobs talks to Alan Finney and Anne Kania

connections and cooperation between humans and animals were a central theme of the book.

Alan: I've enjoyed recent nature hikes more than books lately. Connecting physically with nature has been invigorating.

Sho: Who do you admire?

Alan: My wife, for her unwavering patience with me.

Anne: Also, people like Carrie Krause, a wonderful violinist, thriving in a region with limited support for musical arts—deeply inspiring.

Sho: Any favorite mottos or quotes?

Alan: “Simplicity on the other side of complexity” by Wendal. It reminds me to keep solutions clear and direct, no matter the problem's complexity.

BioHavens Remove Nutrient Loads from Eutrophic Lake - Yingri Lake, Jinan, China
Photo courtesy of Floating Island International

Sho: What's your idea of perfect happiness?

Alan: Making a real difference—experiencing nature.

Anne: Watching geese rise from a river at sunrise. Making great music with wonderful musicians and good friends.

Sho: If you weren't doing this, what else might you pursue?

Alan: I'd probably return to my roots in computer software, although retirement has its appeal too!

Anne: Retirement sounds good, though my "Quality of Life Left" goals are to keep supporting Bruce in his monumental work and to keep singing.

Indeed, retirement sounds like perfection to the three of us. Thank you to both Anne and Alan for their thoughts and experiences. I'll be checking in in another ten years. ×

Turtles basking on this lush BioHaven in North Carolina
Photo courtesy of Floating Island International

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