Zygote Quarterly: an open-source bio-inspired design journal

Marjan Eggermont

Designer, editor and publisher ZQ

zqjournal.org
Our mission is to establish a credible platform showcasing the nexus of science and design in the field of biologically inspired design.
Scientific Writing vs Science Communication

- Provides scientific context (references)
- Text > Graphics
- Focus on results & interpretation

- Provides societal context (examples)
- Text ≈ Graphics
- Focus on conclusions & recommendations
ZQ’s founders

• Tom McKeag is the program director of the University of California Berkeley Center for Green Chemistry (http://bcgc.berkeley.edu) where he co-teaches the Greener Solutions graduate course.

• Adjunct professor Industrial Design California College of the Arts, San Francisco, where he holds the BioWerks studio course.

• Tom writes the monthly Biomimicry Column at Greenbiz.com (http://www.greenbiz.com/blogs/ featured/biomimicry-column),

• and is the founder and president of BioDreamMachine, a California public interest corporation dedicated to teaching BID
ZQ’s founders

- Formally at IBM, Norbert Hoeller founded the design research and consulting practice Sustainable Innovation Network

- Director of BioDreamMachine (http://biodreammachine.org/),

- founder of the Bio-Inspired Design Community (http://bioinspired.sinet.ca/),

- and chair of the Canadian committee for ISO’s Technical Committee on “Biomimetics” (http://www.iso.org/iso/iso_technical_committee?commid=652577)
ZQ’s founders

- Biomimicry Institute Fellow and past member of Biomimicry Educational Advisory Board (BEAB)
- Board member American Society of Engineering Education (ASEE)
- In addition to a background in Fine Arts and Military History, a PhD Candidate in Computational Media Design, specializing in Bio-inspired Information Visualization
- Co-teach first year engineering design & communication to all 800 incoming students and introduce biomimicry.
Contributing Editors

- Kirsten Hoeller
- Heidi Fischer
- Raul de Villafranca
- Manuel Quirós
- Tanya Lynne Sakamoto

Available in Spanish:
Timeline to launch

- July 29, 2011: Initial idea
- Aug-11: Preliminary mandate
- Sep-11: ‘Zygote’ selected
- Oct-11: Draft manifesto
- Nov-11: Preliminary list of interviewees
- Dec-11: Draft questionnaire
- December 31, 2011: Agreed on ‘Zygote Quarterly’
- 12/21: Received Vogel’s article
- 12/23: Questionnaire sent

- Jan-12: Static website
- 1/10: ISSN assigned
- 1/29: Bespoke Innovations article
- 2/11: Globe 2012 announcement
- 2/12: First issue to authors
- 2/21: WordPress site live
- 3/23 - 3/26: Launch
- 3/23: First issue of ‘Zygote Quarterly’
- 3/13/12: Biomimicry 3.8 Education Advisory Board meeting
- 3/21: REGEN article
- 2/29: Draft of first issue
- 3/12: Bespoke Innovations article
- 1/11: Bay Area Biomimicry Meeting announcement
ZQ provides

- Case studies
- Interviews
- Opinion pieces
- Tools and methodology
- Portfolios
- Product design
- Urban planning
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Two Perspectives: Bucky and the Shape of Nature
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Auspicious Forms: Designing the Sanyo Shinkansen 500-Series Bullet Train

The Background

The tiny notice in his local newspaper in 1990 would prove to be auspicious, in the deepest sense of the word, but Eiji Nakatsu did not know this at the time. Even now he is struck by the futility of the little printed square. Few details were given, a lecture about birds by an aviation engineer at the Osaka branch of the Wild Bird Society of Japan. He decided to go and hear what a fellow engineer would say about his favorite topic.

“Auspicious” is derived from the Latin root “augur” and augury was the ancient Roman practice of studying the flight of birds in order to predict the future. It is a remarkably apt description of the next five years of Mr. Nakatsu’s life, all set in motion by a scrap of newspaper. For Mr. Nakatsu, was the General Manager of the Technical Development Department for one of the world’s fastest trains, and he quickly realized that studying the flight of birds could indeed bring his train, and us, into the future.

The Sanyo and Kyushu Shinkansen Lines, operated by Japan Railway West and Japan Railway Kyushu, run between Shimonoseki and Kagoshima at the southern tip of Kyushu Island. The line connects western Japan’s two biggest cities, Osaka and Fukuoka, and is an extension of the older Tokaido Line from Tokyo to Osaka.

The 515 kilometer Tokaido Shinkansen is the world’s busiest high-speed rail line, having moved 400 billion passengers from its opening in 1964 (for the Tokyo Olympics) to 2010. Indeed, more people move by train in Japan then anywhere else in the world, and it is estimated that 64 million Japanese travel by rail all sorts every day. Of this 40% above in world train traffic, 820,000 riders travel each day on the 2508km of the total Shinkansen network.

Railway Route Sources
Photo courtesy of Nakatsu Eiji
The Design Process

The train in service, the Shinkansen 0 series, had a more or less wedge-shaped nosecone, having supplanted the earlier bullet-model trains. This was compared with new alternatives by the use of scale models. All of the Shinkansen companies were attempting to solve the sonic boom problem and RTI made an intensive investigative effort. They found that the ideal nose was either a wedge or a rotational parabolic surface with a section that changed area by a constant ratio.

As with the case, the JR West team obtained the natural artifact and analyzed its dimensions and materials. West Mr. Nakatsu found that the bill of the Kingfisher was consistently round in cross-section, and he described it as an elongated ellipse surrounded by four circles. The Kingfisher bill can also be described as a rotational parabolic body. Both the lower and upper leads of the bird have triangular cross-sections with the sides of the triangles being curved. Together, they form a squashed diamond shape, the same shape that would be formed in the interactions of four perfect circles packed together.

Informed by these parameters, RTI set about to test various nose shapes in a 10-scale model tunnel and measure the pressure waves generated. This was similar to the Kingfisher's bill to the bill of the Kingfisher. Concurrently, the shape of the Kingfisher bill was, indeed, the most efficient of all those tested, beating all alternatives by a wide margin. Refined prototypes were built and ultimately made to full-scale for test runs on the tracks.

It was at this point that Mr. Nakatsu became convinced that nature had much to teach about efficient forms. His initial inspiration had been confirmed by the results of both the large-scale instrument tests and the analysis of the supercomputer. In a dramatic 2004 demonstration of the streamlined quality of the kingfisher bill, TV Asahi broadcast a program showing the differences in splash created when a simple cone and a rotational parabolic body are each dropped into water.
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Curt McNamara

Case Study: Gearing Up (and away): How a little backyard bug might change engineering
Tom McKeag

Article: The ISO/TC 266 Biomimetics Standard Initiative
Taryn Mead and Norbert Hoeller
Case Study

Gearing Up (and away): How a little backyard bug might change engineering

Tom McKeag
for his anthropomorphic analogy, Dr. Fulton revealed that the structure returns to its original shape after each

Together, however, and you get to a structure like an archery bow, the resilin will prevent the structure cracking and will always ensure escape pressure.

The strips have 10 to 12 gear teeth, asymmetric in their form, looking like shark fins on just

...jump sequence

Photo courtesy of Malcolm S. Foxes
Issus nymph gears
3D printed insect gears observation 1

- The ‘gears’ are recessed and are remarkably self-aligning
- Backlash free (any tension in the animal takes up ‘play’)
3D printed insect gears observation 2

- The ‘gears’ are a one-directional timing mechanism
- They don’t transmit much power but they allow very precise orchestrated movements
3D printed insect gears observation 3

- The ‘gear’ shape sweeps through a subtle 3D path (the software had trouble with this)
3D printed insect gears observation 4

- While we could not see many animals it looked like a robust system: able to deal with more shape variation in the ‘teeth’ than the engineering equivalent gear trains

- Applications: evolved mechanisms, ad hoc hinges and latches, and other seldom-used orchestrated movements (closing jaws, multi-linkage mechanisms)
Case Study: Sahara Forest Project: Seeing the Forest For the Trees
Tom McKeag

World: Interview with The Bionic Learning Network of Festo

Case Study: Sticky Wicket: A Search for an Optimal Adhesive for Surgery
Tom McKeag

The Science of Seeing: Stories and Atoms
Adelheld Fischer

Book: Engineered Biomimicry by Akhlesh Lakhtakin and Raul J. Martin-Palma, Eds.
Reviewed by Michael S. Elltson
Festo’s Bionic Leaning Network

Students were given a demonstration of their BionicOpter and we, as the teaching team, followed up with a bio-inspired design project.
Water locomotion device

The project: to design and build a biomimetic device that travels through water. Each team was assessed on:

The ability of their device to utilize a biomimetic means of propulsion to traverse a water trough;

The communication of the team’s design process, including: development and analysis of alternative solutions, prototyping, and testing.
Other work with the students
Students create a map of challenges and strategies based on an organism they have found on asknature.org:

**LOTUS:**

- Generate Energy from sun
  - Photosynthesis

- Maximise exposure to the sun
  - Maximizes surface area with broad leafed leaves floating on pond

- Must be able to support large leaves
  - Leaf supported by floating on top of water with strong stem connected to roots at floor of pond

- Must stay clean
  - Surface texture that allows water to bead, collecting dirt as it washes off the leaf

Design for Surface:
- Coating for Surface
  - Paint
  - Spray

Designed into Surface of Material:
- Plastics
- Metals
- Windows
- Surfaces
- Walls
- Clothes
CHAMELEON

CHALLENGE
Maintain a view from all directions at all times

STRATEGY

Eyes are conical shaped, and mounted on turret like platforms. The eyes can move independently from one another.

CHALLENGE

STRATEGY

Must be able to avoid predators

THE 360 DEGREE EYE MOVEMENT ALLOWS FOR CONSTANT VIEWS OF THE AREA

DESIGN

AVIATION

SECURITY CAMERAS

MILITARY SCOPES

SAFETY

DESIGN

AIR TRAFFIC CONTROL

SHIPPING

SECURITY

NEED TO SEEK PREY FOR FOOD

STRATEGY

360 DEGREE EYE MOVEMENT ALLOWS FOR A RAPID SCAN OF THE AREA FOR SMALL QUICK MOVING PREY

CHALLENGE

CAPTURING PREY

STRATEGY

TOGETHER CREATES BINOCULAR VISION IN FRONT, ALLOWING FOR AN ACCURATE STRIKE WITH ITS TONGUE

Drawing #3
Title: Chameleon Astron
Date: Nov 80, 8009
Scale: 1:1000
Human Heart

**Challenge**
- Acting as a muscular pump for circulation to occur

**Strategy**
- Composed of cardiac muscle that allows contraction of heart for blood flow

**Challenge**
- Separation of oxygenated and deoxygenated blood flow into different parts of the body system

**Strategy**
- Division of chambers in the heart

**Design**
- Methods to deliver and receive (de)oxygcnated blood to ensure blood flow in a closed cardiovascular system.
  - Left cavity will receive oxygenated blood from the lungs.
  - Right cavity receives deoxygenated blood from all parts of the body except for the lungs.

**Strategy**
- Network of flexible tubes or blood vessels.

**Design**
- Tubes such as arteries, veins, and capillaries convey the blood flows.
  - The expansion of capillaries will become veins that circulate back to the heart for the return of oxygen-rich blood.
  - The arteries leave the right ventricle for the lungs to carry deoxygenated blood to the body and returns to the heart through the veins upon heart relaxation.

Connected as branched tubes and allow blood flow through one another via expansion or contraction of the vessels.

**Organ #** 3
**Title** Biochemistry
**Due** Dec 8 20
African Swallowtail Butterfly

Camouflage, Mate Attraction, Warning to Predators

Strategy

Iridescence: produce brilliant and intense colors when light hits the wings

Challenge

Maximize wing color intensities

Strategy

Reflect, diffract, and scatter light numerous times

Challenge

Heat and dry the body and warm to move wing muscles

Strategy

Must amplify the effects of iridescence

Challenge

Colors must change depending on animal's viewpoint

Strategy

When light hits the wings, it is reflected numerous times. The combination of these reflections, along with wing movement, causes color to shift and change. Ultraviolet patterns are also created.

Biomimetics of Butterfly Wing Iridescence

Reflective Displays

Electronic display screen (high emission LED)

Interference/reflective nano-technology in cell smart phones

Polymerized nano-particle coating

Micro-moire patterns

Other concepts without pigments

Paints for clothing, buildings, or other industrial applications

Fabrics

Ceramics

Cottong for Surfaces

Drawing

3

title

Biomimetics of butterfly wing iridescence

date

december 8, 2009

scale

4:1
Bivalve Mollusk

Challenge

Re-open the shell from a closed position

Strategy

Allow compressed ligament to release and utilize elastic resiliency

Challenge

Muscle holds the shell closed, keeping the ligament compressed

Strategy

Signals to muscle are stopped, allowing the ligament to release

A hinge joining the shell halves together allows movement

Design

Muscle contracts from bioelectric signal

Ligament's elastic resiliency releases when muscle relaxes

Electromagnetic Solenoid

Torsion Spring
Gymnarchus niloticus

Undulating fin allows both forward and backward swimming.

Future better/more efficient underwater propulsion.

Knife Fish

Movement in Water

- Strategy
- Use Fins

Challenge

Maximize Speed

Strategy

- Smooth, long shape without caudal, pelvic or anal fins

Challenge

Without those fins, need alternate method of transport

Strategy

- One large main dorsal fin running along most of body for propulsion

Maximize Control

Strategy

- Main dorsal fin allows both precise forward and backward movement

Challenge

- Overcome bad vision when hunting

Strategy

- Generates small electric field around body for sensing prey and obstacles

Drawing # 3

Title Knife Fish

Date December 09

Scale N/A
Case Study: Our Material World: A Composition in Major and Minor Keys
Tom McKeag 8

People: Interview with Rick Dove 76

Case Study: Oh, So Plastic!
Tom McKeag 8

People: Interview with Russell Kershmann 86
tions such as Georgia Tech, CalTech and Harvard will be turning out young engineers who will be looking to NASA for opportunities to apply what they have learned. In order to get this topic elevated within NASA, we are working to include NID in the NASA Systems Engineering Handbook, a project that will benefit from George Studor’s INCOSE initiative.

On a more scientific level, I have been exploring the Phylogeny (evolution), Ontogeny (individual development) and Epigenesis (interaction with the environment) of POE model developed by Moshe Sipper and his colleagues as a way of organizing and making sense of natural processes. The Sipper group conceived of POE as forming the three dimensions of a natural systems process space, where each axis has unique characteristics that can also be viewed as different information processing modalities. Evolution builds a recording of historical events in DNA and this depends on errors called mutations. Ontogeny reads this evolutionary recording to create an individual living organism, but unlike evolution this is very fault intolerant, requiring mechanisms that avoid, detect and rapidly repair errors. Epigenesis involves the resulting animal, plant or microorganism’s response and adaptation to environment changes, often through some form of memory, such as the nervous and immune systems or structures (like bone) that develop through growth under stress. Much as the Cartesian system revolutionized the field of geometry, the POE model suggests opportunities for advancing engineering design in natural systems processes by exploring each axis as well as the interaction within the POE space.

What is your favorite nature-inspired design of all time?

The shining example of successful bio-inspired design in spacecraft engineering has to be the Ames Evolved Antenna (http://www.nasa.gov/centers/ames/news/releases/2004/04_55AR.html), a project led by Jason Lohn (Carnegie Mellon University, Ames Research Center) that used a nature-inspired design process to meet a specific engineering requirement. A conventional antenna had already been designed for an Earth orbit mission called Space Technology 5 (ST5) mission. ST5 was intended to demonstrate new technologies, providing Jason an opportunity to propose an alternative novel antenna design created by using a genetic algorithm (phylogeny) that met all requirements but was different from anything seen before in both engineering and nature. Due to subsequent changes in the ST5 mission design, revised specifications were issued which could have seriously delayed the project because a conventional antenna would have no longer performed adequately. Hardware designs are often ‘baked in’ early in the design process and redesigns can be both expensive and time-consuming, but Jason was able to rapidly design and develop a revised antenna within a month, allowing the ST5 project to remain on track.

Although the goal was not to develop a better antenna but one that only met conventional design criteria, Jason Lohn’s design process based on evolutionary algorithms was able to deliver solutions more rapidly than conventional approaches, which is critical when requirements change. The Ames Evolved Antenna has flown on two other missions that did not have a technology demonstration component: the LADDEE lunar orbiter (http://www.nasa.gov/mission_pages/laadee/main.html) and the IRIS mission (http://www.nasa.gov/mission_pages/iris/index.html). Jason co-founded the start-up X5 Systems (http://www.x5systems.com/) to commercialize his design method.

What is the last book you enjoyed?

Consciousness: Creeping up on the Hard Problem, by Jeffrey Gray.

Whom do you admire? Why...

That’s a tough one. I have met many great people. I would say that out of the many the three that come to mind are my mentor, the late Dr. Guido Majno, Chairman of Pathology at the University of Massachusetts Medical School. If I hadn’t by some stroke of chance early in my medical education attended one of Dr. Majno’s lunchtime U. Mass lectures on the history of medicine, my career would have been radically different. Also, Apollo 17 Astronaut Jack Schmitt, who I worked with on the lunar dust project while I was Chief
Recognition
Click the images below to download finalist logos
Science & Nature Magazine of the Year
In Association with Apazine

- e-Science (Faculty of Sciences, University of Adelaide)
- Focus (Immediate Media Co)
- Kids Discover: Ecology (Joe Zeff Design)
- Lund University Research Magazine (Lund University)
- National Geographic Magazine (National Geographic Society)
- ZQ (Zygote Quarterly)

Specialist Magazine of the Year
In Association with Apazine

- BBC History (Immediate Media Co)
- e-Science (Faculty of Sciences, University of Adelaide)
- Edge (Future Plc)
- Flight Safety Australia (Civil Aviation Safety Authority - Australia (CASA))
- History Revealed (Immediate Media Co)
- Homes & London (Totality)
- Telescope Mag (Telescope Mag)
- The Write Life Magazine (The Write Lifestyle)
- TWM - The Watch Magazine (Watchfinder & Co.)
- WatchTime (WatchTime)
NOMINATED FOR
BEST DIGITAL PUBLICATION

Zygote Quarterly
ZQ

Marjan Eggermont, Designer, Publisher, Editor; Norbert Hoeller, Editor, Writer, Webmaster;
Colin McDonald, Designer, Webmaster, Web Designer; Tom McKeag, Editor, Writer;
Raul de Villafranca, Manuel Quiros, Tanya Lynne Sakamoto, Contributing Editors
Zygote Quarterly
Biomimicry Summit and Education Forum (BSEF)
Special Issue
ZYGOTE MAGAZINE BSEF INTERVIEW

Thank you so very much for answering our interview questions. Your insights are important to us and, with your colleagues’ responses, will form the basis of our periodic assessments of the profession of bio-inspired design.

Bio: (Program bio will be used unless one is added in this document)

Would you please tell us about?

THE SUMMIT

- What are the key takeaways from your conference talk? How would you summarize your presentation?
- What impact do you hope/expect/intend your conference talk to have on your profession and/or others? How will it advance the field?
- What stood out at this conference and what did you learn?
- What is not clear to you and would like to learn or know more about
- Any circumstantial benefits? New collaborations? Interesting discussions during the breaks?
- Any action items after this conference? Things you will do, would like to do?

OUR PROFESSION:

- What are your impressions of the current state of bio-inspired design? What is working well for the current state of bio-inspired design?
- What do you see as the biggest challenges?

http://zqjournal.org/
Interview

Peter Niewiarowski

Gecko

Photo: Panchohp, 2016 | Flickr cc
Dr. Peter Niewiarowski (https://www.uakron.edu/biology/faculty-staff/detail.do?identity=1209909), Professor of Integrated Biosciences (IB) and Biology at the University of Akron (UA), is a Biomimicry Research and Innovation Center (BRIC) Principal Investigator. His appointments include Post-Doctoral Researcher, Savannah River Ecology Lab, University of Georgia, 1993-1995; UA Professor since 1995; and, Interim Director, UA Integrated Bioscience PhD Program, 2009-2012. His research includes projects in amphibian population biology, life history evolution and physiological ecology of lizards and gecko ecology and evolution, especially as it relates to adhesion. Gecko adhesion research, in collaboration with the lab of Ali Dhojwala, a UA polymer scientist and BRIC principal investigator, is the main focus of his current work, including biomimetic applications.

Peter teaches introductory and advanced levels within UA’s Biology and IB programs. He developed courses including Advanced Ecology, Herpetology, Principles of Biology, Vertebrate Zoology, Tropical Vertebrate Biology, Communicating in Integrated Bioscience, Research in Integrated Bioscience, Theory and Foundations of Biomimicry, and Biomimicry Design.

Peter holds a BS in Biology, Marlboro College, Marlboro VT, 1984, and a PhD in Ecology and Evolutionary Biology, University of Pennsylvania, Philadelphia PA, 1992.

What are your impressions of the current state of biomimicry/bio-inspired design?

In my view, it is in a very exciting, generative phase. There is no shortage of activities and initiatives, formal and informal, academic and nonacademic, which are popping up globally. Many are connected or are getting connected through dynamic knowledge and social networks that amplify potential impacts beyond local frames. I am daily struck by the intellectual and creative dissonance that emerges from so many diverse and widely distributed efforts in both the application and process of biomimicry. The dissonance is driven by enormous messiness, which is disconcerting to many people, but which is also a fundamental source of surprise and success. For a biologist, it is like going to a new place for the first time ... the excitement around the un-
known and of discovery is visceral. It is great to be a part of this time in the development of the ideas and application of biomimicry.

What do you see as the biggest challenges?

I think the biggest challenges include finding ways to connect, sustain and deepen the diverse groups developing biomimicry across the globe. From my vantage point, I think we need more work across disciplinary lines in academic settings, and this will require courage, experiments and patience. There are many programs where two disciplines are brought together, like biomechanics and bioinformatics. Much rarer are platforms where the cultures, methods, and perspectives of 3 or 4 fields can be brought to bear collaboratively on problem definition, discovery, design and the application of biomimicry. In my view, expanding what is possible with biomimicry will require such exploration, integration and synthesis. Similarly, we should look for new ways to create paths that cross and become well-worn between academia, business and communities. Universities can lead both of these kinds of changes, but it is not work that universities are necessarily used to. Our collective here in northeast Ohio was built by partners that cross many of the lines noted above and we find the work difficult yet rewarding. Biomimicry as a practice would benefit from more experiments crossing these boundaries.

How did the University of Akron Biomimicry Training Platform Get Started?

Doug Paige (Associate Professor of Industrial Design at the Cleveland Institute of Art, http://www.cia.edu/academics/industrial-design/faculty/douglas-paige) and I started collaborating in 2010 on combining biology and design as part of the University of Akron’s Integrated Biosciences PhD program. Holly Harlan, founder of the Cleveland Entrepreneurs for Sustainability (EaS) network, encouraged us to attend a Biomimicry 3.8 Educators Workshop in San Francisco. When challenged to set ourselves a Big Hairy Audacious Goal, we decided to launch a sustainable PhD platform around biomimicry and collaboration that cuts across fields and programs. It was an idea that would have gone exactly nowhere without the collaboration of Tom Tyrell and Don Knechtges, two entrepreneurs who created Great Lakes Biomimicry (GLBio, https://glibiomimicry.org/), an organization focused on using biomimicry for regional economic development. GLBio connected us to industry, making the funding for biomimicry fellowships possible. The virtual Biomimicry Research and Innovation Center (BRIC, http://ubiomimicry.org/about) was launched in 2012 and recognized as a key initiative of the University of Akron’s Achieving Distinction Strategic Investment Program (http://www.uakron.edu/provost/achieving-distinction/2012-recipients.dot). BRIC’s success in winning university support depended on our corporate connections and economic development focus through collaboration with GLBio. Moreover, the focus of GLBio was to define a large scale sustainable platform for regional economic development through biomimicry. That vision was and continues to be a force driving biomimicry well beyond academic boundaries.
What are the unique features of Biomimicry Training Platform?

Although other institutions support PhD fellowships, they are typically associated with a single professor or grant initiative. The Biomimicry Training Platform is a research area of the University of Akron’s Integrated Biosciences (IB, http://www.uakron.edu/ib/) interdisciplinary PhD program that draws students from a wide range of colleges, such as Arts and Sciences, Engineering, Polymer Science, School of Nursing, Arts and Sciences, Engineering, and Fine Arts. The platform started with three biomimicry Fellows in the fall of 2012 (http://bioinspired.sinet.ca/content/uakron-phd-training-biomimicry-peter-niewiarowski) and has since grown to 15 Biomimicry Fellows (http://uabiomimicry.org/principal-investigators/fellows/). In the same time, IB has grown to 50 PhD students in five research areas.

We admit students with a Bachelor’s or Master’s degree from any program. The current Fellows have backgrounds not only in biology but also arts, industrial design, engineering, mathematics, and computer science. They are supported by BRIC that draws faculty members from all colleges. BRIC is a fluid and dynamic organization—a network that is constantly growing and changing. The members continue to work closely with their mentors in their individual faculties. Additional partners include the Cleveland Institute of Art, GLBio, and the professional design firms Balance Inc. (http://www.balanceinc.com/) and Nottingham Spirk (http://www.nottinghamspirk.com/).

Lastly, Biomimicry Fellows are embedded in industry or schools, supported by five-year industry or foundation stipends of about $130K arranged by BRIC and GLBio. Fellows funded by industry usually work with the company’s R&D department, providing training in biomimicry as a tool, exploring specific initiatives, developing intellectual property, and in some cases working on new products and services. Six of the current fellows are funded by foundations such as the Cleveland Zoological Society, Avon Lake Regional Waters and the Nord Family Foundation—they work with non-profits or help K-12 schools to develop curricula that broaden the STEM (Science, Technology, Engineering and Math) experience to include new approaches to innovation.

What factors helped the initiative be successful?

It is still too early to assess success, given the relative youth of the initiative compared to established PhD programs. We were fortunate to have strong support from U/Akron leadership from the beginning of the project. The partnership among U/Akron faculty, the Cleveland Institute of Art, GLBio, and industry has been essential in building a collaborative that actively engages and nurtures networks.

U/Akron brought academics who understand the challenges of developing PhD programs as well as existing research connections with industry R&D departments. The Cleveland Institute of Art provides a focus on arts and design that complements the U/Akron capabilities. GLBio was started by two entrepreneurs who had a long history in running both small startups and large companies. GLBio had built extensive networks of regional corporate leaders interested in economic development, innovation and sustainability—inevitable in identifying suitable targets for the initial proof of concept. The full im
pact of BRIC, especially beyond the boundaries of the University, cannot be appreciated outside of its deep collaboration with GLBIO. Industry partners such as Partner Hannfin, Sherwin Williams, GOIO Industries, Lubrizol, Bendix, Goodyear, Kimberly-Clark, and Nottingham Spirk help ground the Fellows’ research.

Lastly, BRIC has been able to build a critical mass of local expertise that also has global reach. In spite of the importance of digital communications, face-to-face interactions are still essential for effective interdisciplinary collaboration.

What insights have you developed since founding BRIC?

Interdisciplinary collaboration sounds easy but requires considerable and constant effort if it is going to be repeatable and scalable. Like any complex system, it involves building a network that enables information flows, interactions and creating new capacity.

All parties need to feel that they are getting value from the interaction. BRIC allows industry personnel to learn biomimicry concepts, explore how they can incorporate biomimicry at different scales into different departments, and experiment on specific projects. The value for Fellows tends to be more diverse. Some want to make an impact beyond building knowledge in their field or are attracted by the creative aspects of making ideas real. Others see collaboration as a way to identify gaps in current knowledge, increasing the breadth and depth of their understanding. The process of developing practical applications by creating and then testing models is consistent with how academics work.

Lastly, biomimicry is more than knowledge transfer – often the knowledge is either not available or hard to apply. Success frequently involves negotiating a common understanding across fields. Soft skills in social interaction and confidence combined with humility are as important as specific expertise – key relationships are tested regularly. It is crucial to create a ‘space’ that encompasses the important knowledge fields and ideally enhances all of them.

What results have you seen so far?

The first cohort of three Fellows (Daphne Fechery-Lippens, Bor-Kai Hsiung, and Emily Kennedy) are now in their fourth year. All have vastly different backgrounds but are deeply committed to biomimicry. They are truly the heroes and pioneers, dealing with the enormous challenges of dealing with the cultures of a university graduate program and industry R&D. They take great pride in how the initiative has grown around them. They have shown the value of taking ownership and being empowered to drive change by engaging in the real world.

Industry results depend heavily on company leadership, expectations and dynamics. Emily Kennedy has worked with multiple R&D departments at GOIO (https://www.goio.com/) to improve sustainability, reduce carbon footprint and develop new ways of delivering products, leading to the filing of six patents. I expect that six or so Fellows will be delivering similar results over the next few years.

What opportunities do you see in the future?

Opportunities: really, imagination is the only limit. Most exciting, in my opinion, are opportunities for diverse partnerships to drive formal R&D of methods for the field of biomimicry, and for getting biomimicry thinking into school curriculums at early ages.

What is your favorite interdisciplinary work of all time?


What is the last book you enjoyed?

The systems view of life: A unifying vision by Fritjof Capra

Whom do you admire? Why...

People that pursue their dreams with passion, but never at the expense of others. Because that’s a big part of what improves our world.

If you could choose another profession or role, who/what would you be?

Never even think about that; seems like a distraction to consider it.

What is your idea of perfect happiness?

It seems like an odd question. What I can say is I would be happier if I had a little more time for play, family and friends and a little more money to travel to faraway places I have yet to see. *
“The trouble is that once you see it, you can't unsee it.
And once you've seen it, keeping quiet, saying nothing, becomes as political an act as speaking out.
There's no innocence.
Either way, you're accountable.”
- Arundhati Roy