Biomimicry Newsletter

Welcome to the Last Edition of 2004!

Six months following the gathering, we have indeed been busy. I hope that all of you that attended Biomimicry Gathering III in Montana have received your six month letter by now and have been pleasantly surprised! Over the last six months, Janine and I have given a suite of presentations, worked on several research projects and have continued work on the database, which is now scheduled to blossom in early spring. We are still developing ideas around the formation of a non-profit and are also exploring collaboration with several other sustainability organizations. We'll certainly keep you posted as these efforts formalize.

Planning on our two workshops is proceeding. The 2005 Biologists at the Design Table (BaDT) training will by held in late May in the North Carolina area. A former student from the Biomimicry and Architecture course at Blacktail, Barbara Beechwood, is organizing the course for us. Our spring Biomimicry and Design course will be offered in Costa Rica, April 29th through May 5th. This course is locally coordinated by a former BaDT training student, Corina Logan. Details on these courses will follow in the next newsletter. In the meantime, contact me for more information.

Inside

Happy Holidays to all of you. I hope you've all taken the time outdoors to spend in awe and in conversation with our partners in this endeavor. The Biomimicry Guild wishes all of you the warmth of friends and family, the light of the hope around you, and the deep seeded wellness one can find in taking care of oneself and others.

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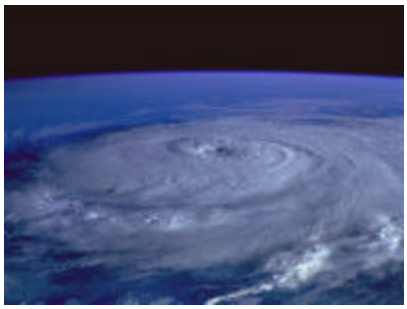
The Science Behind Biomimetic Technology Confirmed

Biomimic Jay Harman reports that a recent independent research study provides scientific confirmation of the underlying theories he uses in his work.

Harman's company, PAX Scientific, is an industrial design firm that translates flow geometries found in nature into industrial technology such as fan blades, pumps, mixers, boat propellers, and other technology to handle fluids. Since its founding, PAX has accumulated a wide variety of in-house and external test results on the fundamental discovery that provides the foundation for the company's unique designs. Harman calls this the PAX Streamlining Principle. Tests demonstrate that the technology's streamlining effect can reduce energy requirements in fans and other rotors from between 10 and 85% (depending upon the application); the fan blade design also reduces noise by up to 75%.

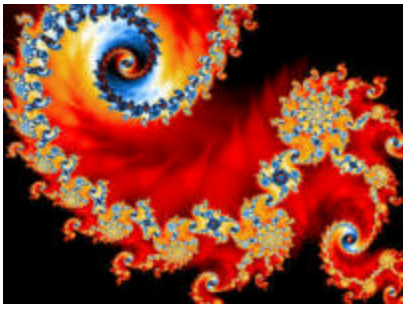
However, it was critical to identify the actual science underlying the PAX Streamlining Principle. At the encouragement of Sam Venneri, former Chief Technology Officer for NASA and one of the company's advisors, PAX entered into a research study with Stanford University-based Cascade Technologies to authenticate the Streamlining Principle. Cascade, a group of nationally recognized fluid dynamicists, had a straightforward goal: to identify and analyze the PAX Streamlining Principle as it is demonstrated in fan blade and mixer/impeller designs.



The project team employed both Computational Fluid Dynamics (CFD) and Particle Image Velocimetry (PIV) technology to measure and assess the differences between PAX and conventional technology. PIV is a method that measures the velocities of fluids using fine particles that are seeded into the test fluid (in this case,

water). Laser light is pulsed into the fluid and a high-speed camera is used to record a series of images of the particles. In this way the movement of the particles - and by extension, the fluid itself - can be precisely measured. CFD simulates the same fluid flow conditions using computer software to solve Navier Stokes Equations, which govern fluid flow. The resulting solution gives detailed information about the behavior of the fluid, and can be used to obtain data that is not easily acquired using experimental techniques.

Using these tools, Cascade's team confirmed the initial theories underlying Harman's discoveries. In side-by-side testing, the researchers identified a number of substantial improvements in the aerodynamics and hydrodynamics of PAX impellers when compared with conventional devices. They confirmed that PAX technology produces and utilizes a previously unknown aspect of fluid dynamics, one that Harman first noticed in natural flow patterns.



The success of this initial project has fostered a continuing relationship with Cascade Technologies and professors from Stanford University. Harman and the Cascade project leader, Gianluca Iaccarino, are developing a white paper on the study's results and have commissioned the next phase of their scientific study.

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Credits:

Abalone	Norbert Hoeller
Hurricane	Ultimate Pix
M81 spiral galaxy	Space Today Online
Fractal images	Luke Plant

Biomimicry and the Green Building Industry

Much of my work in the past year has been centered around promoting biomimicry in the green building industry. I helped organize the Sustainable Resources conference as track chair for the "Life's Designs" track and co-chaired the sustainability track for Greenbuild, the U.S. Green Building Council conference. These roles have lent me the platform to guide biomimicry into important forums for sustainable design and green building.

Sustainable Resources, Boulder, CO, September 27th - October 5th, 2004
www.sustainableresources.org

Janine keynote on Friday evening addressed "Collaborative Solutions". Her presentation was different from previous presentations I have seen her deliver in that she addressed the very important notion of collaborating with children, helping them ask questions, and also listening to them. Personally, I couldn't agree more - if we are to sustain the sustainability movement, we need to continue to learn from and help our youth lead us into the future.

Dayna's keynote on Saturday morning was a hit and as track chair, I couldn't have heard more about it! Dayna offered many current examples of biomimicry – the audience always loves colorful pictures – and supported them with the names of researchers and companies leading the charge into this new frontier. Biomimicry is really happening!! I think her presentation helped demonstrate to the many attendees the potential for and reality of biomimicry.

While the conference wasn't until late September, 2004, my journey started this past spring when I accepted the role of organizing the "Life's Designs" track for the conference. I assembled a small team to help define the track for the conference, outline the topics, and invite individuals with the necessary expertise to present on each topic. We came up with the session topics of Designing with Nature in Mind, the Design Process, Architecture, Waste Processing, and Green Chemistry and Design as a good way to cover an enormous topic. While not all of the presentations were about biomimicry per se, each offered a certain insight into designing with nature and bio-inspired design. This was the first time I presented my thesis results on the creative thought processes of bio-inspired design and was joined by the likes of Paul Stamets, Michael Braungart, Jonathan Todd, and Paul Anastas. Two of the more formal biomimicry presentations were given by Mark Dorfman with his presentation on "Biomimicry in the Chemical Industry", and

Derek Esposito, who presented on "The Biomimicry Database: Linking Biology and Design."

The conference concluded with a Biomimicry and Design workshop led by Dayna, with the help of Derek and myself. The workshop drew a group from a wide variety of backgrounds and was a great way to close a conference rooted in sustainability. The workshop helped prepare participants to think about design in a new way and apply many of the new ideas that they were presented with at the conference.

Bioneers, San Rafael, CA, October 15th - 17th, 2004 www.bioneers.org

While Janine is a familiar face at Bioneers, this year it was Jay Harman who shared biomimicry with conference goers as he joined the ranks of the many brilliant visionaries, activists and earth stewards that have had the honor and privilege of presenting in a Bioneers plenary session. Jay's talk focused on the PAX Streamlining Principle, a design principle based on the effective geometries employed by nature to move fluids. He showed many examples of how fluids are moved throughout nature, from sweat in our pores, to wind and water turbulence, to entire galaxies, and made the connection between these observations in the natural world and the industrial design of a new-age pumps, fans, propellers.

In addition to Jay's plenary talk, he also shared the stage with Amory Lovins for a biomimicry workshop. The workshop was a valuable way for participants to glean insight and how-to from thought leaders and practitioners in the field of biomimicry. Of course, Amory couldn't resist sharing the work he had done in a collaborative design process with his bonobo friends for the Great Ape Trust**.**

Greenbuild (U.S. Green Building Council), Portland, OR, November 10th - 12th, 2004 www.usgbc.org

For the second year in a row, Greenbuild has welcomed a bio-inspired design on the conference roster. In response to a "standing room only" crowd last year, the session was held in a much larger room and saw an attendance of about 500 people. This year, I was able to co-chair the sustainability track for the conference and was subsequently responsible for inviting the speakers. I assembled a panel including Dan Chiras, a sustainability and green building consultant and educator, David Oakey, a textile designer turned sustainability advocate and

philosopher, and Alexis Karolidis, of Green Development Services at Rocky Mountain Institute.

Chiras led the session off with a discussion of basic biological principles in design, including conservation, recycling, the use of renewable resources and restoration. The broad strokes painted in Dan's presentation set the stage for Oakey to explore biomimicry in a bit more depth and offer his philosophy of design to an eager crowd.

Alexis took the session content the next step to additional examples and applications of biomimicry and the biomimicry database project that RMI has been working on with the Biomimicry Guild. This was a great topic to end the session because attendees left not only inspired by all three presentations, but with the recognition that the database signals a meaningful way designers can begin to draw upon nature's genius.

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The 'How' of Biomimicry

Biomimicry is the mimicking of natural patterns and principles in any realm of human design. Janine Benyus, author of *Biomimicry – Innovation Inspired by Nature*, distinguishes 3 different kinds of natural knowledge that designers generally apply when practicing Biomimicry:

- form – relating to structure or anatomy
- process – regarding how things work
- ecosystem – involving relationships between organisms in a system

Beyond these forms, processes, and ecosystems exists Nature's intricate design methodology. In appreciating this methodology, the guiding question becomes not *what* Nature designs, but *how*. The notion of a grand purpose or commanding force behind Nature is neither required nor excluded – a simple acknowledgment of the complex patterns and principles surrounding the emergence of that which we identify as 'Nature's designs' will suffice. By incorporating these patterns and

principles into our own design processes, we may practice Biomimicry not only in designing forms, procedures, and functions, but in designing our very design processes, including our very *practice of Biomimicry*.

How would we characterize Nature's design methodology (for lack of better developed terminology)? Which patterns and principles would we associate with Nature's design process? Mutation and natural selection are recognized as the processes which provide the raw materials and 'weeding' at the individual and species level. Although the effect of genetic recombination and mutations can be dramatic and swift, the overall process is random and works at geological time scales.

Yet natural systems display a remarkable flexibility and resilience, in spite of their incredible complexity. Researchers estimate that the Cretaceous-Tertiary mass extinction eliminated 50% of the earth's species and 90% of marine species, yet here we are. The autonomic system of even the simplest organism is able to smoothly and effortlessly respond to environmental changes – human efforts in autonomic computing are crude in comparison. Stable type III systems (http://www.pcdf.org/Living_Economies/III_Succession.htm) are common and are able to respond to external changes in 'real-time' (appropriate to their scale), because of the diversity of their constituents. One might argue that the excessive energy expended by humans in propping up transitional type I and type II systems for agricultural purposes would have long since led to the extinction of any species without the ability to mine resources at the levels achieved by mankind.

Attempts have been made to extend the natural selection theory beyond the individual scale. James Lovelock proposed the Gaia hypothesis, claiming that the earth is a super-organism with its own self-regulating and evolutionary processes. Mathematical models and computer simulations suggest that both order and adaptability can emerge from chaos. To date, the mechanisms underlying how natural *systems* evolve remain poorly understood.

In *At Home in the Universe*, Stuart Kaufman proposed a number of underlying principles that support 'emergent order'. Dividing systems into 'patches' that provide local optimization while simultaneously interacting with adjoining patches can lead to optimal solutions at the system level. The size of the 'patches' is critical to avoid both paralysis (stasis) and systems that never converge on a

solution (chaos). How nature 'self-tunes' the patch size remains unclear. It is intriguing to speculate whether the principles of ecosystem dynamics (http://www.biomimicry.org/eco_dynam.html) not only define the 'fitness' of natural systems but also describe the conditions conducive to the formation of natural systems that are both dynamic and stable. It would be precisely these principles of ecosystem dynamics which we might mimic in our own design processes, to create conditions supporting the emergence of sustainable designs.

It may be that if we are to truly practice Biomimicry in design, we must mimic Nature in our very design practice. And perhaps if we mimic not only Nature's forms, processes, and ecosystem dynamics, but also Nature's methodology; if we design not only in Nature's image but also in Nature's manner, we will inherently practice Biomimicry in all design…

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Proposed Survey of Biomimicry Applications

A growing number of practical applications of Biomimicry are showing up in the literature. Creating a library of these applications would enhance initiatives such as the Biomimicry database , the K-12 program, and the practice of Biomimicry by providing examples that help make Biomimicry 'real' for practitioners and individuals wishing to teach it.

Analysis of Biomimicry applications can also provide insights into areas such as:

- The kinds of problems that Biomimicry has been able to address
- The pathways that have proved to be successful
- The disciplines that are practicing Biomimicry

Even based on the limited number of examples available today, we believe this analysis may suggest other 'low hanging fruit', or alternatively encourage investigation of other pathways that have not yet been utilized effectively. For example, it may answer the question "Has Biomimicry been more successful for 'product' applications (based on the structure or functionality of natural

organisms), or for 'systems' applications (based on knowledge of how organisms interact in a system)?

We plan to start with a list of 60 articles, which would not support a rigorous analysis, but should provide sufficient material to test the approach. Stephanie has compiled a broad range of classification options that could be used for the analysis.

Participants	Disciplines conducting research
	Disciplines applying knowledge
	Sector (public, private, academic)
	Interested funding organizations
Methodology	Type of knowledge applied (form, procedure, function)
	Chronology (did the problem lead to the application of Biomimicry, or did an understanding of a biological effect precede identification of the problem?)
	Degree to which Biomimicry was crucial to the solution
	Degree of inspiration (vs. copying)
Function	Function exercised (general principles to specific examples)
	Relationship with form (is the function embedded in the form itself)
	Technology domain (i.e. chemical, physical, information)
Impact / Success	Viability
	Degree of improvement over existing methods
	Degree of commercial success
	Current stage of development
	Rating against 10 ecosystem principles
	Breadth (flexibility and adaptability)
	Market success
	Adaptability

One of the risks of any classification system is that we artificially limit the application of principles, particularly by focusing on specific end results. This risk may be acceptable given that we are focused on collecting and analyzing actual implementations of Biomimicry. In fact, the survey may have the opposite effect by demonstrating the applicability of biological principles in diverse ways.

We will be posting the list of articles to ThinkCycle shortly. We would be very interested in your comments on both the concept and the value of the various classification schemes, as well as suggestions on how to best score the various categories. Based on your feedback, we plan to present an analysis of Biomimicry clippings in a future newsletter, but with the intention of leaving the classification scheme flexible so that it can adapt to the changing needs of the Biomimicry community.

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Norbert Hoeller: nhoeller@primus.ca

Upcoming Events

The theme of Expo 2005, held near Aichi, Japan from March 25th to September 25th, has the theme *Nature's Wisdom* (http://www-1.expo2005.or.jp/en). Japan chose this theme in recognition that advances in civilization risk "... degradation of the global ecosystem and imperil our own and our planet's future." The exposition is dedicated to realizing the dream that Japan can "... fuse Asia's traditional wisdom with modern science and technology to create a better world where humankind and nature can co-exist in Harmony." The exposition will demonstrate the principles of eco-communities, using renewable and natural energy development, recycling and modular construction techniques. CO_2 production will be reduced through public and other forms of low-pollution transportation.

The UK Pavilion (http://www.my-earth.org.uk/html/pavilion/index_e.html) will have biomimetics in close to 50% of its content. The pavilion combines landscape, art and science to highlight not only global environmental issues, but also to suggest solutions. Seven displays of biomimetic innovation are planned - see the interactive pavilion guide off the main page (above), as well as http://www.my-earth.org.uk/html/pavilion/innovate/index_e.html.

In June, Janine consulted with the exhibit design firm creating the US pavilion. They wanted to know the who-what-and-why of biomimicry innovation in the US. Hopefully, some of our biomimicry buddies will have their work displayed and celebrated during the 185 days of the Expo.

Janine's speaking engagements for the remainder of 2004 include:

A private meeting with a British biomimicry fan: His Royal Highness the Prince of Wales. Dinner, stay, and breakfast with Prince Charles at his Scottish home Birkhall, Balmoral Castle.	January 20-21, 2005.
Critical Building Blocks and Tools for Sustainability in the Chemical Industry: Identifying an Agenda for National Research, National Research Council, Committee on Grand Challenges for Sustainability in the Chemical Industry	February 7, 2005
University of Vermont	February 8, 2005
Learning From Nature, TED (Technology, Entertainment, Design) Conference	February 23-26, 2005
Sustainability in the Inland Northwest, Boise, Idaho	March 2-3, 2005
ASID Conference on Design	March 17-20, 2005
Biomimicry Design Workshop, La Cusinga Lodge, Playa de Arco, Costa Rica	April 29-May 5, 2005
Sustainable Sarasota	April 17-18, 2005
Schumacher College Course	April 20-23, 2005
Biomimicry and Sustainable Innovation, Schumacher College	April 24-28, 2005
Graduation Commencement, Bainbridge Graduate Institute	May 14, 2005
Future Lecture, Whidbey Institute for Earth, Spirit, and the Human	May 20, 2005
Keynote Tallberg Conference Dalarna, Sweden	July 27-31, 2005

Clippings

Zero refrigeration vaccine trials to begin (SciDev Net, November 1, 2004). Scientists at Cambridge Biostability have developed a method of delivering vaccines that require no refrigeration, reducing the cost of delivering vaccines to the developing world. The technique is based on 'anhydrobiosis' in nature, which allows plants and microscopic animals to survive long periods in a desiccated form. http://www.scidev.net/news/index.cfm?fuseaction=readnews&itemid=1675

'Smart' Clothing Imitate Pine Cones (Roland Piquepaille's Technology Trends, October 5, 2004). University of Bath and the London College of Fashion are jointly developing a fabric combining an inner waterproof layer and an outer layer that opens to admit cooling air when the wearer becomes hot, then automatically closing again. The idea came from pine cones, that open as they dry to release their seeds. http://radio.weblogs.com/0105910/2004/10/05.html

Resources

Recent BioInspire newsletters:

- December 2004: The Biomimicry Way
- October 2004: Biomimetic Buildings: Understanding and Applying the Lessons of Nature
- September 2004: Building the Future of Buildings

The Biomimicry Guild Newsletters are now generally available through ThinkCycle at http://www.thinkcycle.org/tc-space/tspace?tspace_id=49344. You do not need to register with ThinkCycle to read the newsletters; however, registered ThinkCycle members can subscribe to get notified automatically of any new newsletters, and can also use the ThinkCycle discussion group. A ThinkCycle Quickstart guide (requires Adobe Reader) is available at: http://www.thinkcycle.org/tc-notes/show-note?tc_note_id=41609.

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