



BIOINSPIRED!

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THE BIOMIMICRY INSTITUTE

Welcome to the '2009 Alumni Gathering' Special Edition

The first-ever Alumni Gathering of the Biomimicry Guild and the Biomimicry Institute was held in February 2009 at the [Wild Animal Park](#), San Diego Zoo, California.

"Scientists, architects, designers, engineers and business people from around the world attended the event. ... Hosted by Guild founders Janine Benyus and Dayna Baumeister, the gathering served as a launching pad for the latest iteration of the biomimicry meme, a pathway for thinkers and tinkerers, for designers and draftsmen, to ask the

pivotal question "How would nature do it?" During the three-day event, talks and lectures were provided by an array of top industry experts – pioneers and visionaries who have welcomed inspiration from nature with outstanding results."

(Emmet Brady, who also created a [slideshow capturing the spirit](#) of the event)

This issue includes five articles written by participants of the Alumni Gathering. Additional articles will appear in future issues.



Welcome to the rEvolution (*Taryn Mead*)

Taryn Mead is a Biologist at the Design Table for the Biomimicry Guild. An ecologist by training, her specialization lies in the application of nature's genius to the landscape and systems levels of design. She currently keeps her boots at her home base in Helena, Montana.

To be honest, I was not planning on going to the Alumni Gathering. As an employee of the Guild, I hear so much about all of the alumni on a day-to-day basis that I did not think it would be very useful for me. So I held out and listened as the momentum around the office built around the event. There was a flurry of activity with logistics, content organization and the development of the Resource Handbook, as there usually is before an event like this. But then, about two weeks before the event, for some reason I changed my mind and begged Rose Tocke, the event organizer, to let me in at the last minute.

She did and I am so very grateful that I finally had the opportunity to connect with my swarm.

In the three days of the event, we heard from biomimics who are applying a deep understanding of the natural world to a plethora of projects within a number of different fields. We heard stories from product designers, architects, landscape designers, policy developers, business people, engineers and other similarly brilliant minds about how they are nurturing the conscious emulation of nature's genius in their careers and their lives. Many of their stories are contained in this newsletter, so I will let them speak for themselves.

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The Biomimicry Institute, 2003-2009



Welcome to the rEvolution (*continued*)

Personally, I look back on those few days as a milestone in my career. Although I did not give a presentation or play a major role in the content or flow of the course, it gave me a venue to quiet my professional cleverness and absorb the lessons that my swarm had to offer. I learned more about biomimicry and the passionate, dedicated people who are carrying it through the world than I possibly could have imagined. The diversity of expertise, life experiences, ages and nationalities represented at the gathering demonstrated for me just how powerful this 'biomimicry thing' really is. It transcends disciplines, nations, generations, and most importantly, species. It brings us all closer to one another and closer to all of life that we care so much about. And biomimicry inspires and empowers us to make a difference in the world. This alumni group that I had heard so much about in my two years at the Guild represents an immense force for change in the world, a force that I am humbled to be a part of.



I look forward to the Gatherings to come and welcome all of you to stay in touch. I will be doing my best to fill Rose's very big shoes until the Guild formally replaces her, so please drop me a line if I can help you in any way. I will leave you with this final thought from Rose's introductory comments at the Gathering:

"Biomimicry has gotten bigger than any one of us, yet it wouldn't be anything without each of us. My highest ambition for this gathering is to create the conditions for the next evolution of biomimicry, so consider this your open invitation to participate in the revolution."

Welcome to the rEvolution!

[Taryn Mead](#)



Living Systems Practice and Process (*Raymond Lucchesi*)

Raymond Lucchesi is a partner in [Lucchesi Galati](#), a 25-person cross-disciplinary consulting firm that brings together sociology, sustainability and architecture to help create tangible, transformational experiences for our clients, their communities and beyond.

In 1982, my father and I founded an architectural design firm that became **Lucchesi Galati**. By the late 1980s, we realized that the current way of doing architecture was no longer fulfilling in that it did not emphasize the *purpose* of a building and what that meant to people and society. Although the product of architectural design varied greatly, the process of architecture had stagnated and was not able to adapt.

Our firm underwent a transformation in the 1990s, moving away from 'building in a community' towards 'building community'. The focus was no longer on the building itself, but rather how architecture, and the design process itself, could help transform communities towards greater sustainability and a better 'fit' with the environment. We needed a process that was adaptive and consistent with potential and emergence, not an applied process focused on repetition and prediction.

The process must explicitly incorporate meaning and purpose. What can the building do to enhance the community? How can it strengthen a sense of place? How can the building be an integral and living part of the environment?

Rather than adopting a particular style of architecture, we strive to design buildings that are attuned to the context in all its dimensions, from the passage of the sun to the local culture. We do not design buildings for a generic user but engage in participative design with the community that uses and benefits from the building.

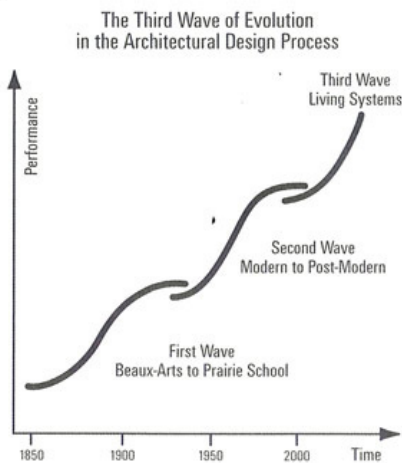
The initial questions that we explore with our clients set the tone for the project. Focusing on fixing specific problems often constrains the solutions and does not allow for true innovation. From our experience, asking 'why' can be challenging for clients. Rather, we post 'what' questions:

- What is the purpose you are trying to achieve?
- What outcomes do you hope for?
- What is the relationship of the building to the local culture and environment?
- What would allow the building to shift from being 'in' a place to being 'of' a place?
- What can we learn from the natural systems around us?
- What can we do to restore and regenerate these systems, giving back more than we take?
- What can we do to create opportunity (instead of competition) and renewal (instead of a return to a mythical stability)?



Living Systems Practice and Process (*continued*)

We believe that living systems are the next wave in the evolution of architectural philosophy and design processes. Dynamic systems do not lend themselves to analysis through the reductionist methods of Descartes and Newton. Although tools for analyzing complex systems are starting to appear, recognizing patterns and making analogies to natural systems can provide us with powerful insights. The Life's Principles can help us access these patterns at many levels and scales.



"Architecture: Celebrating the Past, Designing the Future", ed. Nancy B. Solomon, 2008

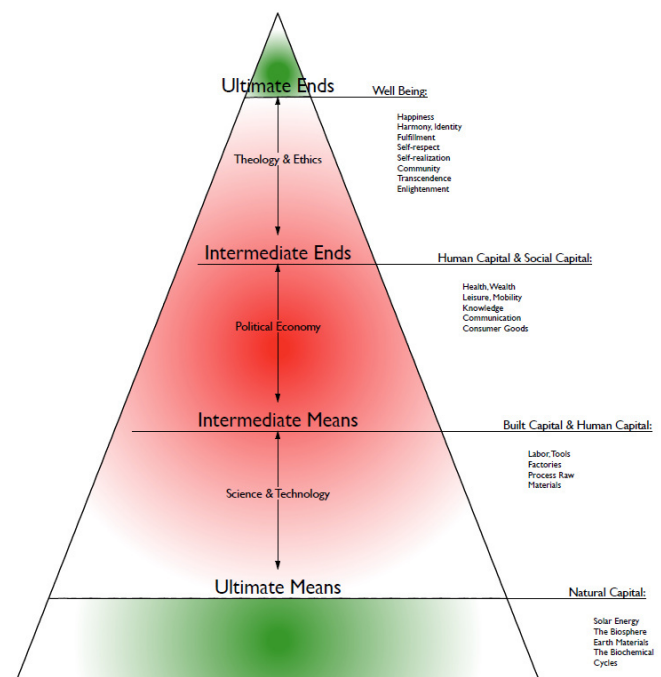
The green movement is part of a larger need, a rediscovery of concepts and ideas that we have always known but have pushed aside. For example, instead of health care and education, we are beginning to emphasize wellness and learning. We are realizing that mechanical systems can only provide a small part of what we need to be truly comfortable. Only by designing and living in the green zone of ultimate means and ends can we collectively address the numerous and linked challenges we face.

[Ray Lucchesi](#)



The Life's Principles can also help us tap into 'ultimate means' and 'ultimate ends'. Traditional designs and built outcomes typically occupy the red area of predictable processes, intermediate means and intermediate ends. In contrast, the green zones are about patterns, potential and connecting natural capital with the collective well being of all the species on Earth. These ideas are not new but can be found in cultures that based decision-making on longer-term perspectives, such as the Iroquois who "[drew] upon the wisdom of seven generations ... and [were] responsible for the well-being of seven generations to come." (*The Iroquois*, Dean Snow, Wiley-Blackwell, 1996).

Designing to ultimate means and ends has proven to be easier than we had expected. We have found that 60-70% of the heating and cooling requirements of a building can be achieved through passive means. The reduced need for mechanical systems and lower energy consumption can make green buildings less expensive than traditional construction. In some cases, we have helped our clients discover that they may not need a building at all and that their ultimate goals could be achieved through other means such as improved workflow planning and other process changes. Although we do not directly design for LEED ratings, we 'back into LEED' by tying 'culture to place' and 'place to culture'.



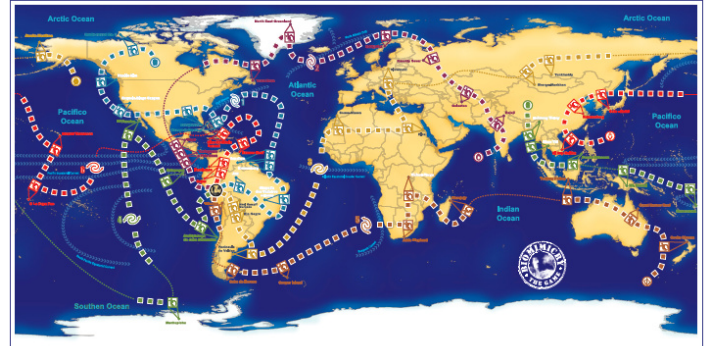
"Indicators and Information Systems for Sustainable Development", Donella Meadows, 1998



Journey to Tambopata with Biomimicry, The Game (Faye Yoshihara)

Faye Yoshihara is a Principal at Pointes Consulting. She is developing a "marketplace of inspiration and exchange for conservation of the Amazon."

A team of Peruvians who work in Tambopata, a region of the Amazon basin, have created **Biomimicry, The Game**. This board game is designed to be a fun tool to help people be inspired by learning to observe nature in Tambopata. It will soon be in use at three Rainforest Expeditions lodges and for the annual Guide Training Program. The game was beta tested during the recent Biomimicry Swarm to determine the viability of bringing the game to a larger audience. If commercialized, it will be sold as an educational tool with proceeds going to conservation projects initiated by the Peruvian biologists and guides who developed the game.



Tambopata Course participants prove learning can be fun by showing off their tattoos

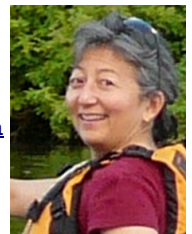
Biomimicry, the Game is the result of a challenge left with the ecotourism guides who served as Frogs during the 2007 Biomimicry and Design course. This week-long course was taught by Janine Benyus and Dayna Baumeister and hosted at the Tambopata Research Center, a remote lodge deep in the heart of the Peruvian Amazon. All

proceeds from the Course are being dedicated to plant the seeds of biomimicry with the people of the Amazon region. The guides were left with a small amount of seed money and a request to think of a way to share the Biomimicry concepts they had learned with eco-tourists, especially on rainy days at the lodges. The team, lead by Alicia Kuroiwa (a biologist and jaguar specialist), came up with the board game design and over 200 challenge cards.

Biomimicry, The Game can be played with 2 to 6 teams. Each team solves sustainable development challenges as they travel a unique route around the globe. Along the way, teams earn carbon-offset points by correctly answering the challenges. The first team to arrive in Tambopata with enough points to offset their ecological footprint wins the game.

Teams compete against one other as they answer three types of timed challenge cards: *Draw It*, *Science Babble* and *Biomimic It*. A *Draw It* card means a player must draw an image while her team attempts to guess the word. When a player receives a *Science Babble* card, she must explain it, without using a list of prohibited words. A *Biomimic It* card means the player must use mimics and charade so that her team can guess the word. *Protected Area* cards and *Wild Water* cards add excitement and education on the journey to Tambopata.

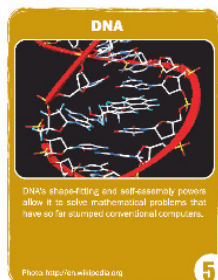
If funded, **Biomimicry, The Game** will be offered for sale in the Biomimicry Marketplace. We are now seeking individuals and organizations interested in helping commercialize the game, to join us in building a marketplace of inspiration and exchange for conservation of the Amazon.



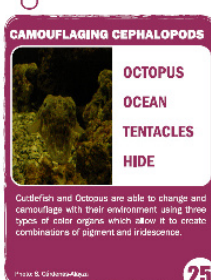
[Faye Yoshihara](#)



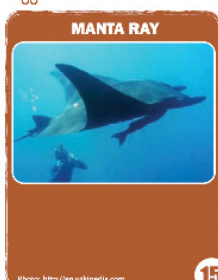
DRAW IT



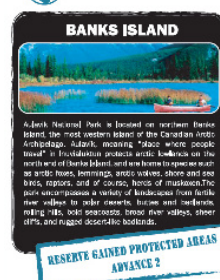
SCIENCE BABBLE



BIOMIMIC IT



PROTECTED AREA CARD



WILD WATER CARD





Competition versus Cooperation (Robyn Klein, Dayna Baumeister, Janet Kübler)

Robyn Klein sleuths for the Biomimicry Guild, following emergent cyber-phenomena like an ant tracks pheromones.

Dr. Dayna Baumeister is co-founder and keystone of the Biomimicry Guild.

Dr. Janet Kübler is an Adjunct faculty member at California State University at Northridge.

During the 2009 Alumni Gathering, the question of competition in nature was asked, specifically with regards to business. What role does competition versus cooperation play in natural systems and what implications does that have for the business world? The discussion was dynamic and warranted a follow-up to clarify just exactly what competition in nature looks like.

Our understanding of biology follows from what scientists have sought to understand. Inevitably, cultural and personal perceptions affect where scientific research is directed, and in some cases, how the results of that research are interpreted. Ideally, the science of biology is purely objective, but humans interpret the natural world according to personal experience as well as what they have been taught in their cultural system. Competition in nature is a good example of this. The interpretation of interactions between organisms has changed throughout history along with the cultural and sociological shifts of human experience. Statements such as “nature red, tooth, and claw” (Tennyson 1844) and “survival of the fittest” ascribed to Charles Darwin in the 19th century resonated with social mores of the time, becoming popular memes. However, they do not give an accurate description of our current understanding of competition in nature.

For most of the twentieth century, competition was assumed to be the driving force in biological communities but was only rarely quantified until the second half of the century. During this time period, competition was the buzzword in business and assumed to be the mechanism driving relationships between organizations. The period from the 1960s through the 1990s saw the birth of quantitative community ecology and the drive to find the strengths of driving factors and relationships in biological systems. Much emphasis was placed on competition, but little evidence arose to support that thesis. By the 1990s, ecologists came to realize that competition was not the universal driving force that it was assumed to be. A landmark special edition of the scientific publication *Ecology* (Ecological Society of America) in October 1997 focused on competition and its mirror image, facilitation. Facilitation or cooperation is a beneficial interaction between species rather than the mutually negative effect of competition. The understanding among ecologists today is that competition is only one of a suite of ways that organisms can interact and occurs rarely, if at all. Surprised? Let us explain.

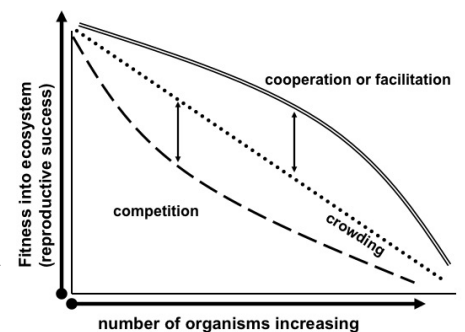
As a rule, living things avoid direct competition whenever possible because it is costly, resulting in reduced fitness as energy is devoted to competing rather than diversifying into new niches. Instead, life evolves toward alternatives to competition, suggesting that we are witnessing in biological systems the *avoidance* of competition, rather than competition itself. For example, two bull elk spar in the season of rut to compete for opportunities to mate. More often than not, a simple look over by each bull preempts the match with the larger bull “denoted” as dominant. If they do actually “lock horns”, bull elk rarely kill each other and sparring matches are usually short. One bull retreats.

Most examples of competition in nature exist as a snapshot in time, a temporary but costly solution. Two bull elk facing off is seasonal and intermittent behavior. Their dance is meant to test, to push the other and see if he will yield. If so, the test was successful. If not, then another niche is sought as a remedy. Killing all the other bull elk would leave wolves only one choice to hunt, not to mention the energy expended and wounds one would incur in the process. Short, intermittent competitive behaviors are certainly part of healthy, functioning ecosystems.

Overall, the struggle to survive in a world of limited nutrients and riches is commonly performed in a fluid dance of push and retreat. An opponent may be tested, but the competition is broken off when it is no longer a benefit to the organism. In contrast, interactions that benefit organisms are reinforced by evolution. Overall, organisms that have long evolutionary histories have many established interactions with others in their ecosystem and most of those interactions are non-competitive. Competition is just too expensive an option.

How do biologists measure the “expense” of competition in Nature? During the discussion at the Alumni Gathering, Janet Kübler drew the following graph and explained it this way:

On the vertical axis is fitness or how well the organism fits into its ecosystem (usually measured as growth rate or reproductive success) while on the horizontal axis is the number of organisms increasing from left to right, causing crowding and interactions. The dotted line shows the effect of crowding alone. The dashed line below the diagonal shows the effect of crowding with competition. It is that suppression of success that biologists use as the hallmark of competition and the vertical difference between the two lines gives a measure of how strong the competition is.





Competition versus Cooperation (*continued*)

Using this measurement tool as a model, competition is seen in cases where artificial boundaries around the community are made as part of an experimental design or where one species is removed and a competing species then expands into the cleared space.

When species are mixed together, or individuals of the same species are crowded together, they may actually have mutually beneficial effects on each other. We call this facilitation, mutualism or cooperation. Facilitation would appear on the graph as a line above the diagonal indicating that individuals or species are more successful together than alone. This is in fact the most common observation of interactions in Nature, outside of mere co-existence.

Our own Dayna Baumeister conducted research on facilitation in mountain forest communities for her PhD thesis. Her work coupled with that of her advisor, Ragan Callaway, who repeated studies on mountain slopes around the world, found not only that facilitation is more common than competition, but also that facilitation was especially common under stressful conditions. When the going is tough, life cooperates more and competes less. That is, the harsher the conditions, the more organisms will attempt to cooperate. We see fewer examples of cooperation in non-harsh conditions because, ostensibly, the needed benefits of a mutualistic relationship are not as important for an organism's survival.

When is there competition? Scientists observe competition when organisms are attempting to use the same limited resource at the same time and their needs will not be met unless they somehow negotiate the interaction. Living systems evolve toward the lowest cost way to share resources and nutrients. Fighting or overpowering is not sustainable because of the cost to growth and reproduction. Evolution to avoid competition leaves more opportunity to grow, reproduce and diversify.

Yet competition does persist in nature, particularly as a mechanism for testing and exploration of new habitats. The costs of competition shorten the length of these interactions and lead to evolution toward mutual facilitation in long-term interactions. We learn from the Life's Principles Butterfly that life leverages interdependence. Competition is not inevitable in biological systems or in human endeavors and really is not sustainable in the long run. Competition does not make you stronger; it just makes you need an alternative strategy more urgently. This is the lesson for business. We should not be asking "How can I become a better competitor?", but rather "What alternatives do I have to competition?" Cooperation, mutualisms, facilitation and niche specialization are common alternative strategies that are worthy of exploration for business strategies and models. So the next time someone asks you about competition in nature, you will have a bit more to talk about.

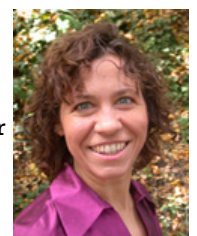
For the time being, the adage still holds true. As "win-win" becomes a buzzword in business, cooperation reveals itself to ecologists. Or is it vice-versa? In the world of biomimicry, finding closer alignment between our human endeavors and those time-tested resilient strategies of nature should always remain our ideal goal.



[Dayna Baumeister](#)



[Robyn Klein](#)



Janet Kübler

Reflections on the Alumni Gathering (*Emmet Brady*)

Emmet Brady, a student of "human ecology", is fascinated by insects and has a career in strategic business development.

One of the most compelling questions asked at the Alumni Gathering was: "Are you an optimist or a pessimist?" From my perspective it was fascinating to hear such a high-caliber group of people consider the question. Many of the responses I heard were full of measured hope tempered by an acknowledgement of the stark realities of our global circumstances.

When discussing the trajectory of eco-nomic debacle, a duality seemed to emerge from within each individual:

- A strong feeling of empowerment shaded by a lack of practical application, a way to actually do something with the information.
- A deep insight into futuristic and inspiring research, tempered by the realities of an economic and political system that is resistant to change.
- An understanding that the natural world has an inherent genius in its assemblage, often contradicted by the constructs of a human society that seems to inch towards chaos with every passing day.
- The immense desire to spread the meme and implement real-world solutions – **to do good** – in the light of problems so ubiquitous and so complex that one is left to wonder: "Can we really do anything at all?"



Reflections on the Alumni Gathering (*continued*)

What I believe is the take-away from such a gathering is the potency of the collective. The attendees came from a variety of different backgrounds and locales in the world. Only a few had any professional collaboration outside the Guild events. Yet the Gathering served notice that biomimicry has a process and a structure which transcend the boundaries that have been erected between human industries. Most of all, the net effects of the intellectual process of biomimicry has produced tangible results both within and outside the Guild and the Institute. That in itself suggests optimism. The best way to tip the scales in favor of optimism is to continue to be engaged and aim for measurable, incremental changes.

The fertile crest between optimism and pessimism is where inspiration meets with reality. Events like the Gathering are certainly inspiring and can tend towards overwhelming, unless we each understand our role. We are not designed to do all things at once, nor can any one person alone solve the immense challenges we face. The optimist understands that nature's design is all about evolution, and biomimicry places us on the path of comprehending the adaptations necessary to flourish.

[Emmet Brady](#)



AskNature...and Get Answers! (*Sherry Ritter, Norbert Hoeller*)

Sherry Ritter is a Biologist at the Design Table at the Biomimicry Institute, a job that allows me to incorporate science, research, writing, speaking, creativity and lots of learning!

The beta version of the [AskNature.org](#) biomimicry design portal was officially launched on November 21, 2008 by Janine Benyus at the [closing plenary](#) of [Greenbuild 2008](#). Since then, more than 85,000 visitors from at least 185 countries have visited the site to check out the 1176 biological strategy pages and 40 biomimetic product pages. More than 1,250 members have registered on AskNature allowing them to add photos, create connections between content pages, curate strategy pages, and participate in discussion forums. We expect to hit a half million page views sometime in June.

Janine Benyus has for years promoted the vision of a free, online, searchable database of Nature's genius organized in a way that makes sense to designers. In 2005, the Biomimicry Guild and Rocky Mountain Institute released a prototype database (described in the [March 2005 BioInspired! Newsletter](#)) based on architectural design challenges. Many designers and students found value in the database, though it contained a relatively small amount of content.

The positive feedback from the prototype inspired The Biomimicry Institute to create the AskNature project. To reduce cost, [John Webb](#) selected Paul Hawken's [WiserEarth](#) social networking platform and negotiated access to the source. [Chris Allen](#) (project manager), [Tim Greiser](#) (technical lead), [Emily Harrington](#) (illustrator) and [Valerie Casey](#) (IDEO digital experience practice) worked feverishly to get the design and software ready in time for the November launch, while Guild members [Megan Schuknecht](#) (Content Manager), [Sherry Ritter](#) (Content Developer) and [Jen Hubber](#) (Content Associate) populated the database with information from the Nature's 100 Best project.

'Biology Organized by Function'

To get to know what AskNature offers, users can dive in and start exploring. However, it is worth taking a few minutes to look under the **About** tab, where users can find information to enhance their journey through AskNature's pages:

- What is AskNature?
- What is Biomimicry?
- Site Tutorial (with hints on using Browse and Search functions)
- Biomimicry Taxonomy

An important feature that many users may not have explored is the **Browse** tab at the top of the AskNature pages. Click on it and up comes a three-column panel: basically a Table of Contents to the site. Users can browse through Forum Discussions, People, Products, and Strategies.

Clicking on **Strategies** will show how AskNature is organized by **biological function**, also called the **Biomimicry Taxonomy**. Information on AskNature uses the Biomimicry Taxonomy to organize how organisms meet different challenges. **Strategies** are potential solutions to those challenges. For example, the challenge and Biomimicry Taxonomy of an insect's strategy might be as follows:

- Insect's challenge: Protect itself from animals that want to eat it.
- Strategy: Anti-reflective eyes to avoid detection in moonlight.
- Biomimicry Taxonomy: Maintain health > Protect from biotic factors > Protect from animals > Nanoscale protrusions.



AskNature...and Get Answers! (continued)

In the above example, "Maintain health," "Protect from biotic factors," and "Protect from animals" are hierarchical levels of biological function, with each one being more narrowly defined than the previous. Other functions might be absorbing water, protecting from impact, or breaking down organic materials. These are the same challenges facing designers, architects, engineers and other innovators. How can a building be designed to self-ventilate? How can a manufacturer design a helmet to be lightweight yet impact-resistant? Even better, how can it be made without toxic chemicals or high heat, the way Nature creates similar structures? Innovators can look to Nature, through AskNature, for inspiration to solve these types of questions.

Once a user has selected a biological function, the three-column browse panel leads to strategy pages and their associated organisms. A helpful yet often underutilized feature of strategy pages is the **Taxonomy** list. When a user clicks any of the taxonomy levels, a box opens showing the biomimicry taxonomy at that level. Here the user can explore other strategies and organisms in the same functional category, making it easy to search for other solutions to the same problem. For example, clicking on the '... Tension' link on the [Strategy: Lightweighting: Scots pine](#) page opens up a taxonomy box showing two dozen other strategies that deal with Tension.

AskNature Social Networking

In addition to being the premier site for biomimetic information, AskNature is a rich collaboration framework that helps members connect to each other around topics of common interest. Using the extensive AskNature user profile, members can find other members based on professional or academic affiliation, geographic location, languages spoken and a free-form description field. AskNature also encourages members to maintain their network of connections to other members and information within AskNature (articles, experts, forums, organisms, products and reference materials). You can never tell when someone out of the blue will answer a question you have posted!

Hints and Tips

1. To improve **Search** results, see **About / Site Tutorial** (http://www.asknature.org/article/view/site_tutorial) and scroll to the bottom for search rules.
2. On the Strategy pages, check out the **Gallery** tab for additional photos and illustrations. Besides being great pictures, these can help users better understand the strategy the organism uses. Users can also upload their own photos or illustrations.
3. There are various accordion tabs below the strategy description. For example, the **Experts** tab may contain more recent papers, posters, or related studies. Another tab worth exploring is **Bio-Inspired Products and Application Ideas**. Users can help increase the

value of AskNature by submitting new examples via a comment on that page or sending them to the [AskNature Editor](#) for inclusion on the site.

4. Discussions in AskNature are called **topics**, which in turn are organized around specific themes called **forums**. Clicking on **Contribute** in the top navigator and then **Join a Discussion** brings up a list of forums sorted by most recent activity. The **Recent** tab shows all topics sorted by most recent activity and the forum in which the topic is found. Anyone can start a new topic if an appropriate topic does not exist - click on **Start a New Topic** on any forum page. At the moment, only a limited number of users have the authority to create new forums.
5. AskNature provides a **watchlist** that will notify you by e-mail when a forum or topic has been updated. If you are creating a new topic, you can add it to your watchlist by checking the box just above the **Save** button. You can also change the watchlist status of any topic or forum using the 'eye' symbol to the right of the title. Moving the mouse over the 'eye' will display what the current action will be. You may want to add your user profile to the watchlist so that you are informed if anyone leaves a comment.
6. Members can control whether their e-mail address and other contact information is visible to anyone browsing the AskNature site. If a member has blocked visibility of their e-mail address, you can use the AskNature 'private messaging' feature by clicking on the **Send Me a Message** on their profile page below their picture and the map of their location.

Improving AskNature

The AskNature team is actively looking for feedback from the user community about the content and usability of the AskNature platform, as well as suggestions for new features and functions. The 'production release' of AskNature is expected to occur in 24 to 36 months. If you have not done so already, register yourself on AskNature, fill in your profile, start collaborating, and provide your input via [AskNature Feedback!](#)



[Norbert Hoeller](#)



[Sherry Ritter](#)



Working the Field of Bio-Inspired Design

A Natural Architectural Language

"Aesthetic III: A Natural Architectural Language", [Ralph L. Knowles](http://www-rcf.usc.edu/~rknowles/aesthetic_3/aesthetic_3.html) (Professor Emeritus, USC School of Architecture), http://www-rcf.usc.edu/~rknowles/aesthetic_3/aesthetic_3.html

For over 40 years, Prof. Ralph Knowles has studied and written about the importance of rhythm and ritual in providing meaning and richness to human life. Traditionally, seasonal and diurnal rhythms have connected our lives with the predictable yet ever-changing face of nature. He describes three types sheltering rituals that link our experience with natural rhythms and provide a "syntax for a natural language of architecture":

- migration to different parts of a building (traditional courtyard house of northwest India)
- transformation of buildings and associated experiences (Berber tent, traditional Japanese *Minka* house)
- metabolism of energy (connections to a central hearth)

Our ability to generate power centrally and then transmit it over long distances has freed us from the constraints of past builders but also has disassociated our lives from natural rhythms. The result has been escalating energy usage and a form of architecture that is largely indifferent to climate and the unique features of the local environment. Knowles argues that we need to "intentionally connect ... architecture more directly to the sun, the ultimate source of our vision, our warmth, our energy, and the rhythms of our lives." He proposes a zoning policy based on the "solar envelope", a three-dimensional construct tied to a specific spatial and temporal context that guarantees surrounding properties will receive a specific amount of solar access.

The article describes the results of a 10-year housing study in Los Angeles that covered a wide range of building densities and types. The solar envelope method not only supported high density but resulted in striking designs reminiscent of the architecture of historic towns and cities. The fluid curve of the solar envelope resulted in buildings that are unique yet clearly part of a community, with numerous roof terraces, courtyards and sunlit spaces. The shape of buildings depended on how they faced the sun, providing a natural guide to orientation lacking in many urban areas.

The solar envelope is typically lower in winter because the sun is nearer to the horizon. Buildings could be designed to change with the seasons and take advantage of the increased space enclosed by the summer solar envelope. Examples include rooftop theatres, temporary marquees and moveable covers similar to the Spanish *toldo* that provide shading and channel cooling breezes. These dynamic changes would strengthen the ties between the changing path of the sun, our buildings and how we interact with these buildings.

Although not directly inspired by biology, Knowles' work shows the power of 'designing to limits'. Meaningful and relevant limits can encourage innovations that improve the quality of human life and reduce resource consumption. The resulting designs can be diverse yet harmonious, optimized to the local conditions and more resilient in the face of declining fossil fuel supplies. By engaging in "a dialogue with nature", architecture can develop a new language based on an "ethic of sustainability" that can once again help connect our lives to nature.

Additional resources:

- [Interview with Ralph Knowles](#) (minutes 33-41 of Feb. 26/2009 Wisconsin Public Radio [To the Best of Our Knowledge](#) broadcast)
- [Ritual House – Drawing on Nature's Rhythms for Architecture and Urban Design](#) (Island Press, 2006)



Low-density Housing: View looking northeastward on hillside site in Los Angeles.



High-density Housing: View looking southeastward on mid-city site in Los Angeles



Working the Field of Bio-Inspired Design (*continued*)

Dancing with the Wind

EcoGeneration, [January/February 2009](#), Issue 50, pages 28-29, Sharolyn Vettese, http://ecogeneration.com.au/news/dancing_with_the_wind/

Dr. Alfred Mathieu recognized the value of wind power from his childhood on a farm in Alberta, Canada. After receiving a PhD in Agriculture at the University of Saskatchewan, his role at the UN Food and Agriculture Organization (FAO) gave him the opportunity to work in over 30 countries and led to an appreciation of technology that is low cost, simple to maintain yet appropriate and effective for the local context.

Dr. Mathieu developed a model of wind dynamics based on the idea that systems which capture wind energy must not obstruct the wind. Every part of the system must contribute to the energy conversion. Typical horizontal wind turbines are inspired by airplane propellers which are designed to move an object through the wind. In contrast, his work has been modeled on sailing ships and Dutch windmills that 'catch the wind'.

When Dr. Mathieu decided to design a better wind turbine, he initially looked at classical airfoil designs for the blades but could find none satisfied his concept of 'good design' based on observations of nature. His daughter, Sharolyn Vettese, noticed the flight of a maple key (or samara) which is shaped such that the seed is carried far from the parent tree. Although Dr. Mathieu found little scientific information on the aerodynamics of maple keys, the shape and performance 'fit' his model of wind dynamics.

The result was the Windancer line of turbines based on two four-bladed rotors offset by 45 degrees. The blades are flat, with a bump on the front to minimize slippage and an airfoil on the back to minimize drag. The blades are mounted on stems so that the wind can pass unimpeded through the center of the rotor. A large wind vane inspired by the fluke of the orca automatically positions the turbine to face the wind, eliminating the control systems and mechanical positioning devices of traditional wind turbines. A wind flap brake inspired by the hawk allows the Windancer to resist high wind speeds.

The Windancer is modular and scalable, ranging in size from 3 to 23 kWh. Because it is responsive to the wind and minimizes turbulence, the turbine can be mounted on shorter towers without guy wires. Although [Wind Simplicity](#) has not yet commissioned detailed performance studies, the design has demonstrated a low start-up speed of one meter/second which allows the Windancer to benefit from lighter winds. The design has won a Gold at the [2007 Design Exchange Awards](#), 1st place in the [2008 Green Dot Awards](#), the prestigious [National Energy Globe Award 2009](#) for environmental protection and energy efficiency, and was nominated for a [2009 INDEX: Award](#) in the [Community](#) category.



The Windancer7 (7 kW) has a blade diameter of 3.3 m. (with permission of Wind Simplicity)

Team Heliotrope

"Sun-tracking device wins student prize", MIT News, September 19/2008,
<http://web.mit.edu/newsoffice/2008/madmec-0919.html>

The [Making and Designing Materials Engineering Contest](#) (MADMEC) is an annual event jointly organized by the MIT's Department of Materials Science and Engineering, Saint Gobain and the Dow Chemical Company. The [MADMEC II](#) contest was based on the theme "Materials Solutions for Alternative Energy" and organized around seven challenges:

- the car challenge
- building efficiency challenge
- the robot challenge
- the bio challenge
- the green building window challenge
- the habitat challenge
- an "open" category for prototype devices that exemplify the contest theme

The team of Forrest Liau, Vyom Sharma and George Whitfield won the \$10,000 first prize for [Heliotrope](#), "a non-mechanical device that allows solar panels to move, tracking the sun's movement throughout the day" and thereby improving energy efficiency while avoiding the costs and reliability challenges of electro-mechanical tracking systems.

The team decided early on to focus on simplifying current renewable energy technologies such as solar and wind. Most involve complex tracking systems involving sensors, electronic control systems and motors. The team's goal was a device that was simple and inexpensive, suitable for the developing world, and ideally using scrap materials.

Brainstorming about solar tracking led to research into [heliotropic](#) plants that orient their leaves towards the sun. Although the team did not have in-depth biological expertise in this area, online searches provided adequate information on [phototropism](#) and convinced the team that it would be difficult to directly replicate the mechanism.



Working the Field of Bio-Inspired Design (*continued*)

Three approaches were evaluated: polymers, shape-memory alloys and metals with different coefficients of expansion. Although the design using polymers had similarities with the stem of sunflowers, technical issues prevent further progress. Shape-memory alloys were found to be too expensive.

The third approach relied on temperature differences between sunny and shaded areas of an arch made of aluminum and steel that supported the solar panels. Work is underway on scaling up the prototype, solving 'real-world' problems such as the affect of wind, and applying for a patent. Heliotrope was also entered the [2009 MIT Clean Energy Prize](#).

a student business plan competition, under the name SunPoint. After being selected as one of 25 semi-finalists, they won 1st place and \$40,000 in the Renewables category.

Although Heliotrope did not copy the mechanism of phototropism, the team successfully emulated its functional principles. "Nature challenged us to look at better or alterative ways of achieving the same effect."



'Voice Your Opinion!' Results

Thanks to everyone who completed the survey mentioned in the February *BioInspired! Newsletter*. Unfortunately, there were too few responses for the results to be representative.

Based on an initial analysis of the responses and comments, some actions have already been taken. Thanks to members of the community that have volunteered to act as 'coaches', three new forums on AskNature.org have been started:

- [Biomimicry and Architecture](#) (Tom McKeag, Josh Stack)
- [Biomimicry and Design Process](#) (Eileen Stephens, Carlos Montana)
- [Biomimicry and Green Chemistry](#) (Mark Dorfman, Eileen Stephens)

Calendar of Public Events

Date	Location	Event
June 3, 2009	Washington, DC	US Society for Ecological Economics 2009 Keynote <i>Taking Stock of Nature's Values: Ecology, Economy and Life's Principles</i> (Dayna Baumeister)
June 4, 2009	Cleveland, OH	2009 Global Forum Keynote (Janine Benyus)
June 8-12, 2009	London, UK	Schumacher College: Nature as mentor, model and measure (Dayna Baumeister)
June 14-17, 2009	Austin, TX	American Society for Engineering Education (ASEE) Conference - Design Methodology Presentation (Marjan Eggermont)
July 6-10, 2009	Bozeman, MT	Biomimicry: The Technology of Biology (Robyn Klein, Montana State University)
July 9-18, 2009	Mexico City and Veracruz	Biomimicry & Design Workshop (Iberoamericana University)

Date	Location	Event
July 13-16, 2009	Las Vegas, Nevada (selected conferences)	WORLD COMP'09 - The 2009 World Congress in Computer Science, Computer Engineering, and Applied Computing
July 21-23, 2009	Vancouver, BC	World Changing Careers Keynote (Janine Benyus)
July 27-31, 2009	Edinburg, UK	17th International Conference on Composite Materials
August 13, 2009	Chicago, IL	2009 Climate Leadership Summit Keynote: Biomimicry as an Educational and Pedagogical Principle (Janine Benyus)
August 30-September 6, 2009	Leshiba Wilderness, South Africa	Biomimicry & Design Workshop (Janine Benyus and Dayna Baumeister)
Oct. 1-2	San Diego, CA	Biomimicry: Educating Leaders in Innovation & Sustainability (San Diego Zoo)
Oct. 28-30, 2009	Dresden, Germany	Natural and Biomimetic Mechanosensing



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"Biomimicry (from *bios*, meaning life, and *mimesis*, meaning to imitate) is a new science that studies nature's best ideas and then imitates these designs and processes to solve human problems. Studying a leaf to invent a better solar cell is an example. I think of it as "innovation inspired by nature."

The core idea is that nature, imaginative by necessity, has already solved many of the problems we are grappling with. Animals, plants, and microbes are the consummate engineers. They have found what works, what is appropriate, and most important, what lasts here on Earth. This is the real news of biomimicry: After 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival.

Like the viceroy butterfly imitating the monarch, we humans are imitating the best and brightest organisms in our habitat. We are learning, for instance, how to harness energy like a leaf, grow food like a prairie, build ceramics like an abalone, self-medicate like a chimp, compute like a cell, and run a business like a hickory forest.

The conscious emulation of life's genius is a survival strategy for the human race, a path to a sustainable future. The more our world looks and functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone."

[A Conversation with Janine Benyus](#)

[BioInspired!](#) is published quarterly and is posted on a public-access [Weblog](#) hosted by TypePad. For those of you familiar with RSS Readers, TypePad supports various feed formats (look for the [Subscribe to this blog's feed](#) link in the right navigator).

Comments can be posted on the newsletter Weblog. At this time, the TypePad RSS feed does not deliver comments.

If you wish to subscribe to this newsletter, please complete the [E-newsletter sign-up](#) form.

Last, but not least, please send any feedback or comments to:

[Norbert Hoeller](#)



Clippings, Resources and Events

Four public-access Weblogs hosted on TypePad are now available to share information of interest to the Biomimicry Community.

- [Clippings](#): short articles relating to Biomimicry.
- [Resources](#): pointers to more extensive information.
- [Events](#): workshops and relevant conferences.
- [BioInspire](#): **NEW** Twenty-six issues of John Mlade's monthly magazine published between January 2003 and July 2005

These Weblogs can be monitored with your favorite RSS Reader. Anyone can post comments. Please be aware that TypePad requires an e-mail address and will display this address to people viewing the comment. Each Weblog has a 'sticky' post at the top with suggestions on how to reduce the impact of getting Spammed.

Contributions of clippings, resources and events are greatly appreciated! Please see the note at the top of each Weblog for instructions.

Thanks, Norbert Hoeller

A CALL TO TEACHERS AND STUDENTS OF BIOMIMICRY

If you are integrating biomimicry into your teaching or learning, we want to hear about it! Just fill out the on-page form you'll find on the web at <http://sinet.ca/tinc?key=zkJeYXyN&formname=BioEducation>. When you're done filling out the information, you simply click on "ok" (lower right) and you're done. Thanks in advance!