Biomimetic Nanostructures

Nature as a mentor

The central principle of bionics can be summed up under the motto of "Learning from Nature". In the course of the evolutionary process, nature has - over millions of years - developed numerous solutions which even today confront scientists and engineers, with all their advanced knowledge, with major challenges. Nature's solutions include robust materials compounds, sophisticated mobility mechanisms, functional ways of building and living, highly perfected information and communication systems and highly sensitive sensors. Many of nature's innovative solutions are in keeping with the principles of sustainable development: Nature reaches its goals economically, with a minimum of energy, and always recycles its waste completely into the natural cycle. The wealth of experience available in animate nature and the resulting high innovation potential must be used by and for humans.

As a result of the dynamic developments in biological research and technology - mainly at the molecular level - totally new approaches are emerging for innovations in the field of bionics. What is characteristic of bionics is the interdisciplinary approach that is taken when solving application-oriented questions which can by no means be reduced to one-to-one copies of biological models.

In the past, the broad application of ideas from bionics failed due to the rigid adherence of scientists to their own disciplines and due to the absence of an effective technology transfer between research and industrial application. This is where the new ideas competition "Bionics - Innovations from Nature" comes in: Industrial companies, universities and research institutions are called upon to formulate ideas relating to the new approaches of bionics and to test them in feasibility studies. At the same time the bionics network BIOKON is intended to contribute to the establishment of cross-disciplinary networks between companies and public research institutions.

http://www.bmbf.de/en/1010.php

Biomimicry Guild

Edited and compiled by: Dr P Susthitha Menon

The Biomimicry Guild (http://www.biomimicryguild.com/) is a dynamic ecosystem of individuals and organizations spread all over the world. It was founded by Dr Janine Benyus and Dr Dayna Baumeister. As specific projects emerge, the Guild bring together the expertise needed to help the project succeed. The Biomimicry Guild is the only innovation company in the world to use a deep knowledge of biological adaptations to help designers, engineers,

architects, and business leaders solve design and engineering challenges sustainably.

Through public presentations and workshops, research reports, biological and sustainability consulting, and field excursions, the Biomimicry Guild helps innovators learn from and emulate natural models. Their goal is to create products, processes, and policies that create conditions conducive to life.

Since 1998, the Guild has been helping companies and communities find, vet, understand and emulate life's time-tested strategies. By emulating 3.8 billion years of well-adapted technology, they help innovators design sustainable products and processes that create conditions conducive to all life.

The company’s vision is to naturalize biomimicry in the design profession in order to increase respect for the natural world and create well-adapted and life-friendly products and processes. Also, the company’s vision is to create flow structure for ideas from biology to design by building tools, building capacity of people, and

Supporting practitioners' successes

The Biomimicry Guild offers the following services:

- A Proven Process for Sustainable Innovation
- Tools to Bring Nature’s Ideas into Your Design Process
- Biologists Who Talk Your Language
- A New Way of Seeing the World
- A Way to “Do Well By Doing Good”
- A Chance to Be a Conservation Leader

The Guild is focussed on activities that lead to:

- Sustainable, well-adapted and life-friendly products and processes
- Solutions to major environmental challenges
- Respect for the natural world
- Conservation
- The naturalization of Biomimicry in the design profession

Their fluid network comprises of but is not limited to principals, BaDTs (Biologists at the Design Table), staff, associates and contractors.

The services provided by the Guild to the public is elaborated as follows:

- Comprehensive Research into how nature has solved your company's challenges.
- Strategic Advice on how your company can implement the most promising of nature's strategies for your products and processes.
- Tools to help your company create sustainable, innovative, effective, cost-saving and life-friendly products and processes.
- Biologists at the Design Table who become part of your company's team from brainstorm to prototype, continually adding biological insight to the process.
- Dial-a-Biologist on-call biology experts who can speak your language, answering technical questions and brainstorming ways that nature's ideas can help improve a product or process.
- Lectures and Workshops to introduce Biomimicry into your company's innovation process.

To find out which services would be best for us and for more detailed information on the services offered, we can download the 2009 Complete Product & Service Reference from the website.

For centuries, biologists have been in labs and fields taking notes on the adaptive strategies life has developed. Unfortunately, much of this information is inaccessible, locked up in technical, scientific papers written for other biologists, and rarely organized by engineering or design function.

The Biomimicry Guild has proven methods and experience in accessing this information. They have a staff of biologists, known as BaDTs (Biologists at the Design Table), who excel at searching through biological research to find the natural strategies that meet a company's challenges, and then assessing which of those designs, chemical recipes, or system strategies are most promising for our needs. The Guild's staff is also adept at taking complex and technical biological data and translating it into language digestible by any business department, from marketing to R&D.

The latest upcoming event organised by the Guild is the Costa Rica Biomimicry & Design Workshop 2010 which will be held from March 24-31, 2010. These specialized courses are designed for individuals in various design fields including architecture, engineering, landscape architecture, interior design, and industrial design interested in applying biomimicry to sustainable architecture and design.

The Biomimicry Guild also has a wide range of experienced speakers to talk to a specific organization about the potential of Biomimicry and the methods of implementing Biomimicry ideas. More information can be obtained from the website.

Nature as a model

http://www.designboom.com/contemporary/biomimicry.html

http://biomimicryinstitute.org/about-us/what-is-biomimicry.html

http://www.biomimicryinstitute.org/about-us/biomimicry-a-tool-for-innovation.html

http://www.via3.net/pooled/articles/BF_DOCART/view.asp?Q=BF_DOCART_139580

Biomimicry- nature as measure

In Biomimicry nature serves as inspiration for new technical designs that are meant to solve severe problems in engineering. Besides functioning as a template, nature can also be consulted for the evaluation of a solution that has already been found. The value of a technical design can be justifiably estimated by comparing with nature, because after 3.8 billion years of evolution, nature has learned what works and what lasts. Biomimicry provides engineers with an ecological standard to judge the sustainability and functionality of their inventions. By juxtaposing technical solutions and life's principles, ways can be found to refine and improve the design. Effectiveness and efficiency are two criteria for a successful method and nothing will ever fulfill both of them the way nature does. Therefore measuring an engineered design against a solution that nature offers makes a perfect fingerpost. For example, regarding the same purpose biology might use completely different components (it works the same for shape, structure and so on) for the achievement in contrast to engineering. In many cases components that are cheaper, easier to handle or even reproducible. Comparing an artificial system to a similar natural one and finding out how nature runs it and what its components are, prompts the question whether improving possible or not because the solution is already appropriate. Nature's recipes require only a few elements of the periodic table, whereas humanity uses every single and even the toxic ones.

Nature also sets the measure regarding efficiency. Waist production is a technology's problem. Only 4% of the production involved material ends up in the final product. Measuring against nature it becomes obvious that solutions found by mankind are definitely not the best.

Referring to sustainability biology offers us a lot to learn as well. After 3.8 billion years of evolution, which of course not a single invention can compete with, nature knows the best how to overcome challenges and obstacles that appear within the years.

Biomineralisation

As the main objective of biomimicry is to use nature as a model, as measurement or as a mentor, the example of biomineralisation would be part of using it as a mentor. Biomineralisation is the way how living organisms, e.g. bacteria, produce minerals. In nature this is adjusted with specific assemblies of proteins, thus macromolecules.[1]

One example: Ca-carbonates can be used as an important informant in climate change studies (e.g. because CO_2 in air and water, temperature and pH influence the calcification of corals[2]). While in the geological field it was believed, that the crystals grow in a certain kind of spatial arrangement because of a kind of competition between them, the biological approach was that there are links between the taxonomy and the respond to environmental changes. Hence a calibration was needed to be able to use Ca-carbonates in environmental change studies. It is also important to know, that there are not only differences between different species but also between fractions of one certain specimen.[3]

Another example for biomineralisation are magnetotactic bacteria. They have been mainly observed in the transition zone between oxygen rich and oxygen poor water (OATZ – oxic-anoxic transition zone). These bacteria produce intracellular crystals of magnetic minerals. The crystals are made of magnetite or greigite and cause the bacterium passively to orientate along the geomagnetic field. This orientation gives the bacterium an advantage in finding the best conditions in the difficult environment.[4]

January 15, 2010

---

[1] The Aizenberg Biomineralisation and Biomimetics Lab, SEAS Harvard. http://www.seas.harvard.edu/aizenberg_lab/research.html [14.1.2010, 21.10]

[2] Coral growth and climate change, Encyclopedia of Earth http://www.eoearth.org/article/Coral_growth_and_climate_change [14.1.2010, 22.50]

[3] The BioCalc background, U-Psud, France. http://biocalc.geol.u-psud.fr/background/background.html [14.1.2010, 22.15]

[4] Kopp, R., Kirschvink, J., 2008. *The identification and biogeochemical interpretation of fossil magnetotactic bacteria.* Earth-Science Reviews, 86, 42-61. Available from: http://magnetotactic-bacteria.com/web_documents/25_2007.08.pdf [14.1.2010, 23.45]

Maybe further reading: http://www.scq.ubc.ca/the-little-workers-of-the-mining-industry/