How to implement the teachings of nature?

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Abstract

In the course of the last half century the concept of biomimetics has become ever more refined. Various sub-disciplines developed and found their way into the curricula of colleges, into R&D departments and influenced the way scientists investigate natural systems. However, researchers and engineers that can integrate the knowledge and skills required to tackle the interdisciplinary field of biomimetics remain scarce. In an attempt to team young graduates from a variety of academic backgrounds and to qualify them to overlook the field of biomimetics in energy systems, a homonymous M.Sc. program has been established at the Carinthia University of Applied Sciences in Austria. As few programs with a comparable approach exist so far, innumerable new applications are likely to arise from the work of interdisciplinary groups striving to cross barriers that still exist between engineers and scientists, between developers and investors. One of the most crucial elements to the success of this endeavour is to bring together young, motivated and qualified people. Costly experimental effort, in contrast, can be minimized if existing knowledge and experimental data is re-evaluated. Keeping furthermore in mind that Pakistan, as well as many developing countries, possesses a great natural diversity makes this approach seem very well suited to boost innovation here.

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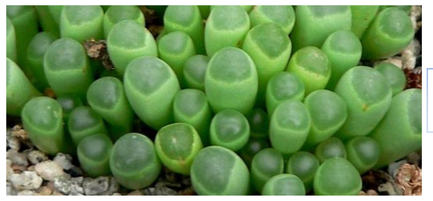
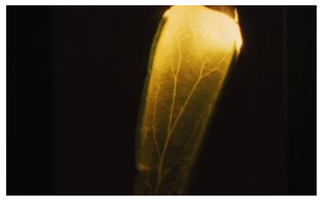
History

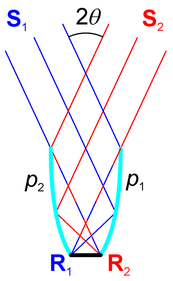
From the early days of science, nature has inspired mankind to devise new machines and tools. As early as in the 15th century, Italian polymath Leonardo da Vinci studied the flight of birds to with the objective of constructing an aircraft[1]. Even though some regard him the first "biomimetic researcher" for this pioneering work; the notions of "biomimetics" or "bionics" only emerged roughly fifty years ago. These terms, coined by Otto H. Schmitt and Jack E. Steele, respectively[2], were important milestones that helped formalizing the approach of abstracting and implementing principles of natural systems. In recent years biomimetic research has been on the upswing, with publications multiplying more than tenfold within the last two decades[4]. Moreover, networks, research clusters and international standards (ISO) focussing on biomimetics have come into being.



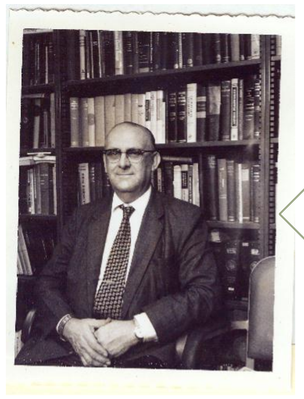
Window plant *Fenestria aurantica* © by asknature.org[10]



Illuminated longitudinal section of a *Fenestraria* plant from the Namib desert, showing the conduction of light, © by Helmut Tributsch



Schematic drawing on non-imaing optics; morphology of *Fenestraria* suggests that this phenomenon might play a role for light collection in this plant © Jcc11[11]



Otto H. Schmitt, © by OttoPages[3]

Two pioneers of biomimetics

Leonardo da Vinci © by neidgruen[12]

Education

Like biophysics, biomimetics is a field that stands at the interface of different scientific disciplines. An interesting thought, regarding education in these realms comes from Otto H. Schmitt: he "carefully avoided formation of a Bio-physics Department [at the University of Minnesota because] this entity would have to reside in one or another school or college and would thus lose the symmetrical multidisciplinary aspect of the program."[6] We think it is reasonable to bear this in mind when educating students in biomimetics. It would therefore be desirable for students to have in-depth knowledge of all the scientific disciplines related to biomimetics; including biology, physics, and also engineering.

However, it is another notion of biomimetics that holds a clue for a more practical education in this field: the *systematic* approach that distinguishes it from concepts like bio-inspired engineering.[7] Important factors in this respect are the ability to establish **connections between different realms**, **to communicate and cooperate with colleagues with other scientific backgrounds.**

If we believe Schmitt, biophysics is furthermore "not so much a subject matter as [...] a point of view"[8] and accordingly students should be trained to internalize this perspective that can originate other results than mono-disciplinary research – be it in biophysics or biomimetics.

Creativity is of course crucial in this field, and while the effectiveness of creativity trainings is not uncontested[9], a playful approach has been a part of biomimetics from the start – for it was verbal play that led to the neologism "biomimetics"[2].

Biomimetics in Energy Systems

Since 2009 the Carinthia University of Applied Sciences (CUAS) in Austria offers the master degree program Biomimetics in Energy Systems. Apart from the aforementioned contents - engineering and sciences – this program features elements of systems theory, business and management. Together with a focus on project-oriented learning and teamwork, this is intended to prepare students to work in a field that is still in the process of defining itself.

Students of the first year that graduated within the last months have presented their works at congresses in different European countries. Projects ranged from research in technical biology (e.g. the optical properties of a window plant) to the fabrication of prototypes (e.g. an energy harvester inspired by the albatross).

Chances for developing countries

As we outlined here, biomimetics very often is about looking at things from a different angle. As projects by students at the CUAS have shown, progress in this field can be expected performing experiments with inexpensive low-tech equipment or even using existing data. Countries like Pakistan, where half of the population is 21or younger[13] and biodiversity is high, including some interesting endemic species[14], might well benefit from this approach that needs fresh minds more than expensive instruments.

References and picture credits

[1]http://www.bionikzentrum.de/default.asp?navA=bionik&navB=geschichte&navID=3&editable= 1; [2]Harkness J.M 2001, A lifetime of connections - Otto Herbert Schmitt, 1913–1998. Phys. Perspect,
[3]http://160.94.102.47/Otto%20Photographs%20full%20size/Otto%20&%20Viola%20Schmitt%20Photos/Otto%20&%20Viola%20Photos%201/Dr%20Otto%20H%20Schmitt%20on%203%20October%201971%20Rogues%20Gallery%20Entry%20100.png [4]according to "results analysis" for the search term "biomimetic*", years 1991 to 2011, in the Web of Science®, http://www.webofknowledge.com/ Default search settings have been used, retrieved May 30th 2012 ; [5]http://www.biokon-international.com/ [6] O. H. Schmitt, "An Adventure" p. 8. ;[7] Gebeshuber, I. C., Majlis, B. Y., Neutsch, L., Aumayr, F., and Gabor, F. Nanomedicine and biomimetics: life sciences meet engineering & physics. In Proceedings of the Third Vienna International Conference on Micro and nanotechnology, Viennano09, Vienna, Austria, 2009.; [8]O. H. Schmitt, "Emerging Science of Biophysics," p. 2.; [9]Scott, G.M., Leritz, L.E. and Mumford, M.D. (2004a) The effectiveness of creativity training: A metaanalysis. Creativity Research Journal, 16, 361–88.;
[10]http://www.asknature.org/strategy/6eb4107cbcdde41d35818191b29f60f5; [11]http://en.wikipedia.org/wiki/File:Nonimaging_Optics-CPC.png; [12]http://www.neidgruen.de/2010/04/05/natur-fakt-leonardo-da-vinci-und-die-baumringe/; [13]https://www.cia.gov/library/publications/the-world-factbook/fields/2177.html;
[14]http://www.wwfpak.org/p_environment_biodiversity.php