Rethinkery

Biomimicry: Innovating for Sustainable and Resilient Organizations

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Biomimicry—the reliance on natural systems for engineering inspiration—has grown as a practice over the last couple of decades. Early on, it was frequently applied to industrial design problems. More recently, organizational designers have also begun taking up biological concepts, especially related to collective intelligence, sustainability, and resilience. Looking forward, work at the frontiers of biomimicry is positioned to tackle the increasing organizational challenges of a densely networked world and the needs of complex designed ecosystems.

Japan's Shinkansen "bullet train" is a design at the forefront of modern rail technology. It is also emblematic of how biological forms can be applied to improve on a human design. When engineers built the train thirty years ago, they did not realize that it would create a loud BOOM when exiting tunnels. The noise proved so disturbing to passengers and residents in addition to being disruptive to wildlife that a solution needed to be found right away.

The engineers turned to nature for inspiration in addressing the challenge. One of their technical leaders was an avid bird watcher and suggested that they examine the **Kingfisher Bird's** structure and movement for some insights.

By emulating the form of the Kingfisher's beak—the shape of which enables it to fly fast and dive straight into the water to hunt for food with hardly any sound—engineers updated the train's structure by elongating the "nose" design. In doing so, the train was better able to pierce air that accumulated at the front and minimized speed drag, resulting in a faster, quieter, and more powerful train, able to maintain speed of 175 mph.

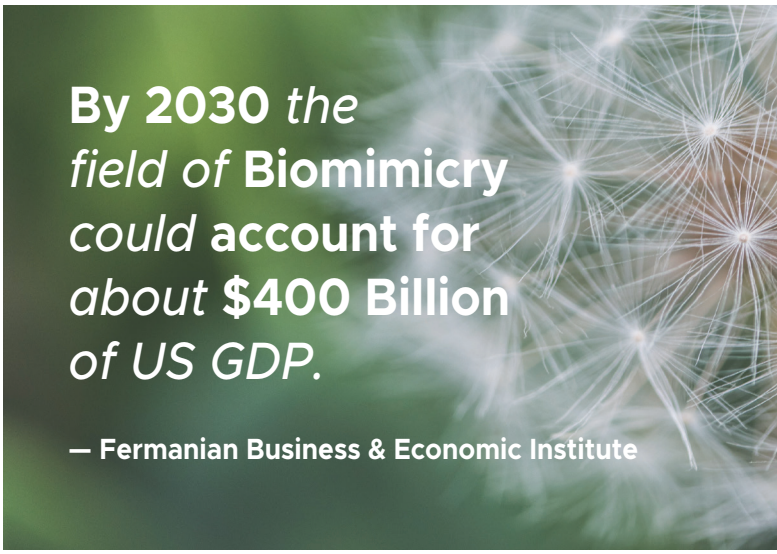
Now, as we move toward creating a society that is ever more digitally interconnected, we're starting to see similar lessons from nature applied to the organizational design of cities, corporate structures and supply chains. In particular, at a time when finding long-term balance with natural systems is a matter of survival, it may be that our human networks can draw design lessons from superorganisms-biological communities like insect mounds and aspen groves where individuals work to create a stable collective unit.

The Rise of Biomimicry as an R&D Tool

The use of biomimicry has grown quickly in the design and innovation space. It is a diverse space, but people who practice biomimicry all tend to look for time-tested solutions that the other inhabitants of this planet have developed to help solve difficult design challenges.

From this perspective, living things on earth—plants, birds, insects, and many others—can be seen as "organic products" that have been tested, refined, and upgraded for four billion years. From this viewpoint, the natural world houses a library of millions of solutions waiting to be discovered, explored, and adapted in the creation of innovative products, services, processes, and systems. Leaders in the field argue that it is the very essence of innovation in practice.

Innovation inspired by the natural world is not a new concept, and can be seen in the work of **Leonardo da Vinci**, **Buckminster Fuller**, **Frei Otto**, **George de Mestral**, and countless others. However, it was **Janine Benyus** who in 1997 coined the term "**Biomimicry**" and spurred global interest in its application to innovate sustainably, with the publication of her book "**Biomimicry: Innovation Inspired by Nature".** This led to the founding of the **Biomimicry Institute** in 2006, which has driven considerable interest in the field.

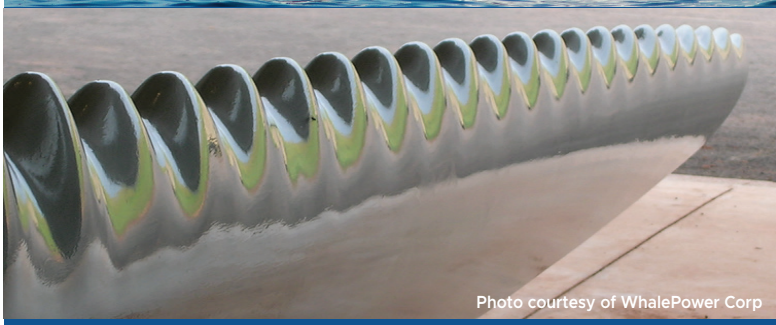


Background photo by Jessica Lewis on Pexels

In business, Biomimicry is increasingly recognized as a differentiator in developing exponential technologies and generative organization structures. **The Fermanian Business and Economic Institute**, a research group that tracks innovation data, estimates that by 2030 the field of biomimicry could account for about $400 Billion of US GDP.

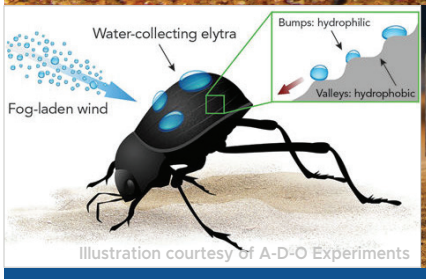
Traditional Biomimicry has already contributed to the development of many new innovations and product improvements. Here are some examples:

DESIGN–Wind Turbine Blades
COMPANY–WhalePower Corporation:
Engineers took inspiration from **Humpback Whales** to create blades that increased aerodynamic performance and reduced energy consumption. They noticed that the spaced "bumps"—known as Tubercles—on the leading edge of the whale's fin served to break up liquid flow, resulting in the reduction of drag and increased lift. By emulating the uneven ridges of the whale's fin in the design of the turbine blades, the engineers were able to overcome the limitations of traditionally designed blades such as poor reliability when winds diminish, noise due to stalled blades, and poor performance in turbulent air currents.



Top: Humpback Whale breaching water surface *(Bio-organism)*
Bottom: Wind Turbine Blades *(Biomimetic Design)*

DESIGN–Water Vapor Harvesting
RESEARCH–University of Akron, Ohio:
The **Namib Desert Beetle**'s ability to convert water from vapor by sticking the back end of its body towards the air to capture fog and dew, which is then converted into water as it runs through the micro grooves or bumps into the beetle's mouth, has inspired researchers to mimic the process of converting vapor into "potable" drinking water. This solution stands to mitigate the effects of climate change that contribute to extreme drought conditions and provide sustainable access to drinking water in arid parts of the globe.



Top: Namib Desert Beetle collecting water vapor *(Bio-organism)*
Bottom Left: Illustration of Namib Beetle vapor harvesting process.
Bottom Right: Self-filling water container prototype *(Biomimetic Design)*

DESIGN–Sustainable Architecture
COMPANY–Miller Hull:

Touted as the greenest commercial building in the world, the design of the Bullitt Center in Seattle, WA emulates **self-sustaining systems in nature**, such as the effectiveness of pine trees in breaking up and retaining rain in the forest floor. The building features plants and other mechanisms that capture rainwater. The water collected is then used to operate the building (e.g., from fountains to flushing toilets). Moreover, the Bullitt Center is also energy independent due to the solar system installed on its rooftop. The center also features natural landscaped areas for visitors and occupants to enjoy.

Photo (L to R) courtesy of Bullitt Center

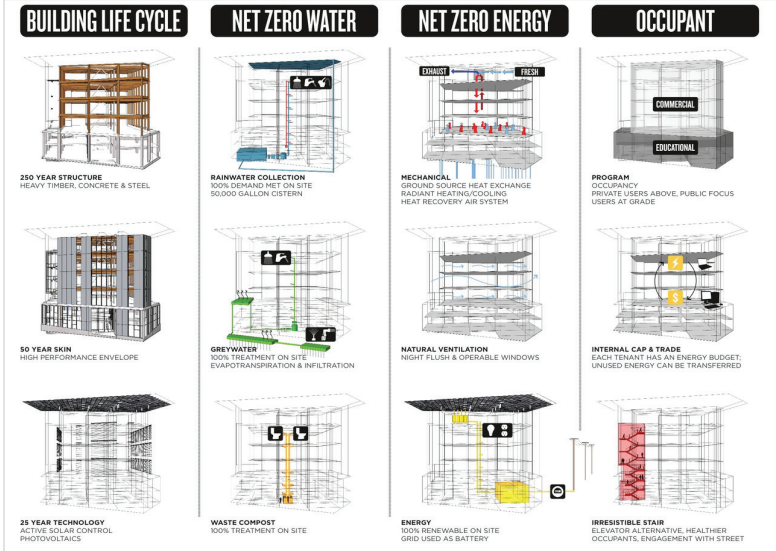


Illustration courtesy of Miller Hull

Top (L to R): Exterior and Interior of Bullitt Center, Seattle, WA
Bottom: Diagram of self-sustaining systems *(Biomimetic Design)*

DESIGN–Material Handling Hose
COMPANY–Parker Hannifin:

In response to complaints from one of its customers—a cement manufacturer in Europe—frustrated with having to routinely shut down operations to repair or replace damaged steel pipes worn down by abrasive materials, engineers at Parker Hannifin leveraged insights gained in conducting biomimicry research to design a new pipe that was flexible as a rubber hose, yet strong as steel. The resulting "CERGOM Hose" proved more durable as it could effectively withstand transportation of abrasive materials due its inner structure that's composed of ceramic hexagonal plates, similar to the structure of **snake skin (scales)** that allows it to navigate harsh terrain.

Photo by Pixabay

Photo (L to R) Courtesy of Parker Hannifin

Top: Close up of snake skin *(Bio-organism)*
Bottom Right: Cross-section of "Flexible pipe" lining *(Biomimetic Design)*
Bottom Left: "Flexible pipe" in use

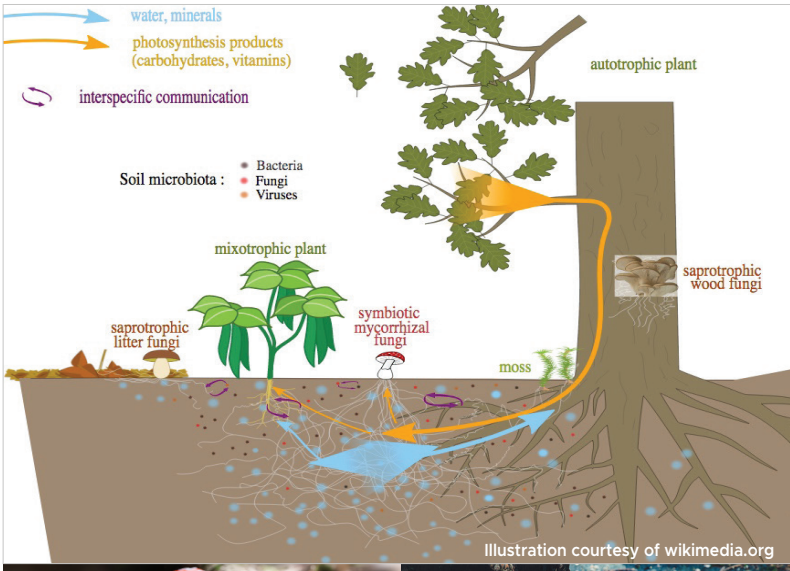
Toward "Biohacking" Traditional Organization Structures

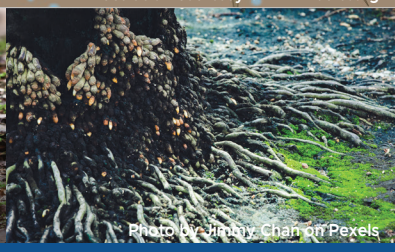
More recently, biomimicry attention has turned increasingly to organizational design. Early experimentation has focused on collective intelligence, reducing hierarchy, and increasing resilience to change.

Superorganisms in particular have been recognized as an important source of insight, given their unique organizational properties. In her book "**Teeming**" (2017), **Dr. Tamsin Woolley-Barker** focuses on five insights from superorganism structure that can be applied to organizations:

- Collective intelligence
- Swarm creativity
- Distributed leadership
- Alternative approaches to teamwork
- Regenerative value

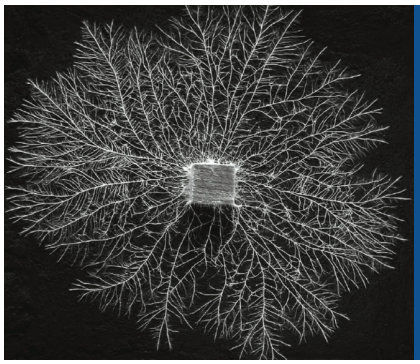
For example, networks of **Mycorrhizal Fungi** are associated with around **90% of plant species**, and have been living in symbiosis with them for **nearly half a billion years**. These networks are extremely resilient, made up of genetically unique fungi and plant organisms, that enable the transfer of mutually beneficial sugars and nutrients, both plant and trees need.





Top: Illustrative overview of symbiotic exhange of sugars and nutrients between fungi, tree roots, and moss (**Bottom - L to R: As viewed in nature)**

Not-for-profit organizations such as the **U.S. Green Building Council** use **Fungal Networks** as a model for their organizational structure. The new structure gives a lot of autonomy to local chapters while still maintaining a high level of engagement in the organization's overarching mission.



Fungal Networks form stems that connect and communicate the need for—and exchange of—water, minerals and nutrients within a mutually beneficial ecosystem.

Photo courtesty of Mark Fricker at Researchgate.net

The HR company **Waggl** emulate **beehive "bio team" principles** and asserts that learning from nature helps organizations become more sustainable as they are able to grow and evolve. Creativity and innovation tend to emerge from a culture that appreciates individual differences and a culture of experimentation.

Beehives demonstrate the principles of effective "bio teams" such as member autonomy, effective communication systems, and action bias.

Photo by Pixabay

Data management company, **America Learns**, mimic the practice of 'hibernation' as a way to get better. For two months annually, the company slows down operations to conduct internal evaluations and reconfigure processes as needed. The nature-inspired ritual has resulted in a 20% increase in sales following the first year of establishing this 'hibernation' practice.

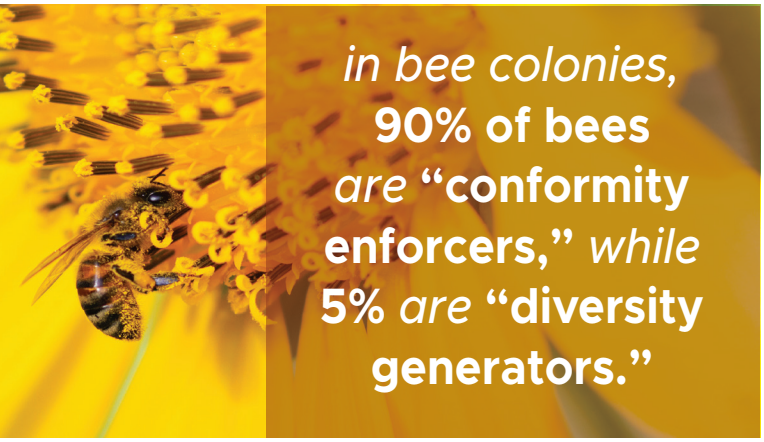
Terrestial Snails escape extreme weather by entering into a state of hibernation (winter), or estivation (summer), until environmental conditions are optimal.

Photo courtesty of wikimedia.org

Future-proofing Organizations and the Planet

Looking forward, the application of biological principles to organizational design is growing more ambitious, turning to artificial ecosystem management for both the human economy and increasingly complex technological networks.

In a **recent paper**, for example, Edita Olaizola, Rafael Morales-Sánchez, and Marcos Eguiguren Huerta argue that we should not be surprised that modern companies cannot respond effectively to calls for sustainability, given that, the features associated with sustainable development are difficult to fit our "current model of the market economy in the current definitions of markets and businesses." They argue for moving to a more biologically realistic model based on considerations of the overall ecology, within which individual businesses operate.



Background photo by Achini Kobbakaduwa on Pexels

Similarly, research into the detailed organizational structure of superorganisms has become an area of great interest. For example, researcher Marilyn Hamilton argues for the concept of an **Integral City** which explicitly takes into account different roles of individuals in superorganisms. Hamilton points out that in **bee colonies**, 90% of bees are "conformity enforcers," while 5% are "diversity generators." The conformity enforcers focus on collecting food from known sources, while the diversity generators explore new sources, pushing the colony in new directions when the yield of old ones decreases- an interesting insight for innovation leaders.

Looking beyond institutional structures, applications of superorganism lessons to technology ecosystems has also been increasing. For example, **recent research** focused on applying swarm intelligence models to build Internet of Things (IoT) systems, provides a possible reference architecture for software to manage robotic hives. This type of specific and implementable application of biological principles to the management of artificial ecologies is likely to increase as our systems get more complex.

Conclusion

Inspiration for the design of new products and solutions to solve intractable problems can be found everywhere in the natural world. A keen eye for observation and research is needed to learn from living organisms and translate findings into solutions that address human challenges. Indeed, innovation is essential to a company's sustainability and continued competitiveness.

To future-proof businesses and organizations, the capacity to solve problems and create innovative products, processes, services, and systems by emulating living organisms (in micro) and living systems (at macro), will be a clear advantage. The latter, as enabled by Biomimicry may also have the impact of reframing the relationship humans have with the "natural world" in shifting from an extractive source pushed to the point of ecological collapse to that of an invaluable partner that inspires the design of a world that enables all living systems to thrive.

Rethinkery Foresight is a strategic hub for organizations working to navigate disruptive change. For more information on how we can help your organization to strategically rethink its assumptions in light of change, please contact us on info@rethinkery.com

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