

BIOMIMICRY WHITE PAPER

This is a mock white paper on Biomimicry. GreenMimic Inc is a fictional entity, but the details on biomimicry and the references used are very much authentic. The submersible well pump mentioned doesn't exist, but it is based on real synthetic trees that scientists have successfully built. You can read more on that [here](#).

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Introduction

Designs form the basis of our world and our lives. The human body is a design. So is the computer or mobile device you are reading this white paper on. Walk into a rainforest and you will realize what a wonderful example of design it is where nothing goes to waste. If an organism perishes, it becomes a resource for another. However, when you step into a human-made environment, such as a city or a building, it occurs to you that we utilize very poor and uninspired models that consume a lot of energy and lead to pollution. This practice results in the dual drawbacks of environmental degradation and a compromise on life quality.

Designs are important— from that of multi-billion dollar architectural projects to common household objects. And it is important for designs to be better.

Biomimicry is not just a buzzword. To create a sustainable future for humanity, it is something that we must embrace wholeheartedly. Unfortunately it is often sidelined in favor of poorer techniques. The goal of this paper is to elucidate the idea of biomimicry and highlight its many benefits. We will also discuss why it remains underexploited, and the opportunity that awaits smart companies and organizations.

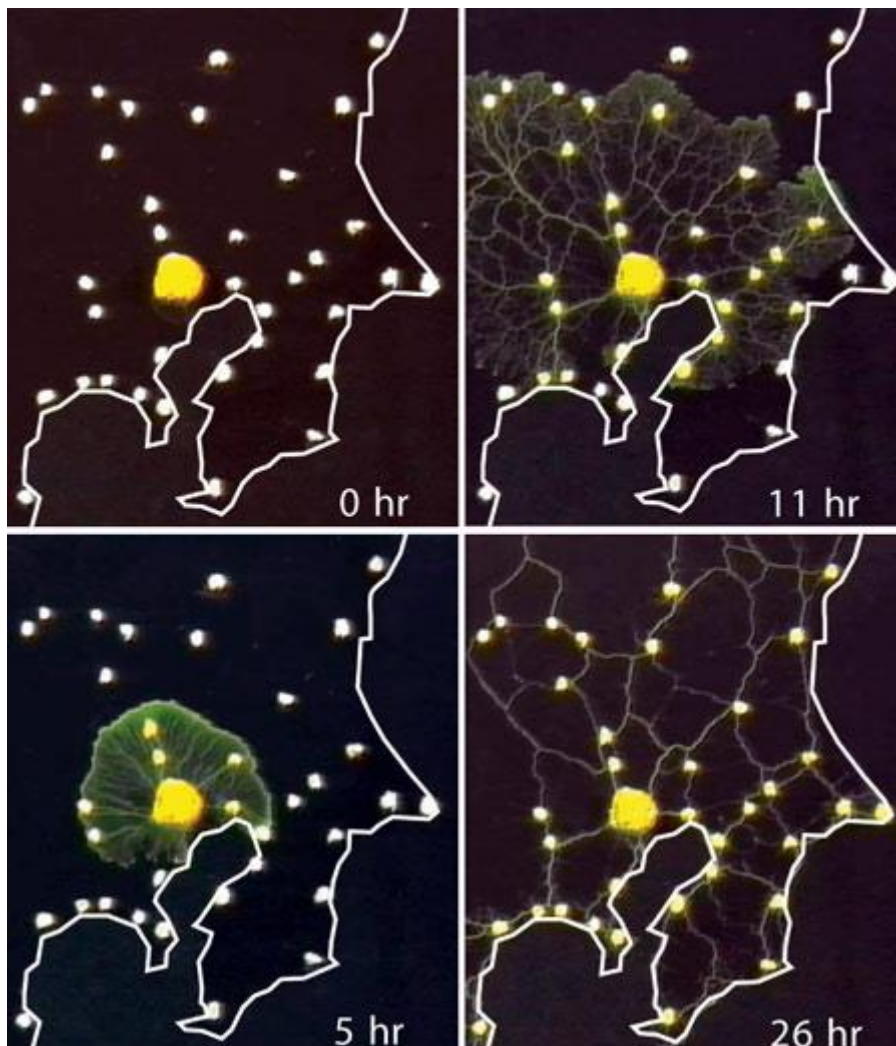
What Is Biomimicry?

Biophysicist Otto Schmitt first came up with the term 'biomimetics' which in simple words can be understood as "imitating life". In the late 1990's Janine Benyus popularized the term 'biomimicry' and renewed interest on the subject. Biomimicry is learning from nature and emulating nature's forms, processes and ecosystems to come up with solutions that adhere to biological principles. The designs thus created continuously support life and produce

conditions favorable for life to thrive. Biomimicry.org lays down three essential elements of biomimicry:

- I. Emulate— learning from and replicating nature
- II. Ethos— understanding life and developing designs that support life, and
- III. (Re)connect— spending time in nature and better understanding life so as to have a better ethos to emulate biological strategies

What is common between the Lotus Temple, Brunelleschi's Florentine cathedral dome, dirt-free paint and umbrellas? They were all inspired by nature. An interesting case to consider is that of the Tokyo Railway system. Countless engineers toiled for even more countless hours to design it, when a slime mold *Physarum polycephalum* was able to construct a near identical network design of comparable efficiency and reliability despite lacking any college degrees— or a brain for that matter ([Tero et al., 2010](#)). Wasps have known how to make paper long before humans. Effective designs abound in the natural world. The reason behind is the millions of years of evolution which discard poor designs that can now be found buried in the earth or encased in stone as fossils. It is clear that nature possesses tried and tested designs that humans can implement in their own projects for superior efficiency.



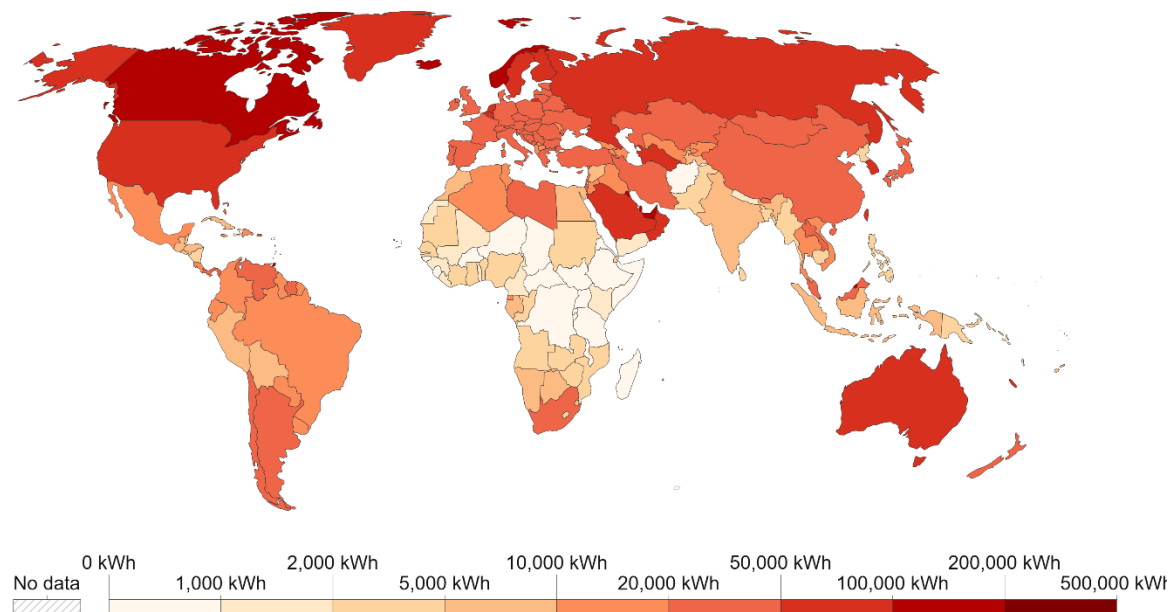
A slime mold maps out train routes around Tokyo ([Science, 2010](#))

The spike in interest in biomimicry comes at a time when humanity is facing environmental crisis when as a species our obsession with globalization is devastating the green jungles– the lungs of the world– and critically endangered marine animals are choking to death because of our non-biodegradable plastic waste that is filling up our oceans ([WWF, 2021](#)).

In the twenty-first century living standards are increasing, so is energy consumption. The alarming fact is that hardly 11% of the energy used worldwide comes from renewable sources ([Ritchie et al., 2022](#)). The average US citizen consumes ten times the energy of a person in India ([Ritchie et al., 2022](#)). Developing nations tend to have a bigger population and if an Indian, Chinese or Brazilian were to use as much energy as an American—a possible scenario in the future– the environmental costs will be astronomical. Globalization is not the answer to our woes, we need new, better technology ([Theil & Masters, 2014](#)).



Energy use not only includes electricity, but also other areas of consumption including transport, heating and cooking.



Source: Our World in Data based on BP & Shift Data Portal

OurWorldInData.org/energy • CC BY

Note: Energy refers to primary energy – the energy input before the transformation to forms of energy for end-use (such as electricity or petrol for transport).

Energy use per person for the year 2021 ([Ourworldindata, 2022](#))

Biomimicry holds immense potential to rebuild the world in a more sustainable and resilient way. A new world where we work with nature instead of against it, unlike the current trend.

Infusing Designs With Nature

Sustainability is often seen as a progressive way to do business. When a company genuinely cares for the planet it creates a positive brand image. But sustainable solutions often take considerable time to devise. Lethargic R&D cycles force companies to resort to programs that generate revenue quicker but have adverse effects on the environment. Biomimicry offers a way out of this dilemma. Biological blueprints have been successful over millenia and can launch groundbreaking ideas faster. There is no need to reinvent strategies ([Biomimicry Institute, n.d.](#)).

The approach of biomimicry is popular among architects, who incorporate nature into structures to create safer homes and buildings. However biomimicry has generated development in diverse fields such as aerodynamics, robotics, land restoration, medicine, energy production, adhesives, colorants, textiles and water purification ([Learn Biomimicry, 2021](#)).

The main hurdle for implementation of biomimetics is that the people who design our world aren't always well versed with biology and hence are not so inclined to take biological designs into consideration for solving their problems. They are unable to find biological analogies that can serve as inspiration to find answers for humanity's challenges ([Biomimicry NE, 2016](#)). In these cases, it would be practical to consult with multi-disciplinary professionals who not only have in-depth knowledge of biological systems and processes but also have an aptitude for engineering, design and business as well as an awareness of the latest technological developments.

Understanding nature is a complex task. But incorporating biomimicry into our designs has become easier because of new companies like GreenMimic Inc. with knowledgeable experts who assist you by decoding nature.

GreenMimic Inc.

So we know that emulating mother nature can make our lives easier. But what are the ways in which this can be achieved?

GreenMimic Inc. is a consulting company that specializes in biomimetics, with a focus on designs and processes derived from the plant kingdom. Established in 2003, GreenMimic has provided services to clients in North America, Europe, South Asia and New Zealand. GreenMimic's work has won numerous accolades and it has been in the frontline in the war against environmental degradation for the past two decades.

GreenMimic's CEO stresses the importance of forward thinking: "In recent years we have seen an increase in environmental consciousness. But a major hurdle in the implementation of biomimetics is simply a lack of awareness about its immense potential. Many top officials in companies don't even know what biomimicry actually is. This might sound droll, but they tend to have a misconception that biomimicry means production of plastic flowers.

"A major complaint of opponents is that biomimicry is costly, particularly during the research phase. But this mentality is more of a sign of risk aversion stemming from a fear of the new, as biomimetics is only a recently introduced approach. But we have seen that biomimetic designs often tend to generate a great return of investment in the long run, so the fears are irrational. For example, it might take more money to construct a building with self-cooling features like the Eastgate center in Harare. But a design like that would recoup its cost by saving a lot of money otherwise wasted on energy. The same principle applies with self-cleaning surfaces that are made to mimic lotus leaves. There is no need to spend money on pollutive detergents.

"Nevertheless, we understand concerns over upfront costs. For this reason we have a dedicated team of business people who advise our biologists. They keep financial risks for our clients at

a minimum, and ensure that the products we help design succeed in the markets by suggesting viable business models.

“We led the ideation process that led to the development of a prototype submersible well pump that can function without a motor. We took inspiration from how water is transported up the stem of a tree passively. The process of transpiration occurs through nanoporous ceramic discs termed as ‘leaves’ and multiple silicone tubes that mimic xylem of real plants. The delightful news is that the manufacturing costs are hardly double that of regular pumps. This could be a potential game changer for the industry.”

GreenMimic’s USPs
A priority on long term vision without underemphasizing short term returns
A focus on risk minimization and profit maximization using designs that contribute to a healthy natural environment
A dedicated business team that collaborates with biologists, engineers and designers to cater to the needs of the clients.

Biomimicry & Efficiency

In most people’s vocabularies, design means veneer ([Steve Jobs, Fortune Magazine, 2000](#)). Worse is the tendency to build anything simply based on arbitrary factors like aesthetics and what the people next door are building. These kinds of habits have a long history indeed, both in individuals and in society at large. We learn through imitation of our seniors– our parents and our teachers– and our peers. At schools we are taught to stick to the curriculum prescribed by educationists. A curious pupil gawking at a blooming flower is considered to be wasting their time. Ironically, if humanity hadn’t gawked at birds flying in the blue sky, airplanes would not have even been a dream, let alone a reality. Even today, nature continues to provide aerospace corporations with invaluable insights on improving flight ([Airbus, n.d.](#)). But we still tend to forget that Mother Nature is senior-most and has unparalleled experiences.

One might have observed the popularity of hook-and-loop fasteners in places where temporary bonds are required. They are safe and maintenance free, and the decline in effectiveness is minimal even after a number of uses. Hence, their applications are numerous. They find usage in NASA space shuttles and they optimize surgical technology and spaces ([Velcro, 2022](#)). There is even a new biodegradable variant that can connect with a plant’s vascular system and deliver pharmaceuticals, pesticides and bacteriacides ([Forbes, 2021](#)).

Velcro was inspired by Mother Nature. The inventor, George de Mestral, tried to mimic the hundreds of hooks of the burs of bodock and successfully created an omnipresent and highly efficient piece of technology.

We copy human made designs and systems without taking into account their many drawbacks. This is akin to creating square wheels, when we can observe a rolling log of wood and create

an invention that can alter the shape of human history for the better. New designs and systems are the need of the hour, and Mother Nature hosts a large library that we can select from.

The Reasons Why Designs Based On Nature Work So Well

Studies and observations have revealed that biomimetic designs can often achieve the same or superior results merely through better structure that conventional technology relies on toxic chemicals to accomplish. Anti-bacterial surfaces without any biocidal additives have already been made, taking inspiration from the micropatterns on shark skin ([National Institute of Health, 2020](#)). Carbon dioxide— a much despised gas due to its contribution to global warming— can be turned into glucose through the Calvin-Benson-Bassham cycle ([Gould, 2013](#)). Closed loop systems eliminate the concept of waste ([Winkler, 2011](#)).

Biomimetics can even be applied in business management. A bioinspired fruit tree model shapes the structure of an organization around the fruit i.e. people rather than around a pyramid of procedures and positions— as is the traditional method of structuring companies ([Tazzi, 2016](#)).

There are a five main lines of explanation for the superiority of biomimetic designs.

Time: The earliest evidences of life are from over 3.8 billion years ago ([Mortillaro, 2017](#)). Furthermore, life has survived five major cataclysms and many more smaller ones. Plants like *Ginko biloba* are considered living fossils as they have been around for hundreds of millions of years ([RBG Kew, 2020](#)). A point of argument may be that present-day species could cease to exist in the future. While this is true, this line of thought doesn't hold much merit. If a cyanobacteria has been around for 3 billion years ([Oldest, n.d.](#)), it is a seasoned survivor and has successfully dodged a multitude of extinction events, and we would be wiser to learn from it.

Sometimes a species might perish, but the design remains. For example, you will not see any pterodactyl in the skies of the twenty-first century, but bats fly around with similarly built wings of skin and muscle ([Swartz & Konow, 2015](#)). The designs found in nature have been time tested over eons. In comparison, man-made ones have hardly faced any challenge over the short period of their existence.

Life collaborates: The second reason for biomimicry's superiority is that "life creates conditions conducive for life" ([Biomimicry Institute, n.d.](#)). When a tree dies, it falls to the ground, rots and fertilizes the soils. This gives a boost to other plant life. When a man-made product becomes old, it is deposited in a landfill and releases hazardous chemicals. The triumph of natural ecosystems is that they can turn waste into a food/energy source. There is an ill-begotten tendency to use 'competition' as a synonym for 'evolution'. The phrase 'survival of the fittest' conjures images of an unending breakneck race that the trillion species of earth partake in. But a deeper analysis reveals that despite its immense diversity, life thrives through collaboration. Often symbiotic relationships arise as a response to ecological pressures and opportunities that play a crucial role in evolution ([Resilience, 2017](#)). The Sanskrit phrase "Vasudeva Kudumbakum" means "the world is one family" and the biosphere is a seamless family of interdependent and interconnected species ([The Future of Design, 2016](#)).

Regenerative tendencies: Additionally, designs found in nature are known for their regenerative properties. Damages are often short-term. Wounds heal, a Gecko grows back its

tail, and an abandoned building is overgrown by plant life in a matter of time. If we could engineer regenerative cities by emulating functions of whole ecosystems, they would go beyond merely minimizing environmental impact to creating ecological and societal health, and have beneficial biodiversity outcomes ([Zari and Hecht, 2020](#)).

Many regenerative materials are in development inspired from the self sealing properties found in plants ([Rampf et al., 2011](#)). Such ‘smart materials’ are bound to play an important role in the twenty first century as there is a high demand for materials with increased safety, long term durability and minimum repairing costs ([Sobczak & Drenchev, 2014](#)).

Structural possibilities: An interesting observation in the natural world is that structural variations alone can achieve certain results that are on par with the effects yielded by use of chemicals. For example, several plants such as *Pollicia condensata* and *Elaeocarpus angustifoliosus* are known to produce structural colors.

Optically active films have been developed from cellulose nanocrystals which are biodegradable and ecofriendly as they are extracted from plants, animals and bacteria. Moreover the colors are potentially everlasting and very vibrant ([Dumanli et al., 2014](#)).

Self assembly: Last but not the least, living systems are known for their ability to self assemble– and disassemble at the end of life. Life creates by infusing information into matter. Self assembly processes resulting in nano and micro structures are common in nature. Atoms, molecules, and other building units self-organize to form well defined structures ([Barthlott et al., 2017](#)). This can be replicated in an artificial setting to produce functional materials ([Levin et al., 2020](#)) Nacre, alternatively known as mother-of-pearl self assembles itself and is incredibly strong. It has inspired artificial super-strong materials that are ten times stronger than conventional ceramic ([PHYS, 2014](#)). Adapting self assembly to the production process can eliminate manufacturing hazards, improve employee health, and minimize our reliance on the ‘heat-beat-treat’ method that generates more waste than product.

So now that we have underlined the benefits that come with biomimetic designs, the big question to answer is why are nature-based designs not as frequently used as they should be?

The Problem With The Modern Business Ecosystem

Businesses in our times are overdependent on and overfamiliar with the take-make-waste model. The circular economy is not a new concept and has been around since the 1960s, thanks to work by pioneers like Kenneth Boulding ([Rolandberger, 2022](#)) but circular models require more innovation and can be trickier to execute, although the results are always worth it. Many still remain in denial that global warming is real ([BBC, 2020](#)).

Businesses are reluctant to move to a closed model, unless they are clearly explained the many benefits they would reap through a sustainable design. Businesses are not charities. They exist to make money. They need incentives to transition to a sustainable model. First and foremost they want to know the possible profits a product based on an iridescent berry could make. Environmental concerns perhaps occupy the tenth position of their priority list– or perhaps none at all. However savvy businesses will realize the competitive edge that comes with sustainability practices like biomimicry.

GreenMimic Inc. disentangles the dilemma that modern businesses face by solving the profit-loss concerns with healthy designs that have a positive impact not only on revenues, but the environment too.

Conclusion

Sustainability is often seen as something decorative— a fashion fad— that is supposed to improve the brand's image and be in the good books of the public. But there is overwhelming evidence that sustainability can be much more than that. Sustainability practices like biomimicry can directly impact the revenue and profits, by creating better products and by improving the way a company functions. Sustainability often is treated as a fancy feather on a hat— but this attracts allegations of greenwashing ([Kotler & Keller, 2017](#)). It is when sustainability is incorporated into the core of a business that it starts working its magic. The interesting fact to note is that customers will happily pay more for goods that do not harm the environment ([World Economic Forum, 2018](#)).

We need to understand the gravity of the times we are living in. As the environmental crisis worsens, we must adapt and change tactics. We must let go of old mindsets that neither improve life quality nor our bank balances. People are already fleeing their homelands ravaged by flood and drought ([World Economic Forum, 2021](#)). In our cities the mere act of breathing is worse than smoking ([Hindustan Times, 2016](#)). We have already filled up the earth with as much poison as we could have. Any more, and we are dooming future generations. Biomimicry is a potent compass as we seek the directions to a world free of garbage heaps, where technology and nature work in harmony. We must use it to our advantage.

Act today we must, to build a better world and avert catastrophe. It might be too late by the time we feel the heat, or see the people in our families fall prey to diseases borne of pollutants, or become climate refugees ourselves. The rising temperatures and sea levels will wait for none.

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