Biomimicry

* **"Biomimicry** is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies."
* From: http://biomimicry.org/

* **Examines nature, its models, systems, processes, and elements— and emulates or takes inspiration from them to solve human problems sustainably..**

* **From Leidy Klotz, UVA**

Learning from mosquitos to create "a nicer needle"

Medicine

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Have you ever noticed a mosquito bite (or two or three) that seemingly appeared out of nowhere? It turns out that the tip of the mosquito's mouth is composed of several moving parts that work into skin with the minimum of fuss–and the minimum of pain.

More...

Materials researchers and engineers at **Kansai University** in Japan saw amazing potential in the structure of the mosquito's mouth. They used sophisticated engineering techniques that can carve out structures on the nanometer scale. The result of this blend of materials science and biology was a **needle that penetrates like a mosquito, using pressure to stabilize and painlessly glide into skin**. Tests proved it worked flawlessly.

The efficient drill of the wood-boring wasp's ovipositor (an egg-laying spike) works on the same basis. Two toothed blades ratchet a central drill deeper and deeper into the wood. Because of the efficiency of this design, no motor is needed–just the delicate force the wasp exerts. This goal of guided, smooth penetration is exactly what neurosurgeons need in their tools.

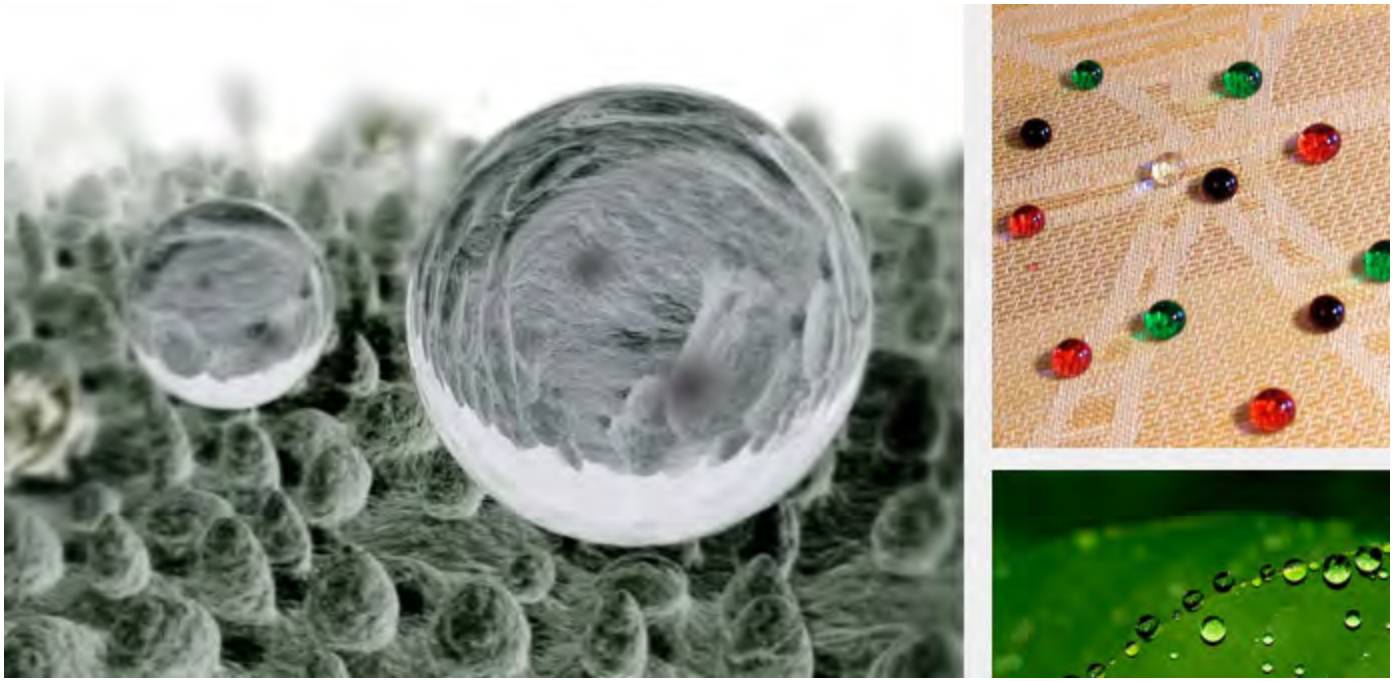
Researchers at **Imperial College** and **Rutherford Appleton Laboratory** in the UK have applied engineering techniques similar to those of their colleagues at Kansai, achieving similar results. T**hey showed that a neuroprobe tipped with this biomimetic design required the least amount of force to move.** The less force a neurosurgeon can use, the more they can be certain to leave your brain undamaged, thus preserving your memories of **cult 80's movies**.

Written by Tom Benson

https://biomimicry.org

Learning Efficiency from Kingfishers
The Shinkansen Bullet Train of the West Japan Railway Company is the fastest train in the world, traveling 200 miles per hour. The problem? Noise. Air pressure changes produced large thunder claps every time the train emerged from a tunnel, causing residents one-quarter a mile away to complain. Eiji Nakatsu, the train's chief engineer and an avid bird-watcher, asked himself, "Is there something in Nature that travels quickly and smoothly between two very different mediums?" **Modeling the front-end of the train after the beak of kingfishers, which dive from the air into bodies of water with very little splash to catch fish, resulted not only in a quieter train, but 15% less electricity use even while the train travels 10% faster.**

http://www.biomimicryinstitute.org/case-studies/case-studies/transportation.html



Learning from Lotus Plants How to Clean without Cleaners

Ask any school child or adult how leaves keep water from sticking to them, and they'll almost certainly say, "Because they are so smooth." Yet one of the most water repellent leaves in the world, that of the Lotus (Nelumbo nucifera), isn't smooth at all. The myriad crevices of its microscopically rough leaf surface trap a maze of air upon which water droplets float, so that the slightest breeze or tilt in the leaf causes balls of water to roll cleanly off, taking attached dirt particles with them. Now, microscopically rough surface additives have been introduced into a new generation of paint, glass, and fabric finishes, greatly reducing the need for chemical or laborious cleaning. For example, GreenShield, a fabric finish made by G3i based on the "lotus effect", achieves the same water and stain repellency as conventional fabric finishes while using 8 times less harmful fluorinated chemicals.

http://www.biomimicryinstitute.org/case-studies/case-studies/toxics.html

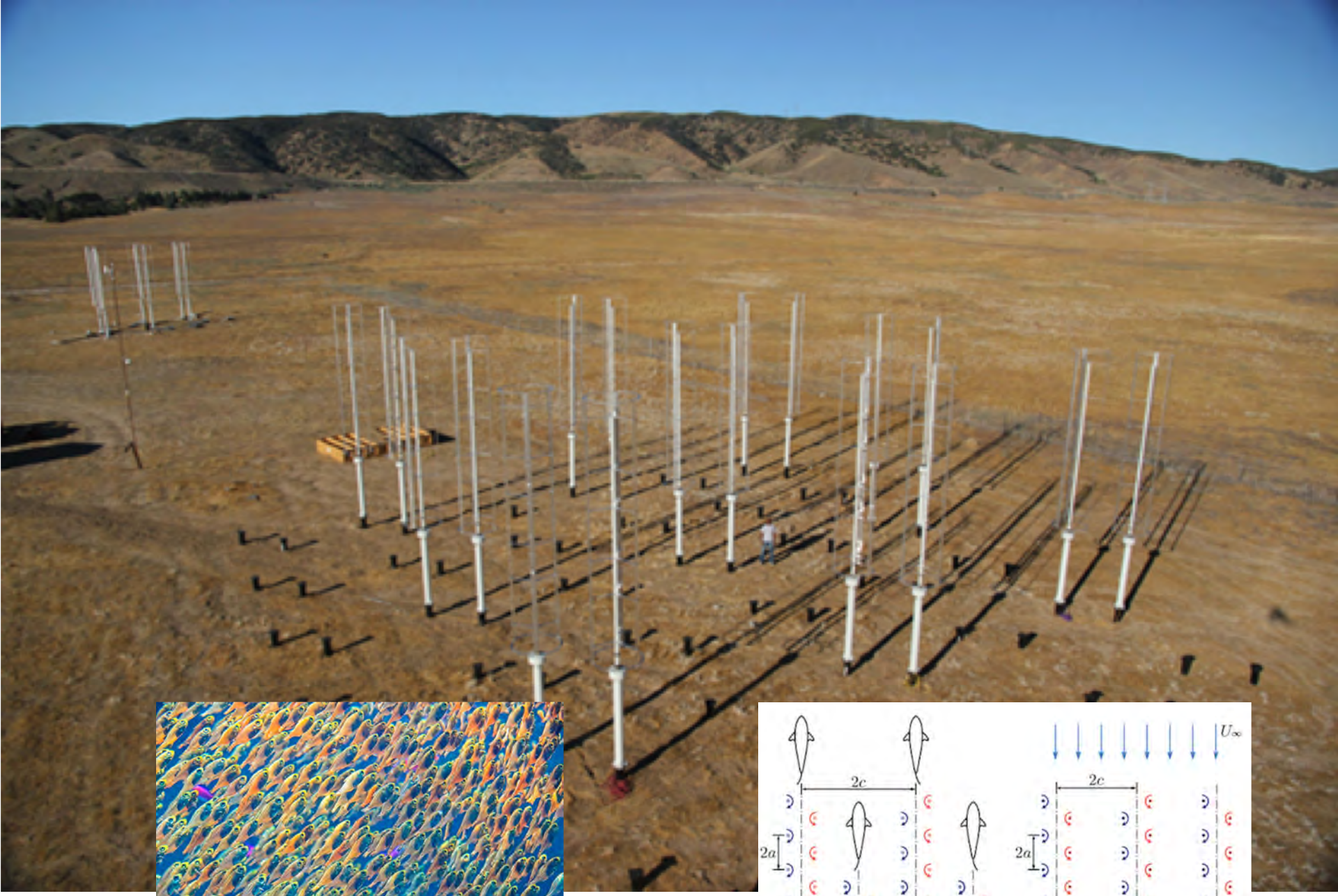
http://nanoarchitecture.net/images/544.jpg

Learning From Chimpanzees How to Heal Ourselves

One-quarter of all modern medicines are derived directly from plants, and there are hundreds of thousands of other plant species yet to examine, each with dozens of unique chemical compounds that could prove of medicinal value. If one wanted to discover more valuable medicines, where would one start looking? It could take millions of years, literally, to sort through this enormous variety of plants and plant compounds to find ones with medicinal value. Fortunately, this is exactly what researchers have discovered that chimpanzees (Pan spp.) have already done, over millions of years of evolutionary time. By observing how chimps and other species cope with illness, researchers have acquired leads on plants with promising medical applications to human health. Trees from the Vernonia genus, for example, which chimpanzees regularly seek out when ill, have been found to contain chemical compounds that show promise in treating parasites such as pinworm, hookworm, and giardia in humans.

http://www.biomimicryinstitute.org/case-studies/case-studies/medicine.html

L. Klotz



L. Klotz

Learning from termites how to create sustainable buildings

Architecture

We generally think of termites as destroying buildings, not helping design them. **But the Eastgate Building, an office complex in Harare, Zimbabwe, has an air conditioning system modeled on the self-cooling mounds of termites** that maintain the temperature inside their nest to within one degree, day and night (while the temperatures outside swing from 42 °C to 3 °C).

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More...

The operation of buildings represents 40% of all the energy used by humanity, so learning how to design them to be more sustainable is vitally important. Architect Mick Pearce collaborated with engineers at Arup Associates to design Eastgate, which uses 90% percent less energy for ventilation than conventional buildings its size, and has already saved the building owners over $3.5 million dollars in air conditioning costs.

https://biomimicry.org

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https://inhabitat.com/extraordinary-living-chandelier-with-algae-filled-leaves-purifies-the-air/

"Brilliant zero-energy air conditioner in India is beautiful and functional"

http://inhabitat.com/brilliant-zero-energy-air-conditione
in-india-is-beautiful-and-functional/

Active Learning Activity

* Learning Activity 7.3 (Biomimicry)
* Learning Activity 7.4 (Insulation)
* Active Learning Exercise 7.1 (Carbon Footprint)

Learning Activity 7.4 Which Insulation Is Most Sustainable?

Good product engineering requires that we design with our end users in mind. In this activity, you will integrate principles of green engineering with market analysis to evaluate which type of building insulation is most sustainable for a start-up firm. This activity also illustrates the powerful role that economics plays in getting (or not getting) sustainable products into the marketplace.

Assume that you are the founder of a start-up building materials company committed to green engineering and making sustainable resources readily available to the do-it-yourself homeowner market. You conduct some market research and find that the U.S. building insulation market is projected to reach nearly $9 billion by 2016, with annual increases in sales of nearly 8%. The strongest growth will be in the residential sector, as new housing starts recover from the economic downturn and existing homeowners focus on greater energy conservation. Because of this market data, you decide to expand your product line to include insulation products.

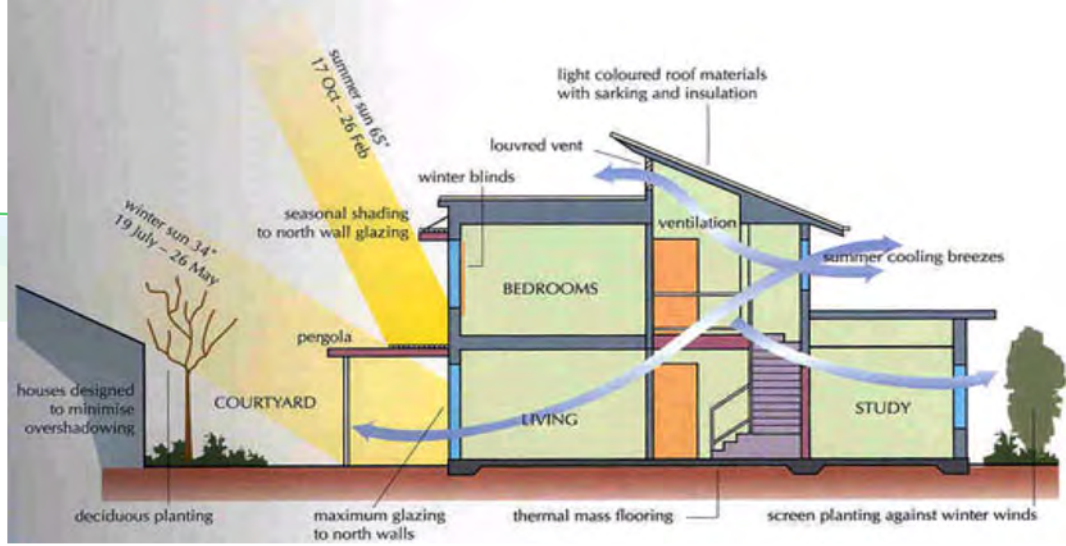
Conduct an Internet search in which you obtain information about fiberglass batt, mineral wool, cellulose, polyurethane spray foam, and soy spray foam insulation. As you search, look for the following types of information:

- Materials content, including any use of toxic or hazardous substances in the manufacturing process.
- Safety and health issues associated with do-it-yourself installation of such products.
- Ease of installation, and flexibility of the product (for example, it can be used in a wide variety of climates or building conditions).
- The cost of the amount of insulation required to achieve roughly R-12 to R-15 for 1,000 square feet of surface.

The **material safety data sheet** for these products will give you a wide variety of information, as will various websites that provide insulation cost calculators.

Use the principles of sustainable and green engineering to evaluate which of these materials are the most sustainable from a business perspective. Which one do you select to develop for your company? What would have to change (if anything) for your product to be more competitive in the insulation market? What are your next steps in terms of directing your engineering and product design team for new product development?

Activity



Invent an example of how biomimicry could be used in engineering to contribute to a more sustainable solution.

1. Ask yourself - "what is my fundamental goal?" (e.g., move water, cool air, gather light). This is essential - don't say "light a space" when what you really want is to be able to see.
2. Identify an example from nature that is accomplishing a similar goal to your project. At minimum, you should use the excellent website www.asknature.org and go look around outside.
3. Figure out how you could draw on the example from nature to improve your project (you should go through more than one iteration).
4. Each table selects a top idea to share with the class.

Active Learning Exercise 7.1 Your Carbon Footprint

Use the U.S. EPA individual carbon footprint calculator (www.epa.gov/climatechange/ghgemissions/ind-calculator.html) to estimate your carbon footprint and answer the following questions.

- How much carbon dioxide do you emit for your lifestyle in an average year based on the EPA calculator for:
  - Heating
  - Transportation
  - Home energy
  - Consumer waste emission
- Create a pie chart of your emissions for each of the four categories above. What category contributes the greatest amount of GHG emissions? What category contributes the greatest amount of GHG emissions?
- How do your emissions compare to the U.S. average from How do your emissions compare to the U.S. average indicated in your summary of estimated savings?
- What would your emission rate be if you reduced emissions associated with electricity use by 75% by using electricity produced from a power generating facility that would adopt carbon capture and sequestration technology?
- How would this impact your total CO_2 emissions?
- What is the difference in your CO_2 emission if you were to recycle zero of your consumer waste compared to if you were to recycle all possible components of your consumer waste?