We all know what that is . . .

. . . but we didn’t have a special name for it

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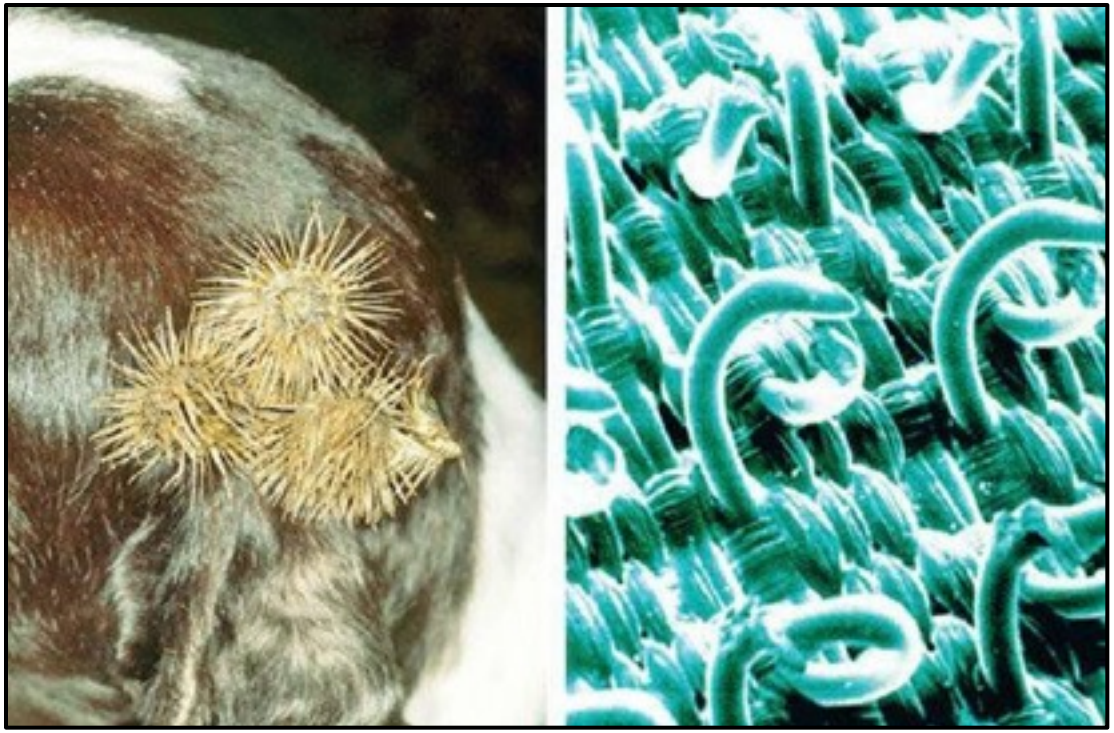
BIO-MIMIC-RY

from the Greek ***bios***: life

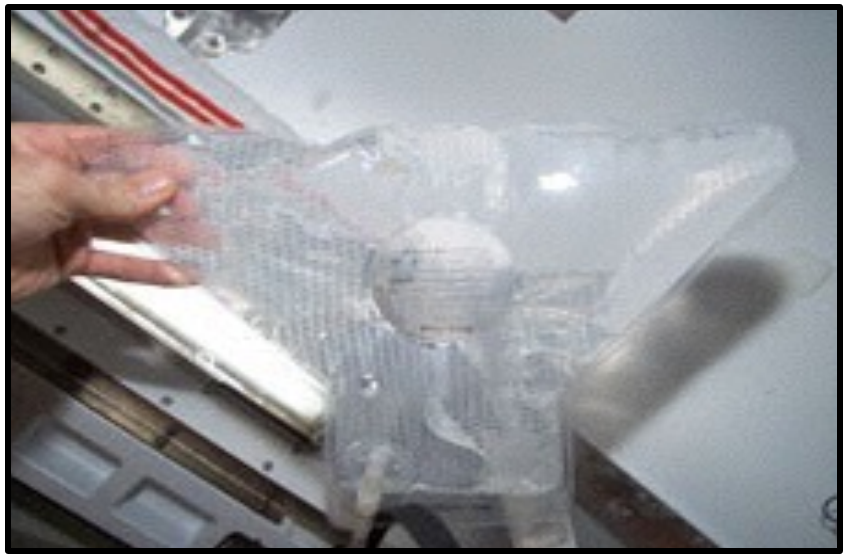
and ***mimesis***: imitation

Burdock Burrs Inspired Velcro



After a hunting trip in the Alps in 1941, Swiss engineer George de Mestral's dog was covered in burdock burrs. Mestral put one under his microscope and discovered a simple design of hooks that nimbly attached to fur and socks. After years of experimentation, he invented **Velcro** – and earned US Patent 2,717,437 in October 1952

NASA utilizes Velcro



In-Suit Drink Bag
A plastic, **water-filled pouch attaches to the inside of the Hard Upper Torso using Velcro.** A plastic tube with a valve sticks out of the bag. The tube and valve can be adjusted to be near the astronaut's mouth. Biting the valve opens the tube so the spacewalker can take a drink. Releasing the bite closes the valve again.

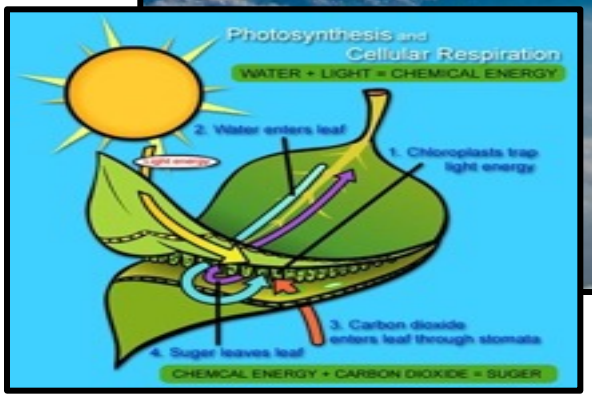
Neil's [Armstrong] Intravehicular (IV)gloves as displayed at the Kansas Cosmosphere. Apollo XI 2006

Termite mounds Inspired the TeePee

Building on a N/S orientation helps the termites control airflow and temperature inside the mound to a constant 86-87 degrees F

The opening near the top, facing down wind, draws smoke out

Photosynthesis Inspired Solar Panels



Solar Impulse 2

Top surface of wings covered with 17,000 solar cells

4 electric motors store enough daytime energy to keep the plane moving throughout the night.

TEDTalk: Biomimicry

- https://www.youtube.com/watch?v=sf4oW8OtaPY

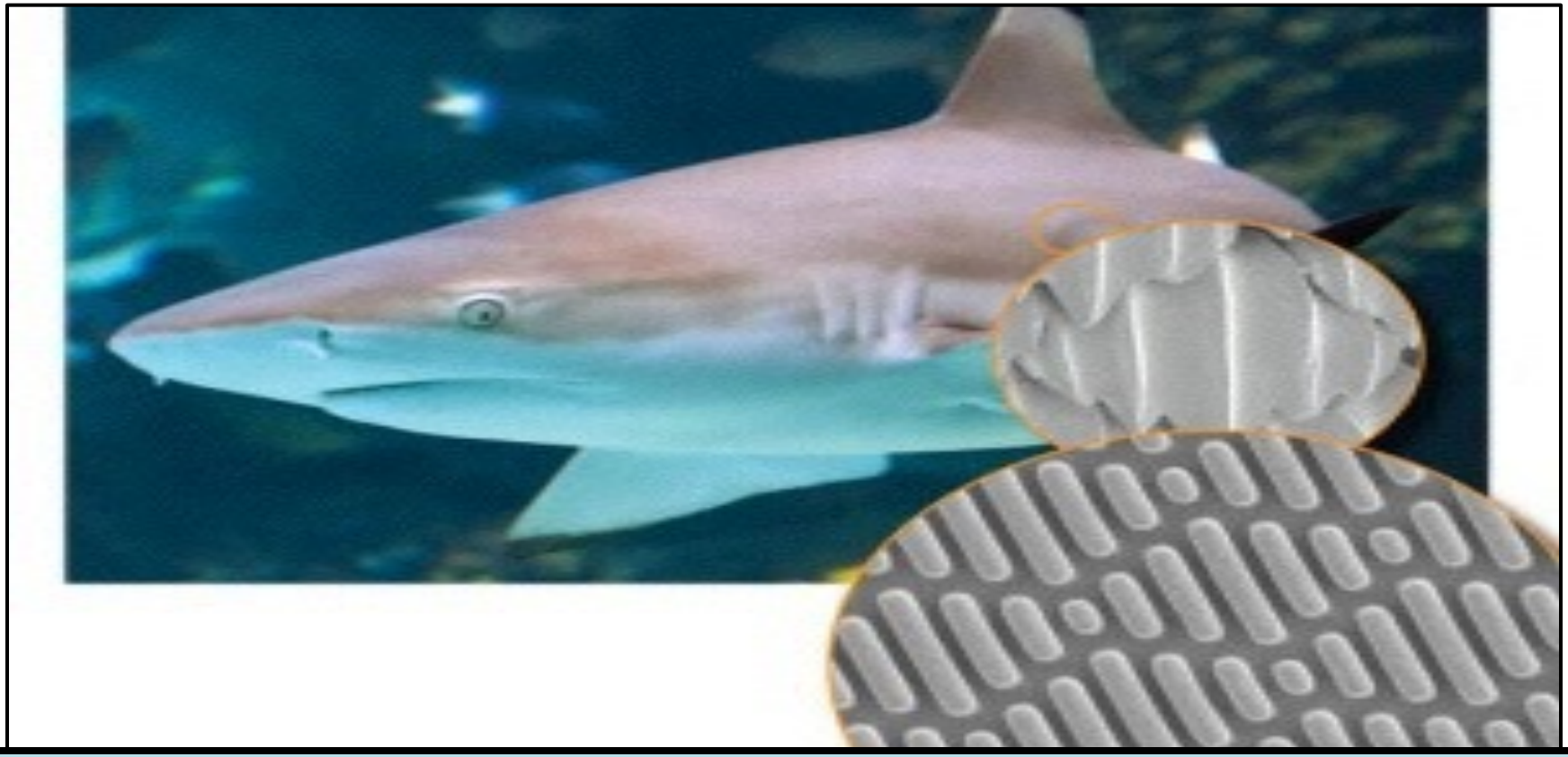
Shark skin Inspired Swimsuit Design

Sharkskin-inspired swimsuits received a lot of media attention during the 2008 Summer Olympics

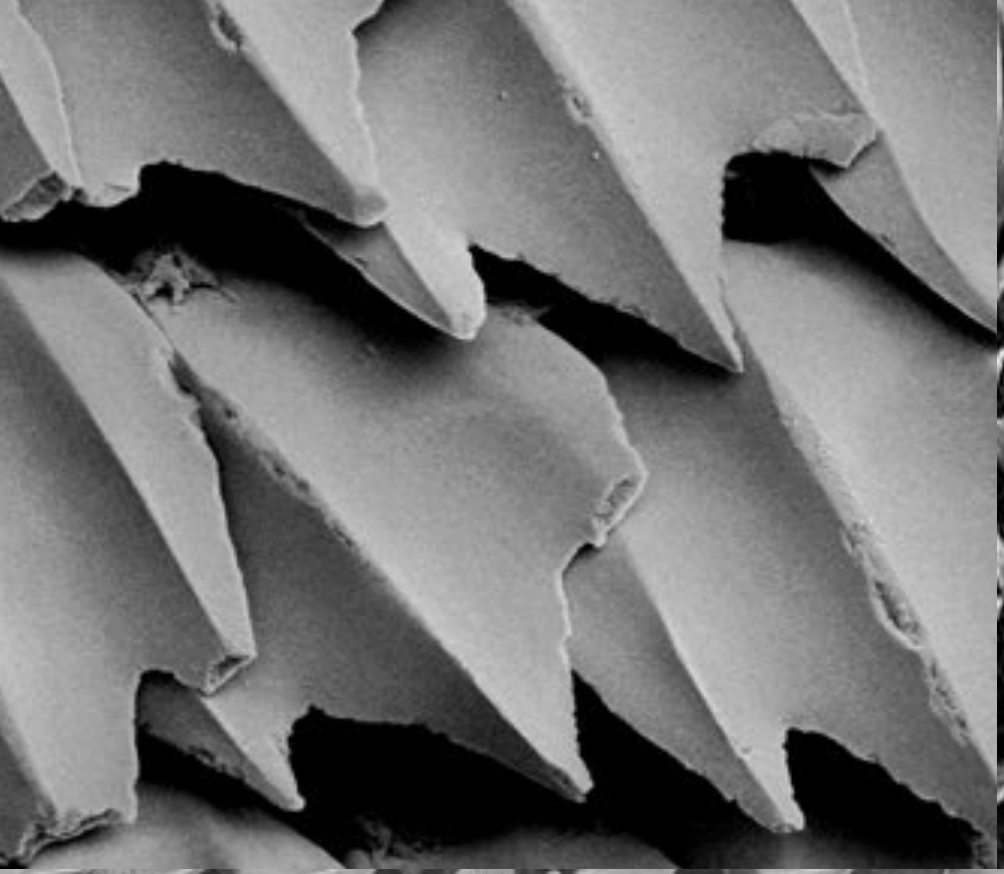
Suits banned as of Jan 2010

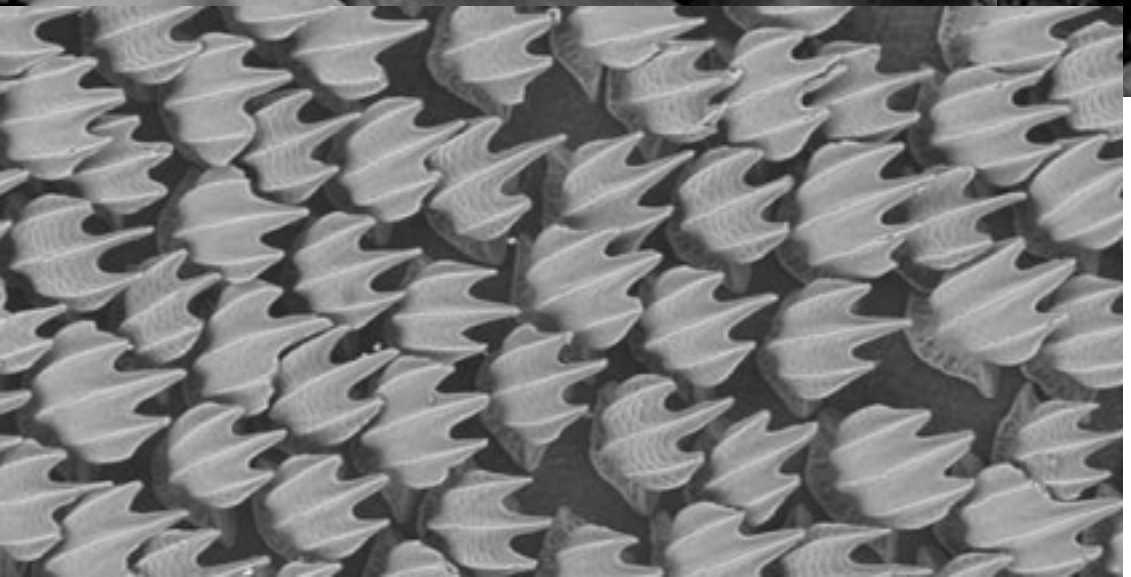
No-kill, non-toxic & environmentally-friendly surface texture designed to inhibit bacterial growth

Inspired by the natural microbe-resistant properties of sharkskin



Studies by Dr. Brannan and Sharklet Technologies confirmed that the Sharklet™ **pattern was extremely effective at inhibiting the growth of multiple pathogenic bacteria, including *S. aureus*, *E. coli*, *P. aeruginosa*, *VRE*, and *MRSA*.**



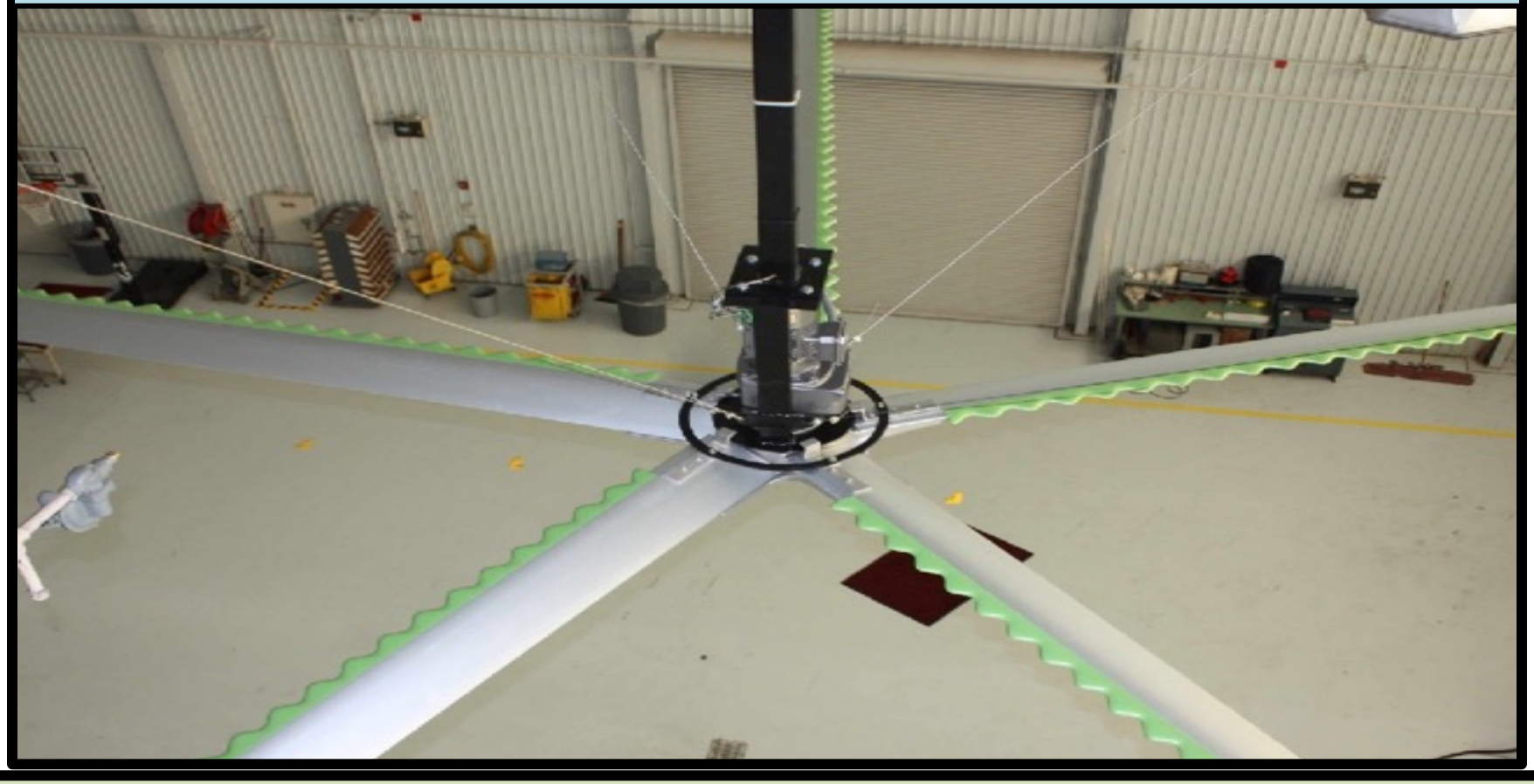


Different sharks,
different scales . . .
but same principle

Whale Fins Inspired Blade Design

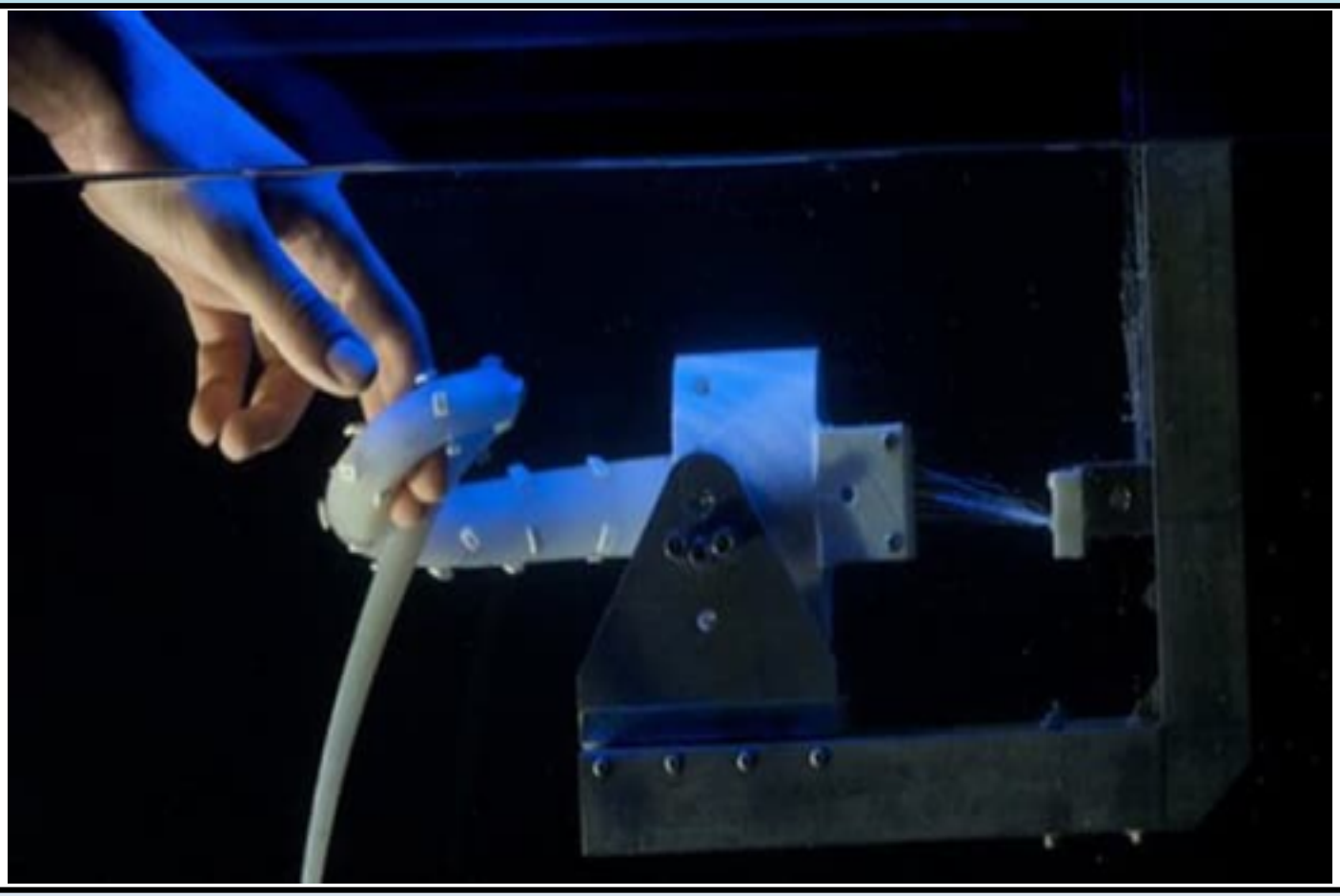
A Humpback whale's flipper has **32% less drag and 8% more lift** compared to a flat-edge flipper.

Whale Fins Inspired Blade Design



Accelerated air flow **increases efficiency by 20%**
and **dramatically reduces noise.**

Octopus Arm Inspired Robotic Tentacle



Octopus Project creates robotic tentacle for:
Exploration in very small spaces and Rescue under debris

Water Swirls Inspired Windmill Design

Snail Shell Inspired Body Armor

Hot Vent Gastropod with Super Shell leading to

Improved Body Armor Systems

Super-shell has a unique <u>three-layer</u> structure dissipating energy that would cause weaker shells to fracture

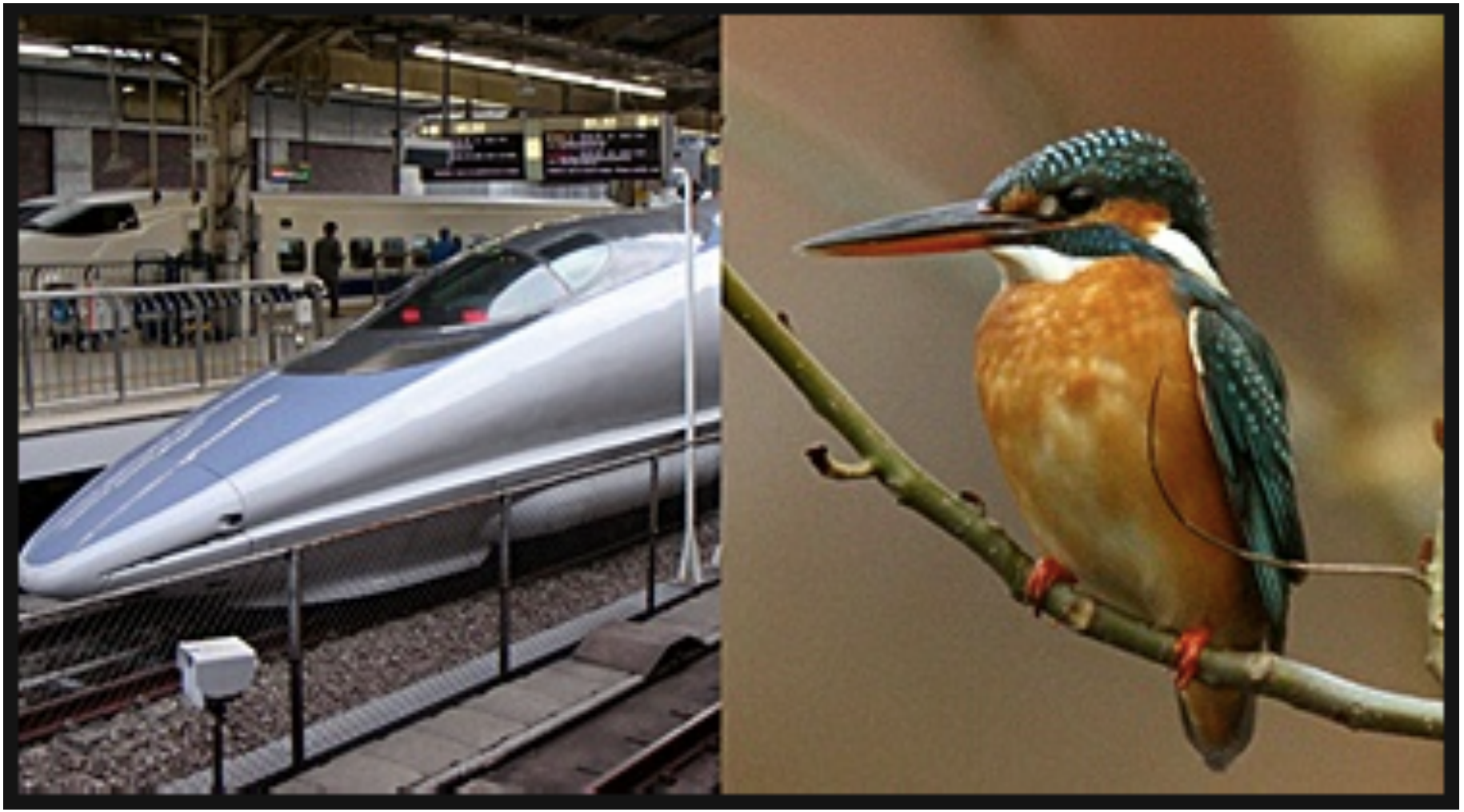
Lobster Inspired Underwater Robots

RoboLobster* and **RoboLamprey** are used in

- **underwater mine detection**
- **underwater search** and **surveys**, **environmental tracking**, and the **inspection of bridge pylons and dams**

- ***Northeastern University** Marine Science Center, MA

Kingfisher Inspired The Bullet Train



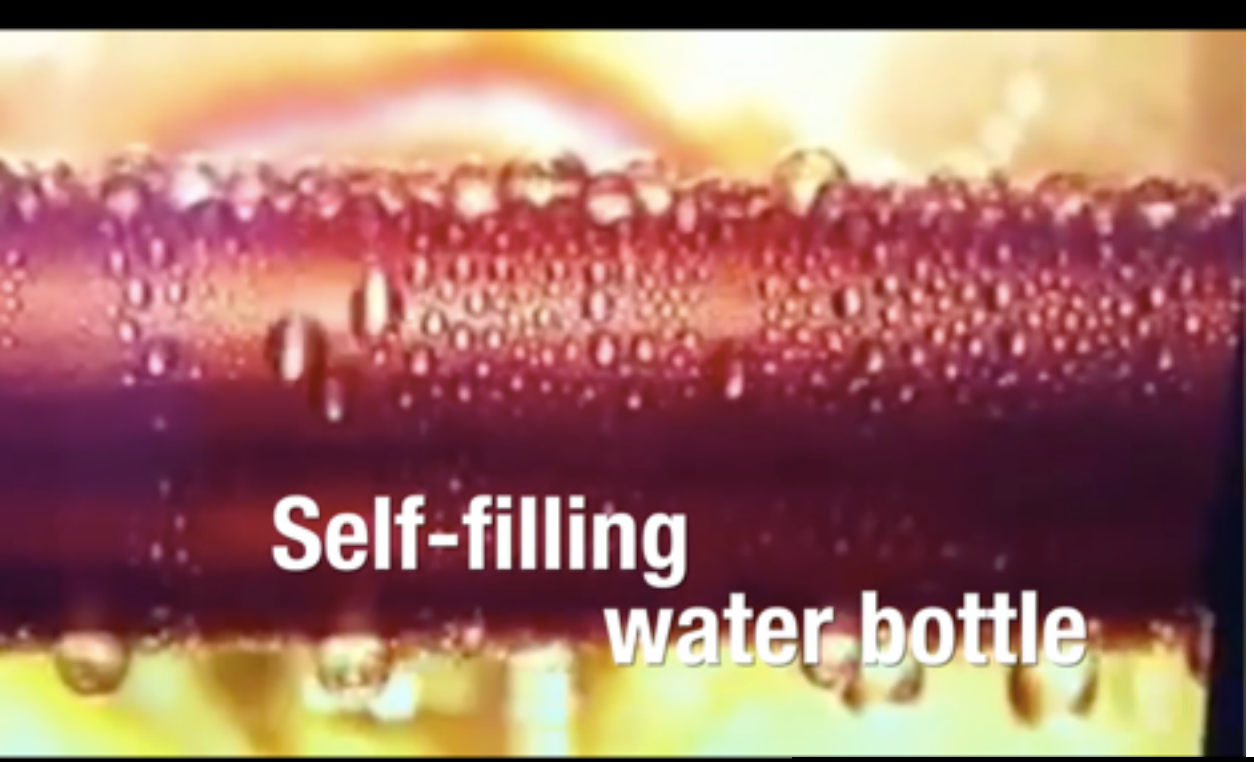
Japan's Shinkansen "bullet" Train

Moving at very high speeds, the trains produced significant noise*, …from wind resistance over the trains body

The problem that bedeviled engineers for some time involved sonic booms that were produced when the trains emerged from tunnels as a result of the air being compressed by the speeding train.

Namib Beetle Inspired . . .

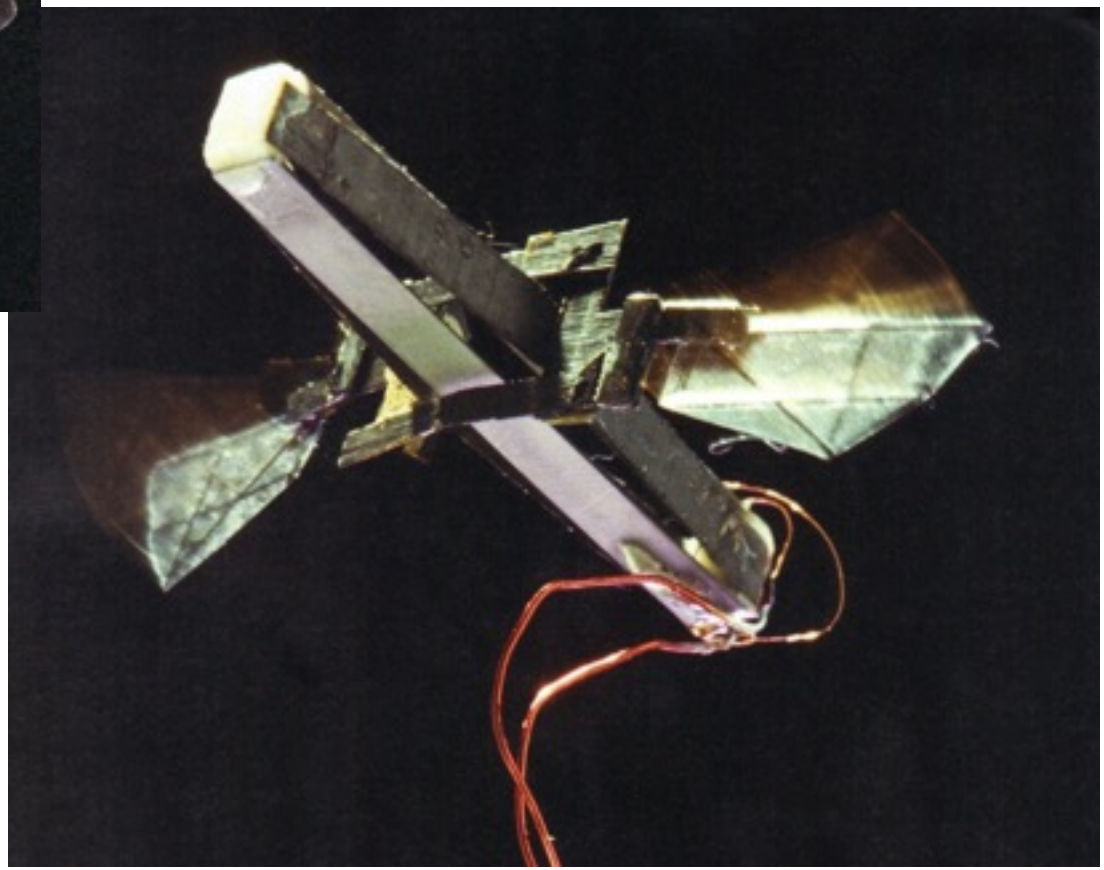
The shell is covered in tiny bumps that are water attracting (hydrophilic) at their tips and water-repelling (hydrophobic) at their sides. The beetle extends and aims the wings at incoming sea breezes to catch humid air; tiny droplets 15 to 20 microns in diameter eventually accumulate on its back and run straight down towards its mouth.



Water collection in nature . . . .

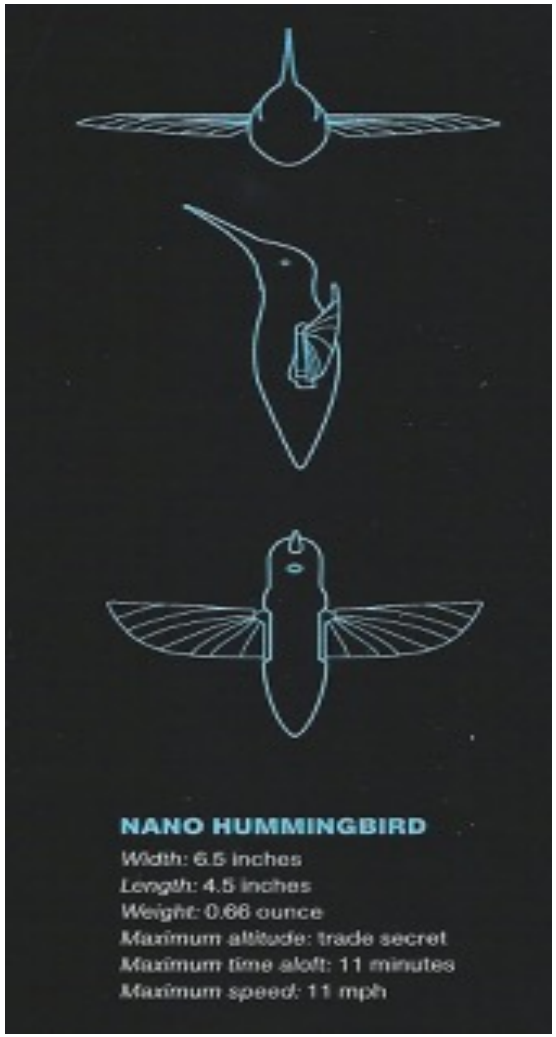
Blowfly Inspired Minidrones

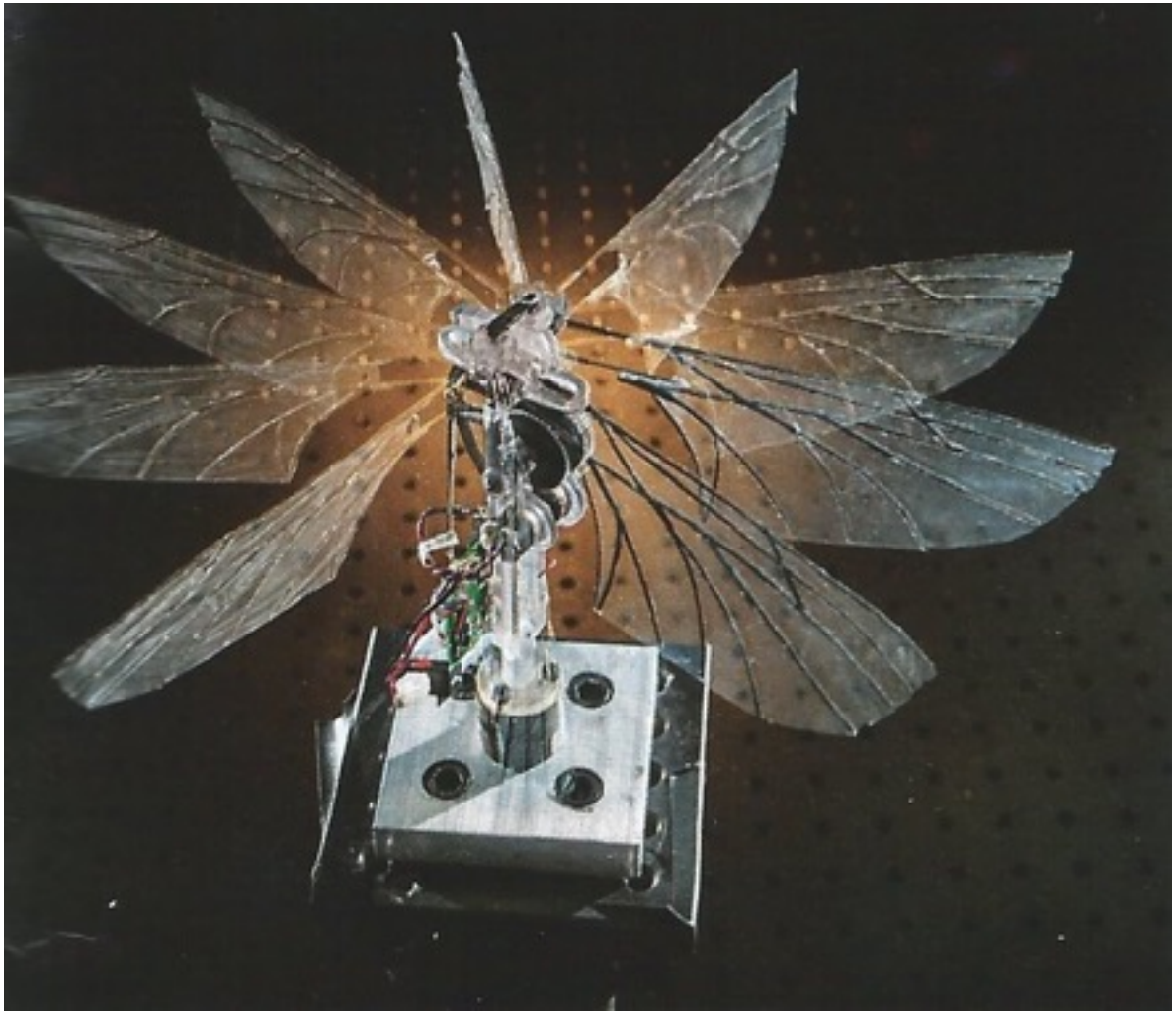
Robots for rescue; espionage



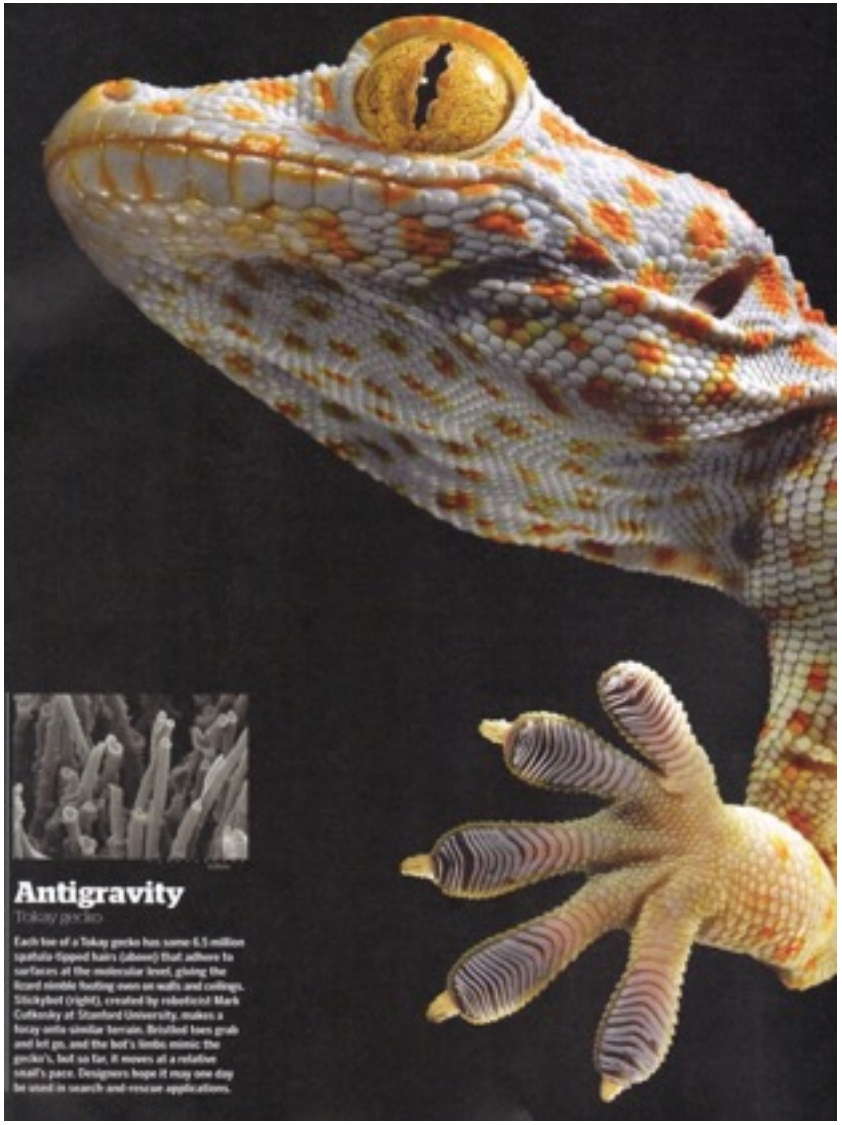
Robotic insect flaps its wings 275 times/sec.
Goal is to develop a robot that weighs 1/20th of a paper clip.

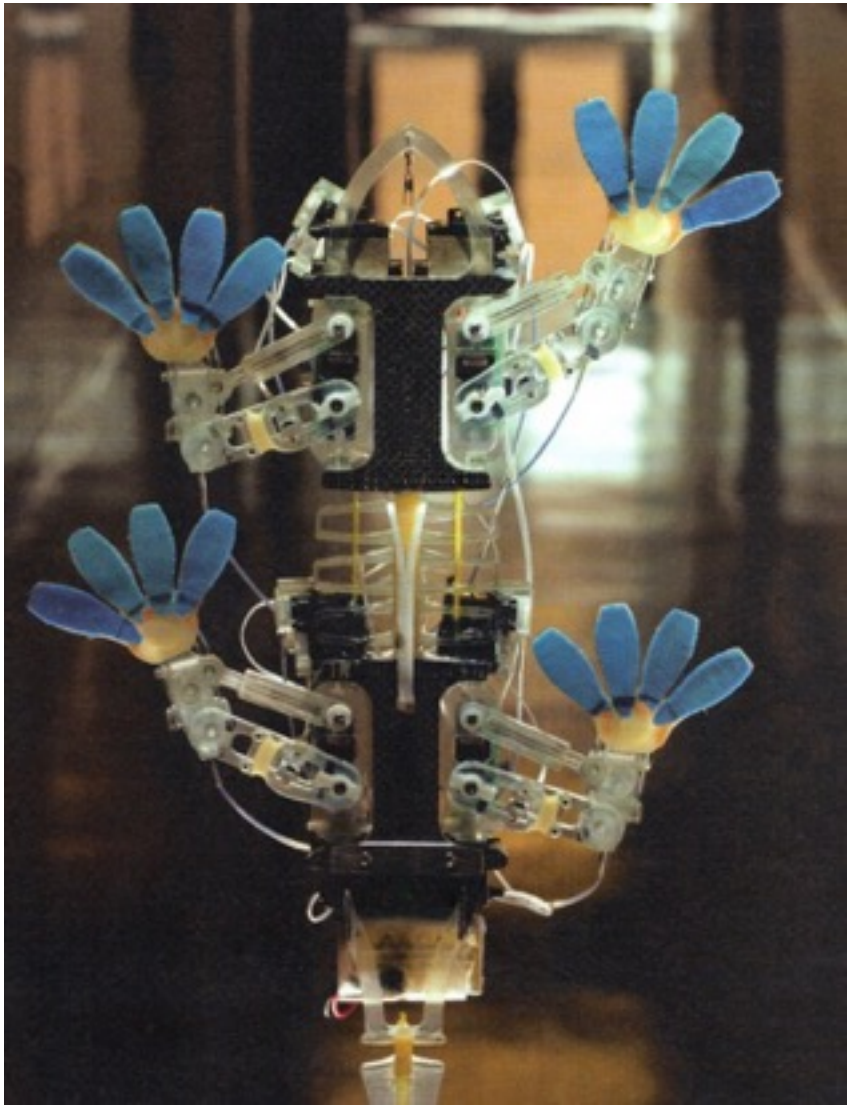
Hummingbird Inspired Minidrones





Gecko Inspired Climbing Robot

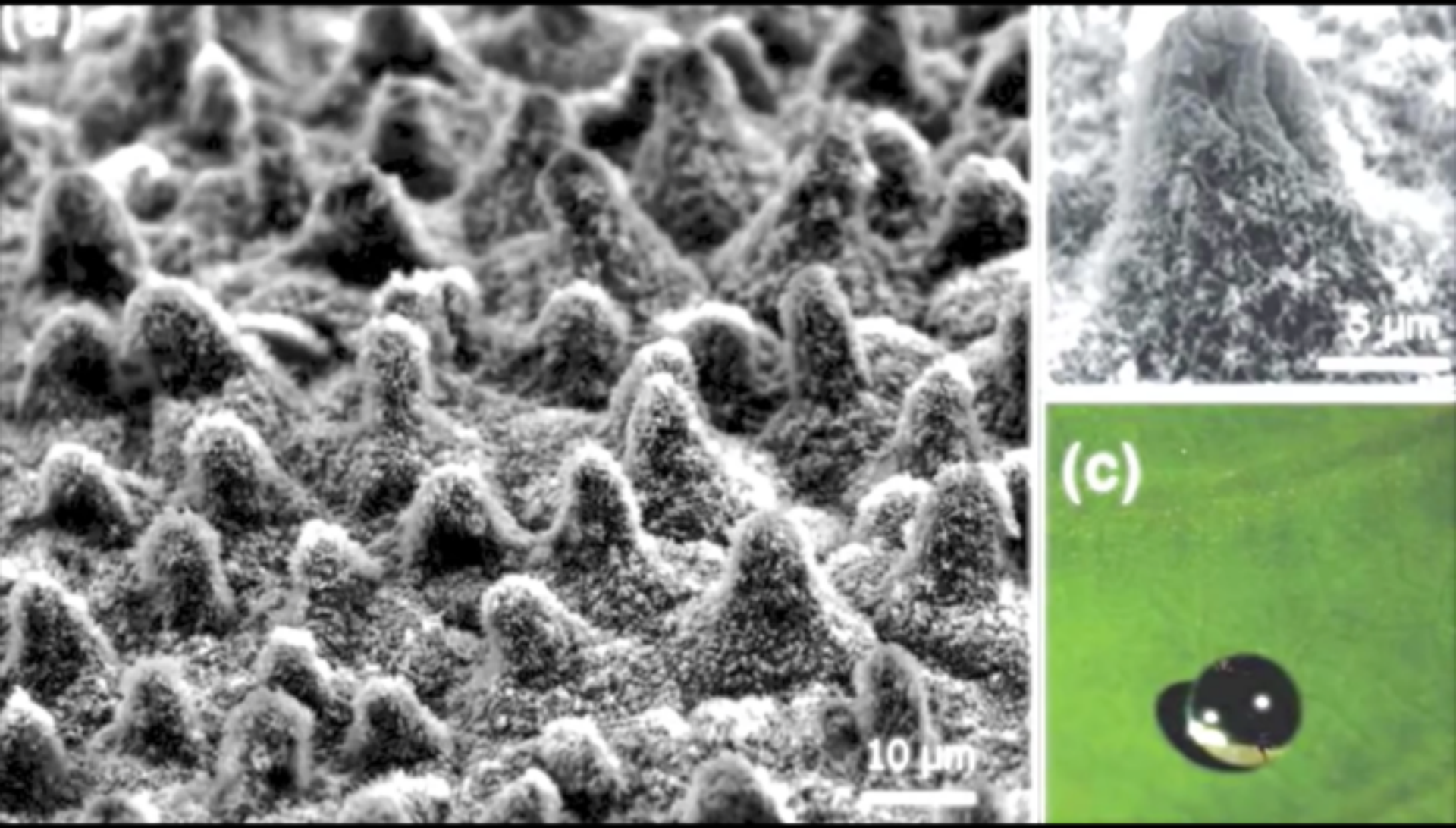




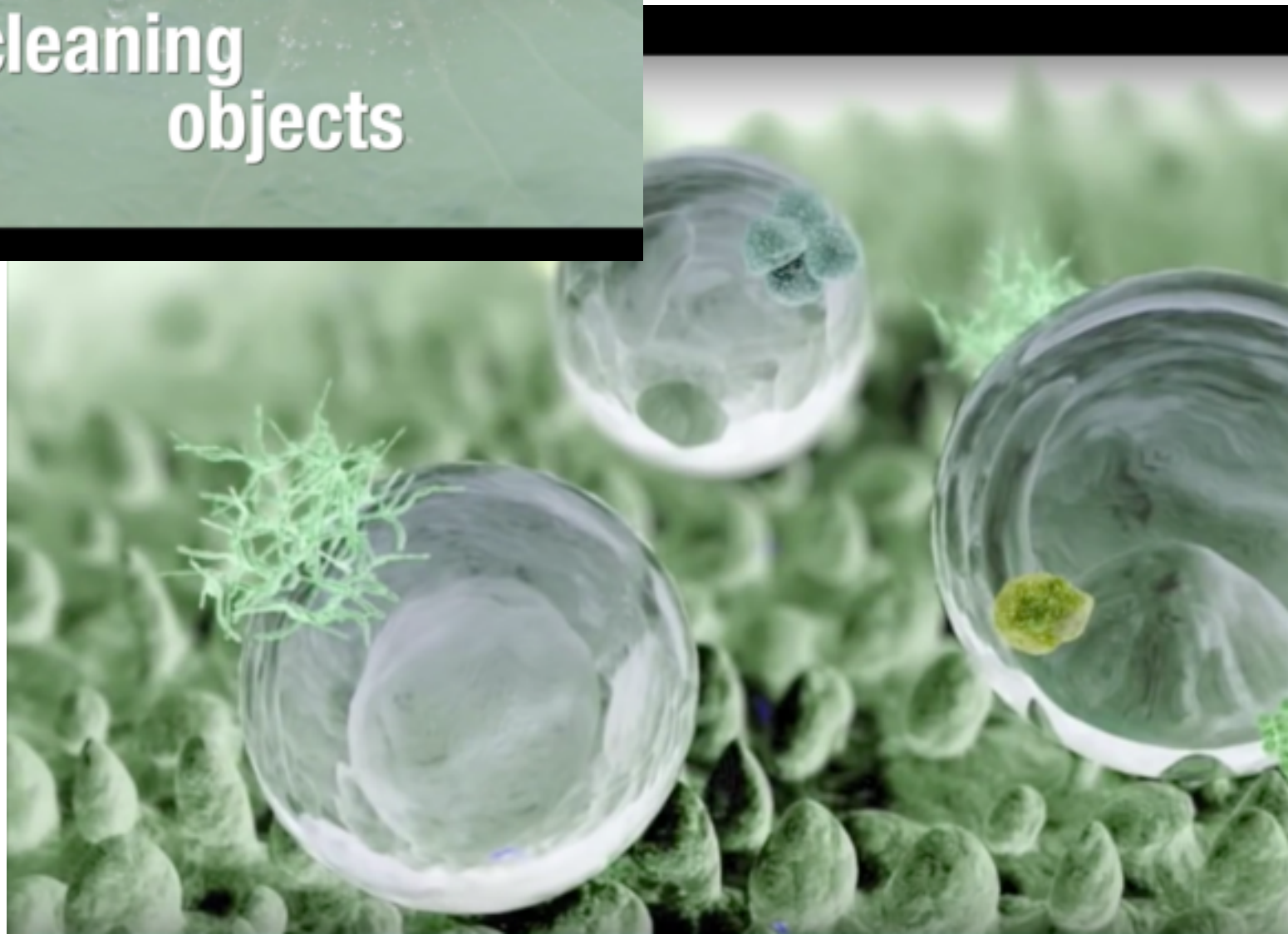
Forest Floor Inspired Carpet Design

Easy to change carpet pieces <u>increase sustainability</u> and <u>reduce replacement costs</u>

Surface Structure Inspired . . .



The Lotus Effect . . .




4x
brighter

. . . Pigment-free
Paints (Colors)

Questions for The Future

Engineers working with Biologists can determine whether new solutions for a device, process, or system **promotes life**

- **Does it Run on Sunlight?**
- **Does it only Use the Energy it Needs?**
- **Does it Fit Form to Function?**
- **Does it Recycle Everything?**
- **Does it Reward Cooperation?**
- **Does it Bank on Diversity?**
- **Does it Utilize Local Expertise?**
- **Does it Curb Excess from Within?**
- **Does it Tap the Power of Limits?**
- **Is it Beautiful?**
- **Biomimicry Innovations Inspired by Nature Janine Benjus**

Thank You!

Nature's Laws, Strategies, and Principals Inspiring Biomimicry Applications

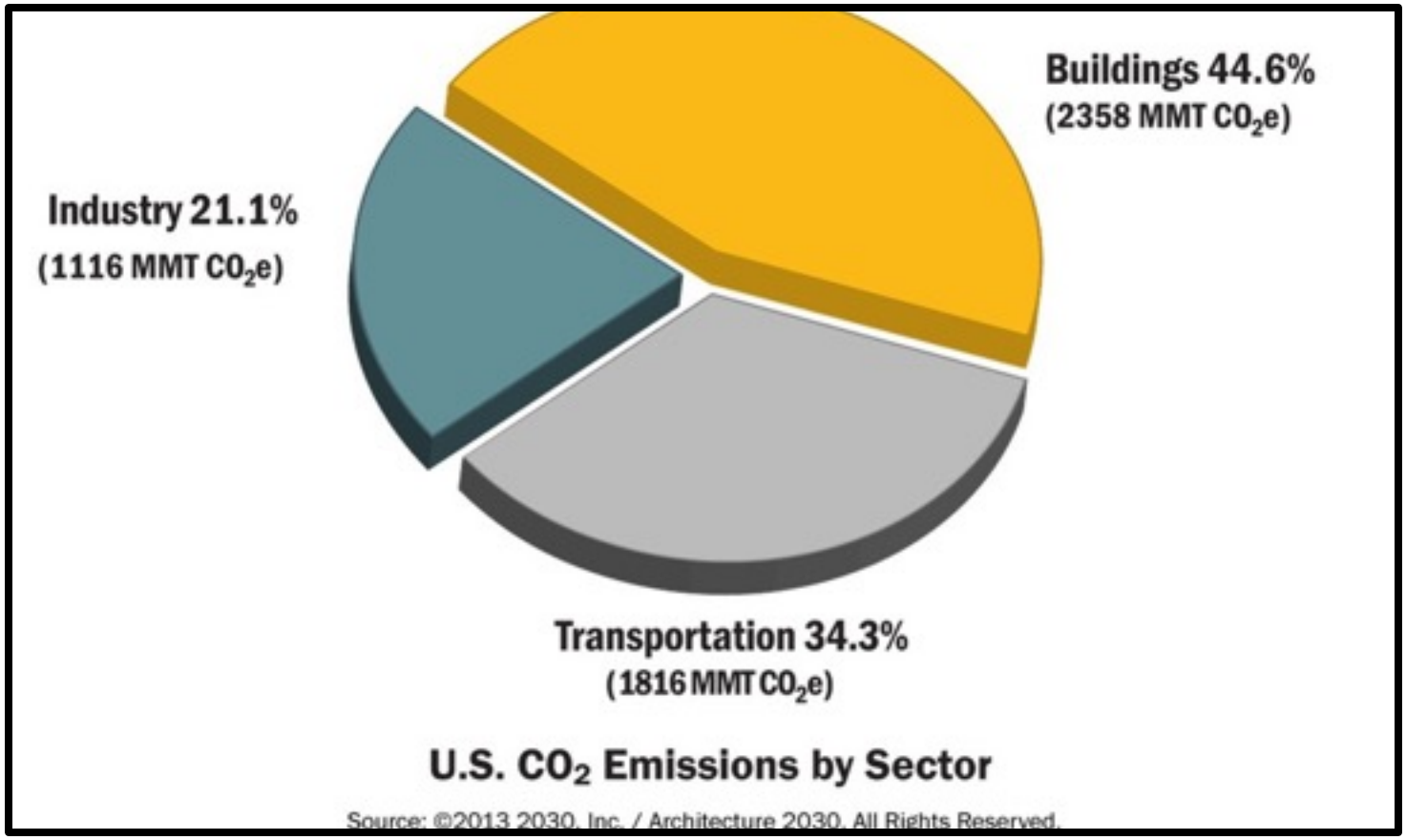
- Nature runs on **sunlight**
- Nature uses only the **energy it needs**
- Nature fits **form to function**
- Nature **recycles** everything
- Nature rewards **cooperation**
- Nature banks on **diversity**
- Nature demands **local** expertise
- Nature **curbs excess** from within
- Nature taps the **power of limits**

from Biomimicry Innovation Inspired by Nature, Janine M. Benyus

Tiny lamprey-inspired robot could locate diseases inside the human body

While not the prettiest of sea creatures, the jawless, blood-sucking lamprey finds itself the subject of this biomimicry project not only because of its ability to swim, but because of its **primitive nervous system,** which researchers believe can be reproduced as part of a micro, or even **nano-scale robot**.

- **…..robot [would] contain an electronic microchip "brain" and an electronic nervous system with sight and smell perception derived from mammalian cells as well as artificial muscles.**
- **…… the robot would respond to light and chemicals in the same way as biological systems, allowing it to navigate its way through the body collect data from its surroundings, including information on the presence of disease.**
- **"Nothing matches a living creature's natural ability to see and smell its environment and therefore to collect data on what's going on around it," says bioengineer Dr Daniel Frankel of Newcastle University, who is leading the UK-based work.**



How we plan and design the built environment from here on out will determine whether climate change is manageable or catastrophic.

Getting to carbon neutral for a new building or major renovation is a two-step process….. **The first step is design**; to integrate **sustainable** and **passive design strategies** that are **low-cost** or **no-cost. The second step is to provide fossil-fuel-free energy**; ideally from **on-site renewables**.

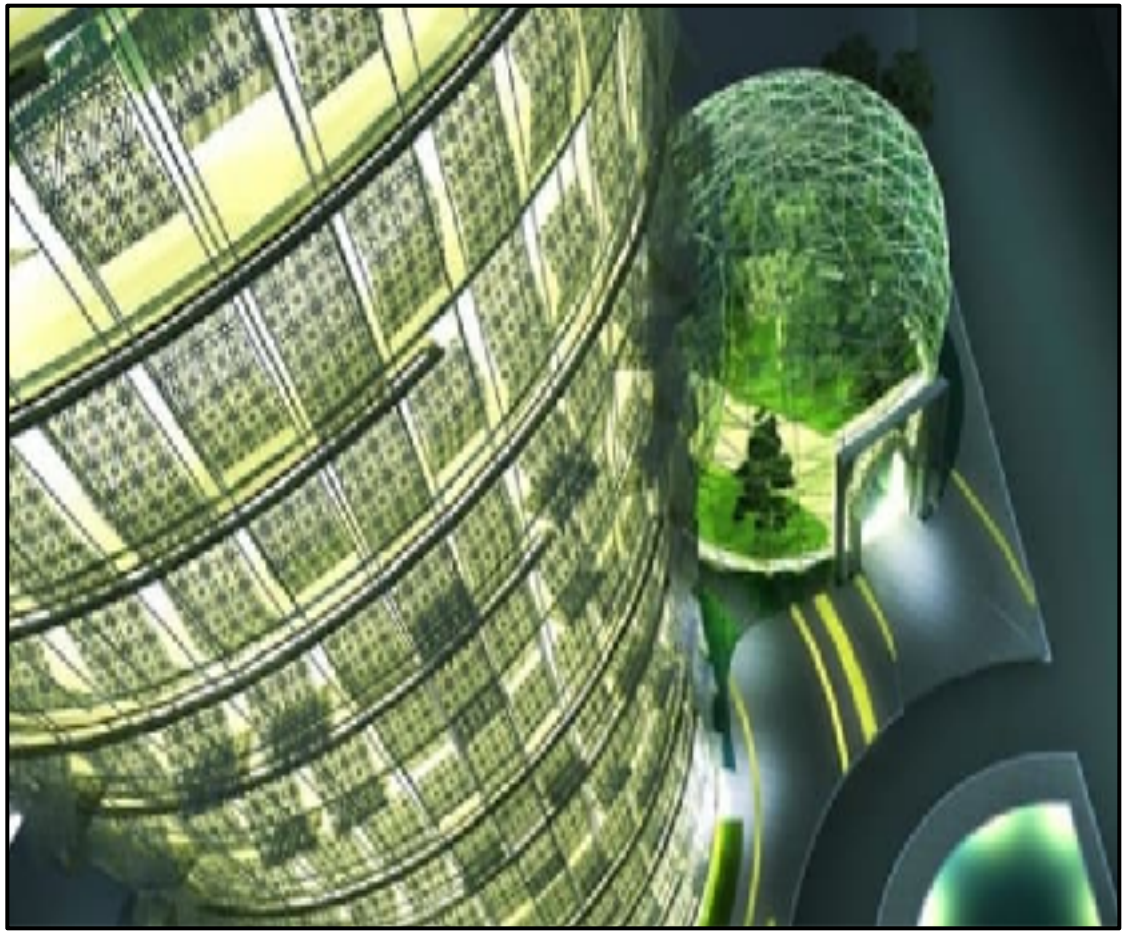
333,000 square-foot Eastgate Centre, which uses 90 percent less energy to heat and cool than traditional buildings.

The building has large chimneys that **naturally draw in cool air at night** to **lower the temperature of the floor slabs**, just like termite dens. During the day, these **slabs retain the coolness, greatly reducing the need for supplemental air conditioning.**

Passive Cooling inspired by Termite Mounds

- Eastgate: Energy Efficient, But Greater Savings Possible: The Eastgate complex in Harare, Zimbabwe, which opened in 1996, drew inspiration for its construction from the termite mounds that litter the African nation's rural countryside.
- The first building to use passive cooling so fully, the Eastgate building's cooling system cost a tenth of conventional systems and uses 35 percent less energy than similar buildings in Harare. It works by absorbing heat into the walls of the building during the day, then using fans to pump the heat into the interior of the building at night. Nat Geo 4-20-2012

Cacti Inspire Building Design

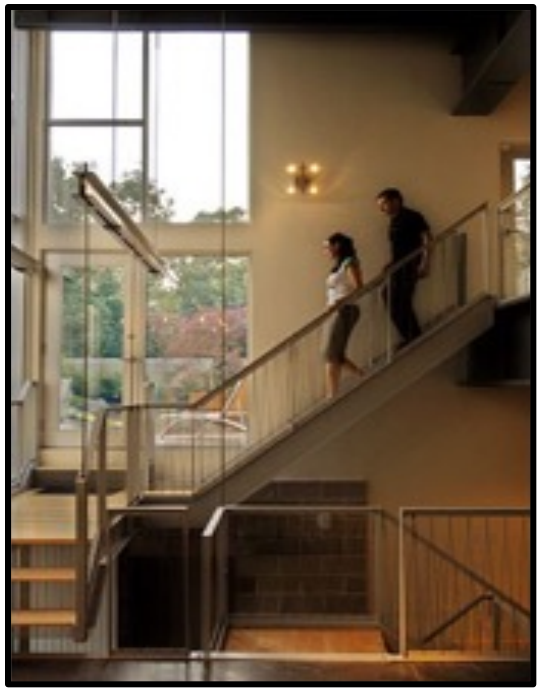


- …the cactus project has been designed with energy efficiency in mind; sun shades on the windows can be opened or closed to suit the prevailing temperature (thus **mimicking the activity of the cactus which performs transpiration at night rather than during the day in order to retain water**).

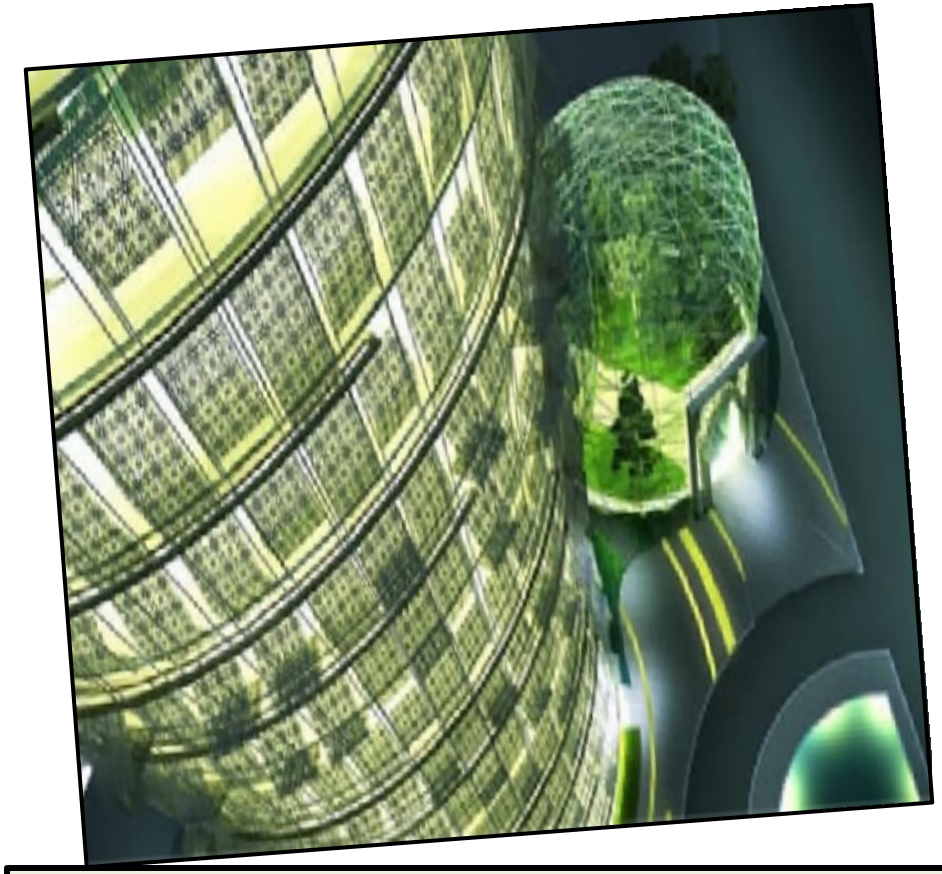
From Highway to Home

4,300-square-foot home in Lexington, Massachusetts, …. incorporates 600,000 pounds of recycled materials.

Pedini's Big Dig House is built from highway panels and bridge piers salvaged from the largest public-works project in the history of the United States.



Qatar's Cactus Project designed with Energy Efficiency in Mind



……**sun shades** on the windows can be **opened or closed** to suit the prevailing temperature (thus **mimicking the activity of the cactus which performs transpiration at night rather than during the day in order to retain water**).

700 Series Shinkansen Bullet Train
Unlike the sleek 500 Series Shinkansen, the 700 series is characterized by its flat 'duck-bill' nose.

The Shinkansen 700 Series trains for Japan's Shinkansen dedicated high-speed rail lines were built between 1997 and 2004, entering service in 1999. The design goal was to produce a train almost as fast as the 500 Series Shinkansen but at a substantially lower cost. Top speed is 285 km/h (177 mph); given that speeds higher than that are only permitted on a few stretches of line.