

MIRRORING NATURE

Increasingly, scientists and companies are turning to nature for inspirational designs and solutions to problems. This derivative innovation from nature, termed biomimicry, is not new. Examples include the popular Velcro that is inspired by the tiny hooks found at the end of burr needles and the scintillating sharkskin-inspired swimsuits of the 2008 Beijing Olympic Games. Here is a look at the life-transforming world of biomimicry

THE LOTUS EFFECT

Lotusan® paint

What: A building exterior coating that regains its cleanliness after a mere rinse from rain

INVENTOR	Sto Corporation
PROJECT PHASE	Available
PROJECT TYPE	Self-cleaning coating

DESIGN INSPIRATION

Lotus leaves stay dirt-free even in muddy conditions. This is accomplished through the micro-topography of their leaf surfaces

DESIGN FEATURES/CAPABILITIES

The paint mimics the microstructure surface of a lotus leaf – tiny peaks and valleys minimise the contact area so dirt rolls off with water

DESIGN APPLICATIONS

Buildings using the paint on the exterior fend off algae and fungal spores, staying in pristine condition for years



BETTER THAN SPIDER-MAN

Timing Belt Based Climbing Platform (TBCP-II)

What: A tank-like prototype robot that scales walls, crawls over ledges and negotiates corners without using suction cups, glue or liquid bonds to adhere to surfaces

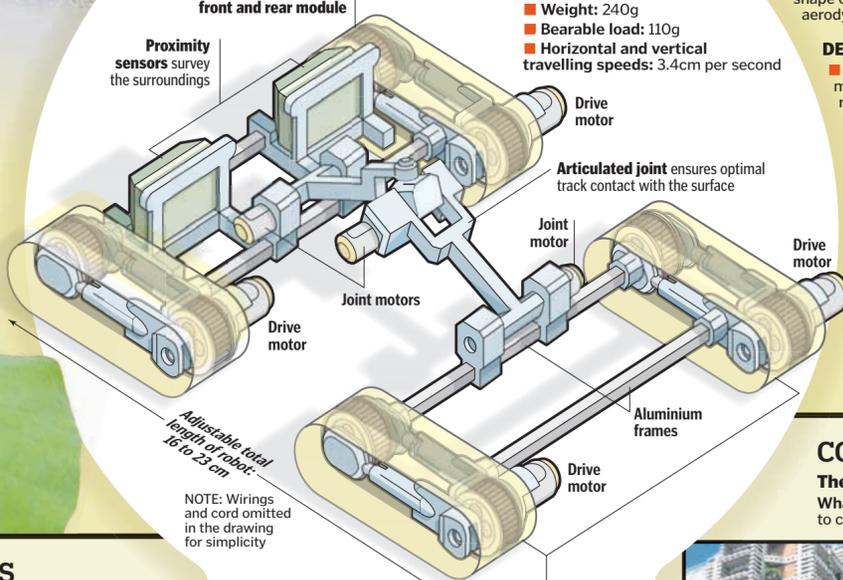
INVENTOR	MENRVA research group at Simon Fraser University, Canada
PROJECT PHASE	Development/Prototype
PROJECT TYPE	Robot

Prototype comprises a front and rear module

Proximity sensors survey the surroundings

ROBOT FACTS

- Weight: 240g
- Bearable load: 110g
- Horizontal and vertical travelling speeds: 3.4cm per second



Adjustable total length of robot: 16 to 23 cm

NOTE: Wirings and cord omitted in the drawing for simplicity

THINK WITHIN THE BOX

Mercedes-Benz Bionic

What: A concept car that borrows the Yellow Boxfish's boxy but aerodynamic shape and unique skeletal structure

INVENTOR	Mercedes-Benz
PROJECT PHASE	Conceptual
PROJECT TYPE	Car

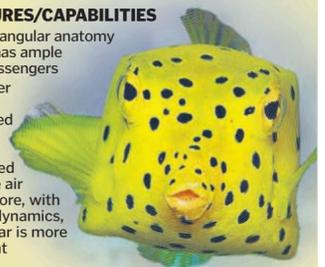
DESIGN INSPIRATION

The boxfish's bulky appearance belies a skilful swimmer. When applied to automotive engineering, the shape combines aerodynamics and rigidity



DESIGN FEATURES/CAPABILITIES

The fish's rectangular anatomy means the car has ample room for its passengers. About 60 per cent of the power required to cruise at highway speeds is used to overcome air drag. Therefore, with better aerodynamics, the Bionic car is more fuel-efficient



DESIGN APPLICATIONS

By studying the bone structure of fishes that move fluidly in the water, automobile engineers can improve the aerodynamics of vehicles and design of eco-friendly cars

ROUGH AROUND THE EDGES

Tubercle Technology Blades

What: A fan and wind turbine blade design that is more energy-efficient by reducing drag and increasing lift

INVENTOR	WhalePower Corporation
PROJECT PHASE	Available
PROJECT TYPE	Blades of fans and wind turbines



DESIGN INSPIRATION

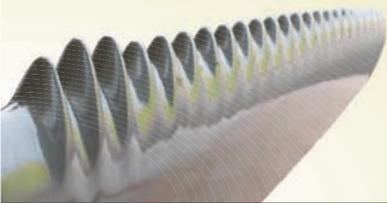
The flippers of humpback whales have tubercles or bumps on the leading edges but demonstrate better fluid dynamics than the smooth edges of conventional blades

DESIGN FEATURES/CAPABILITIES

The wind turbine blades with bumpy edges (below) require lower wind speeds, increasing the amount of time and the number of locations where they can actively generate electricity

POTENTIAL DESIGN APPLICATIONS

Besides turbines and fans, the same principle may be applied to the sails of boats for more manoeuvrability and the shape of hoses to improve water flow



A single polymer microfibre, 0.017mm wide and 0.01mm high



A strand of human hair



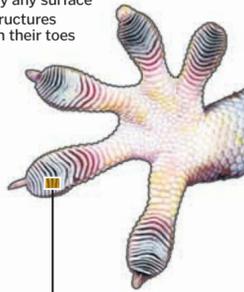
0.1mm

Adhesive belts/tracks

- Studded with mushroom-shaped caps of polymer microfibres (left, top)
- Belts are used instead of legs for simple design and better motion control

DESIGN INSPIRATION

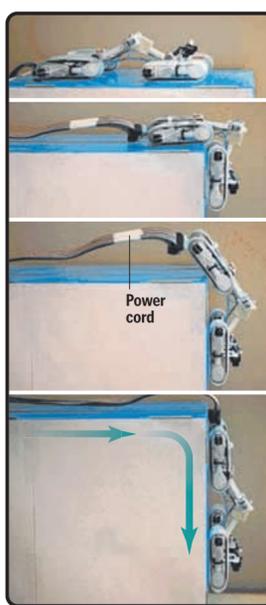
- Geckos run on virtually any surface
- Millions of hair-like structures called setae are found on their toes
- The tip of each seta consists of up to 1,000 spatulae which exert very weak forces of attraction called van der Waals forces
- Billions of these microscopic contacts combine to create a powerful adhesive bond with climbing surfaces which leaves no residue
- A gecko would be able to lift a weight of 133kg if all of its spatulae are in contact with a surface



Above: Arrays of setae
Left: Spatulae on the end of a single seta, magnified 30,000 times

DESIGN FEATURES/CAPABILITIES

- Prototype transfers itself from horizontal to vertical surfaces (left) – and vice versa – over both inside and outside corners
- Proximity and distance-measuring sensors on the robot survey the surroundings, allowing it to adjust itself accordingly
- Able to climb vertically on materials such as plastic, glass and painted steel
- Autonomous version in the future will come with a battery and computer brain



POTENTIAL DESIGN APPLICATIONS

- Inspect pipes, buildings, aircraft and nuclear power plants
- Assist in search-and-rescue operations in hazardous environments

COOL BUILDING

The Eastgate Centre, Harare, Zimbabwe

What: An office-retail building that uses natural ventilation to cool its interiors as inspired by African termite mounds



INVENTOR	Architect Mike Pearce and engineers at Arup Associates
PROJECT PHASE	Opened since 1996
PROJECT TYPE	Architecture

DESIGN INSPIRATION

African termites construct air vents that constantly move air throughout the mound, cooling or heating it to the same temperature

DESIGN FEATURES/CAPABILITIES

A network of ventilation tunnels at Eastgate allows air from outside to flow freely through the building without using electricity

POTENTIAL DESIGN APPLICATIONS

Large buildings that are designed with ventilation tunnels can save on electricity consumption



OUT OF THIN AIR

Airdrop Irrigation

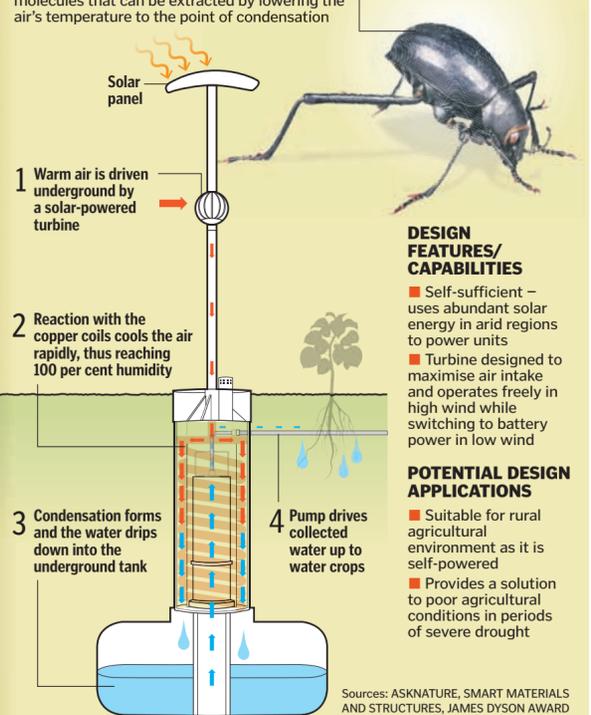
What: Airdrop is a low-cost, self-powered irrigation system that draws water from the air and may solve the problems of agricultural land in arid regions

INVENTOR	Edward Linacre, Melbourne-based inventor
PROJECT PHASE	Initial development and prototyping
PROJECT TYPE	Irrigation system

DESIGN INSPIRATION

- The Namib beetle lives in one of the driest places on Earth
- It survives by consuming the dew it collects on the hydrophilic (water-attracting) skin of its back in the early morning
- Airdrop uses the same concept, based on the principle that even the driest air contains water molecules that can be extracted by lowering the air's temperature to the point of condensation

Namib beetle faces the fog-laden wind, and moisture condenses on its abdomen. Grooves collect the water and direct it towards the head



DESIGN FEATURES/CAPABILITIES

- Self-sufficient – uses abundant solar energy in arid regions to power units
- Turbine designed to maximise air intake and operates freely in high wind while switching to battery power in low wind

POTENTIAL DESIGN APPLICATIONS

- Suitable for rural agricultural environment as it is self-powered
- Provides a solution to poor agricultural conditions in periods of severe drought

Sources: ASKNATURE, SMART MATERIALS AND STRUCTURES, JAMES DYSON AWARD

SPEEDY NOSE JOB

500-Series Shinkansen in Japan

What: The train has something that looks like a beak of a kingfisher at the front, that effectively reduces the loud bang caused by sudden changes in air pressure when the train shoots through tunnels



INVENTOR	West Japan Railway Company, Eiji Nakatsu
PROJECT PHASE	Retired (In service 1997-2010)
PROJECT TYPE	Bullet train

DESIGN INSPIRATION

Kingfishers barely make a splash as they plunge into water for fish. It was discovered that the kingfisher's beak was the ideal shape to cut through sudden pressure changes like those in water or tunnels

DESIGN FEATURES/CAPABILITIES

The train, equipped with a nearly 15m kingfisher-shaped nose, is not only quieter, but it also uses 15 per cent less electricity while travelling 10 per cent faster

POTENTIAL DESIGN APPLICATIONS

The shape can be applied to vessels that need to travel from one medium to another with different density

