

TECH FROM NATURE

Many innovative solutions and designs, such as the recently unveiled armadillo-inspired 'foldable' car, are derived from our knowledge of the natural world. The Sunday Times picks out the unique, unusual and jaw-droppingly brilliant ideas borrowed from nature's designs.

COMING TO A FLOWER NEAR YOU

WHAT: RoboBee – an insect-scale, flapping-wing robot for possible rescue missions

INVENTOR
Scientists at Harvard University

PROJECT PHASE
Prototype/development

PROJECT TYPE
Miniature robotics

AT A GLANCE

- Weight: 80mg
- Wingspan: 3cm
- Wings flap at 120 times per second

(A paperclip next to a life-size RoboBee.)

POTENTIAL APPLICATIONS

- Search-and-rescue operations.
- High-resolution weather and climate mapping.
- Autonomous robotic bees to assist with crop pollination (below).

DESIGN INSPIRATION

Bee and fly

- Bees can fly for hours and perform amazing aerobatics using only their tiny wings and brains.
- They can maintain stable flight in windy conditions – even with heavy payloads.

DESIGN FEATURES

POWER

- Artificial muscles, in the form of ceramic strips, expand and contract when electricity is applied.

Now: Thin power cable tethered to the robot.

Future: Compact high-energy cells for autonomous flight.

BRAIN

Now: Control is wired from a computer.

Future: Onboard artificial brain that helps direct flight and identify targets.

BODY

- Fabricated using revolutionary "pop-up" manufacturing process.
- Made up of layers of various laser-cut materials that are compressed into a thin, flat plate.
- Fabrication process is quick, robust and precise.

WHAT NEXT?

- Perform more difficult flight moves and land properly.
- More durable robots. Current material wears out and fails after 15 minutes of use.

ULTRALIGHT AIRFOIL WINGS

- Controlled independently in real-time
- Attached to the body-frame by fine plastic hinges

MOTION-TRACKING MARKERS

ARTIFICIAL MUSCLES control the wings' flapping and rotational motion

POWER AND CONTROL SIGNALS sent through wire tether

UV TARGETING SENSORS
Mimics bees' ability to see a broader spectrum of light

PHOTO RECEPTORS
Detect changes in light intensity and direction

POWER SOURCE

POLLINATION AND DOCKING APPENDAGES

FLIGHT STABILISERS
Act as gyroscopes during flight

Real bees in a colony rely on one another to plan, scout and forage.

Complex algorithms need to be developed to replicate this intricate behaviour in thousands of RoboBees.

CLEAN, GREEN & FOLDABLE

WHAT: Armadillo-T – a small, foldable experimental electric car

INVENTOR
Engineers from Korea Advanced Institute of Science and Technology

PROJECT PHASE
Prototype/Development

PROJECT TYPE
Small and light car for urban commute

DESIGN INSPIRATION
Three-banded armadillo (*Genus Tolypeutes*)

Only two species of armadillos – the Southern and Brazilian three-banded armadillos – have the ability to roll up like a jigsaw into a tight ball for protection.

DESIGN FEATURES/BENEFITS

The two-seater car has no rear-view or side mirrors. Digital cameras show the back and sides of the car on a dashboard screen.

AT A GLANCE

- Length: 2.8m
- Weight: 450kg
- Top speed: 60kmh

How the "little armoured one" does it

The body has two domed shells with three armoured bands in between joined by flexible skin.

How the Armadillo-T tucks its rear body away

Travelling position
The golf cart-sized car in its travelling configuration.

Self-parking can be performed by clicking on a smartphone app.

Front-mounted lithium-ion battery pack powers four separate wheel motors. A 10-minute electrical charge allows the car to travel up to 100km.

When in danger, its body bends in the middle. It tucks in its ears, head and tail, curling itself into a tight, defensive sphere.

Movable, shell-like rear section folds forward and up.

Voila – a hard "ball"
Its body shells are often left slightly open, waiting to shock and injure probing predators by forcefully snapping shut on them.

POTENTIAL APPLICATIONS

- Urban transit transfers.
- Golf resorts and tourist zones such as amusement parks.

- Strict road safety standards and crash-resilience requirements have to be met before it debuts on public roads.

- Serves as a useful reference for future city-travel designs.

LESS PAIN, MORE GAIN

WHAT: "Painless" quill-inspired injection needles

INVENTOR
Researchers at Harvard University and Massachusetts Institute of Technology

DESIGN INSPIRATION
North American porcupine (*Erethizon dorsatum*)

Its 30,000 quills – tipped with microscopic backward-pointing barbs – are used for self-defence.

PROJECT PHASE
Prototype/Development

PROJECT TYPE
Injection needle

Magnified view of a quill's conical black tip

Barbed quill

Barbless quill

Backward-facing barbs

- Resembles serrated knife edges.
- Up to 800 barbs are found on the first 4mm of the tip.
- Feature reduces penetration force but increases extraction force.
- Less tissue damage compared with barbless quills.

DESIGN FEATURES/BENEFITS

- A prototype injection needle with barbs needs 80 per cent less force to penetrate skin than a regular barbless one.
- This results in greater placement accuracy, less pain and less chances of breakage.

POTENTIAL APPLICATIONS

- Injection needles with degradable barbs that enable both easy penetration and removal.
- Biodegradable adhesive patches that could replace staples or sutures.
- Wound dressings with tiny barbed points to hold drug delivery systems in place.

SURF'S UP, SUIT UP!

WHAT: "Shark-proof" wetsuits and watersport products

INVENTOR
Shark Attack Mitigation Systems and Oceans Institute, University of Western Australia

PROJECT PHASE
Available

PROJECT TYPE
"Shark-deterrent" suits

DESIGN INSPIRATION

- Research claims that sharks see in shades of black and white.
- They are believed to rely on vision in the final moments prior to an attack.
- The designs resulted from studies on how some large sharks perceive objects at various depths, distances and at different times of the day.

DESIGN FEATURES/BENEFITS

Stave off or lower the chances of shark attacks by confusing their visual system and rendering the wearer "invisible" in the water.

For surfers (far left)

- Bold, navy blue-and-white stripes mimic the coloration on the pilotfish (below), one of the fish that live alongside predatory sharks.
- Suit presents the wearer as non-prey, noxious or "dangerous".

For divers and swimmers (left)

- Suit blends in with the surrounding water, making it difficult for sharks to see the wearer.

Sources: HARVARD UNIVERSITY, KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, SHARKMITIGATION.COM