

Nature got there first

Fourteen things people copied from plants and animals, to put on the tables.



Wind Tunnel 6 examples



Moon Buggies 4 examples



Nature's Engineers 4 examples

Each example has a page of photographs and a page to read from. The photograph page carries the credit line the photographer asked for, so please keep it on when you print.

Four of the fourteen are stories that turned out to be wrong, and they say so. They are worth keeping: checking and changing your mind is the point.

WIND TUNNEL · KINGFISHER



Common kingfisher (*Alcedo atthis*) perched in profile. Alexis Lours, CC BY 4.0, via Wikimedia Commons



500 Series Shinkansen at a platform showing the full 15 m nose. Santetsu, CC BY 4.0, via Wikimedia Commons

Kingfisher

and the nose of a bullet train

A kingfisher drops into a river and hardly makes a ripple. Its beak is long and pointed, so it slides into the water instead of hitting it.

Fast trains in Japan used to make an enormous BANG as they shot out of a tunnel. So the engineers gave the train a nose shaped like a kingfisher's beak, to slide into the air the same way. The bang stopped.

Look at the front of the train. Can you see the bird?



Barn owl (*Tyto alba*) in flight seen head-on. Dannymoore1973, CC0, via Wikimedia Commons



Pantograph and fairing on a 500 Series Shinkansen roof. Takeshi Kuboki, CC BY 2.0, via Wikimedia Commons

Owl feathers

and how to make things quiet

An owl can fly right past you and you will not hear it coming.

The front edge of an owl's wing is not smooth. It is more like a tiny comb. The comb breaks the big swirls of air into small ones, and small swirls are quiet.

Engineers put the same comb on top of that Japanese train, and on the blades of wind turbines, to stop them being noisy.

Wave your hand as fast as you can. Can you hear the air?



Silver maple samaras on the branch. US Fish and Wildlife Service, public domain, via Wikimedia Commons



A single maple samara pair on black. Fcb981, CC BY 2.5, via Wikimedia Commons

Maple seed

the seed that spins

Drop a sycamore or maple seed and it does not fall straight down. It spins.

Spinning makes it fall slowly, and falling slowly gives the wind time to carry it a long way from the tree.

A helicopter can do this too. If its engine stops, the blades keep spinning and it comes down gently instead of dropping.

The paper helicopter on our table is a seed. Drop one and watch it.

WIND TUNNEL · DANDELION SEED



Dandelion (*Taraxacum officinale*) seed head. David Perez, CC BY 3.0, via Wikimedia Commons



Parachute canopy on final descent. Rstpch, CC BY-SA 4.0, via Wikimedia Commons

Dandelion seed

a parachute made of holes

A dandelion seed has a little parachute of bristles, and it is almost all holes. You would think the holes would let it drop like a stone.

They do the opposite. Air pushing up through the bristles gets caught in a spinning ring just above the seed, and the ring holds it up.

It floats four times better than a parachute of the same size with no holes at all.

Blow one and count how long it stays in the air.

WIND TUNNEL · SHARK SKIN



Caribbean reef shark swimming over sand. Dennis Hipp, CC0, via Wikimedia Commons



Lufthansa Cargo Boeing 777F in flight. MarcelX42, CC BY-SA 4.0, via Wikimedia Commons

Shark skin

ridges that help you slip along

Shark skin is not smooth. It is covered in tiny ridges, all lying the same way, and water slides past them easily.

Some aeroplanes now wear a sticker with ridges copied from shark skin. Each ridge is thinner than one of your hairs.

A plane wearing the sticker uses a little less fuel to fly the same distance.

Stroke a shark one way, then the other. Only one way feels rough.

WIND TUNNEL · HUMPBACK WHALE



Humpback whale breaching with the long flipper raised. NOAA Office of National Marine Sanctuaries, public domain, via Wikimedia Commons



Wind turbine nacelle and blades against sky. CaptJayRuffins, CC BY-SA 4.0, via Wikimedia Commons

Humpback whale

bumps on the front edge

A humpback whale is longer than a bus, and it can still turn in a tight circle to catch fish.

Look at the front edge of its long flipper. It is bumpy, not smooth. The bumps keep the water flowing sweetly past the flipper even when the whale tilts it up steeply.

Wind turbines are now being built with bumpy blades, for exactly the same reason.



Feel the front edge of the flipper. Bumpy wins.

MOON BUGGIES · BOXFISH



Mercedes-Benz Bionic concept car on museum display beside a boxfish model. NatiSythen, CC BY-SA 3.0, via Wikimedia Commons



Yellow boxfish (*Ostracion cubicus*) head detail. Rickard Zerpe, CC BY-SA 2.0, via Wikimedia Commons



Juvenile yellow boxfish showing the cube-shaped body. Bernard DUPONT, CC BY-SA 2.0, via Wikimedia Commons

Boxfish

when scientists change their minds

A boxfish really is shaped like a box, and it pootles around coral reefs.

In 2005 a car company built a car shaped like a boxfish, because they thought a shape like that must slip through water beautifully.

Then scientists measured some real boxfish. The shape is not especially slippery, and it makes the fish wobble rather than swim straight. So the story was wrong.

They checked, and they changed their minds. That is a brilliant thing to do.



Tokay gecko (*Gekko gecko*) with toe pads visible. Thomas Fuhrmann, CC BY-SA 4.0, via Wikimedia Commons



Gecko toe pads pressed against glass. PanWoyteczek, CC BY 4.0, via Wikimedia Commons

Gecko toes

sticking with no glue

A gecko can walk up a window and hang upside down on the ceiling. It has no glue, no suckers and no hooks.

Its toes are covered in millions of hairs so small you cannot see them. They get so close to the glass that they simply cling on.

To let go, a gecko peels its toe off, and only one way works. Robots on the Space Station use grippers with hairs like these.

How would you pick something up with no sticky tape?



European tree frog (*Hyla arborea*) gripping a stem. Holger Krisp, CC BY 4.0, via Wikimedia Commons



Wet-weather racing tyres showing drainage tread. Gregory Moine, CC BY 2.0, via Wikimedia Commons

Tree frog toes

grip in the wet

A tree frog holds on to a soaking wet leaf and does not slide off.

The bottom of each toe is tiled with little hexagons, with grooves running between them. The grooves push the water out of the way so the flat tops can touch the leaf properly.

Tyres made for rainy days have grooves that do the very same job.

Wet your finger and press it on the table. Now dry it and try again.



Great spotted woodpecker (*Dendrocopos major*) on a stump. Charles J. Sharp, CC BY-SA 4.0, via Wikimedia Commons



A claw hammer. Santeri Viinamaki, CC BY-SA 4.0, via Wikimedia Commons

Woodpecker

not a cushion, a hammer

A woodpecker bangs its beak into a tree over and over, very fast, and never gets a headache.

People thought its head must be a cushion soaking up all the bumps. Helmets were even designed from that idea.

In 2022 scientists filmed a woodpecker very slowly indeed. The head is not a cushion at all. It works as a stiff hammer, and the brain is safe because it is so small and light.

Sometimes the best answer is: we looked again, and we were wrong.



Wild honeycomb hanging beneath a branch. Charles J. Sharp, CC BY-SA 4.0, via Wikimedia Commons



Hexagonal mirror segments of the James Webb Space Telescope under test. NASA/MSFC/David Higginbotham, public domain, via Wikimedia Commons



Honey bee on hexagonal wax comb. Matthew T Rader, CC BY-SA 4.0, via Wikimedia Commons

Honeycomb

the shape that wastes nothing

Bees build honeycomb out of hexagons, and every cell is the same.

Why hexagons? Because hexagons fit together with no gaps left over, and they need less wall than any other shape. Bees have to make that wax out of their own bodies, so saving it really matters.

The giant space telescope in the other photograph is made of 18 hexagon mirrors, for the same reason.

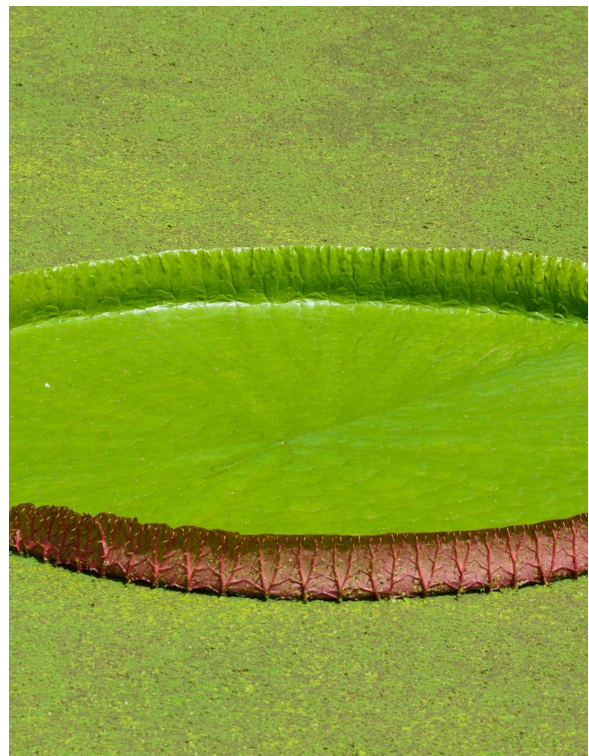
Try covering a page with circles. Where do the gaps go?



The Crystal Palace in Hyde Park (hand-coloured print). Read & Co. Engravers & Printers, public domain, via Wikimedia Commons



Ribbed underside of a giant water lily leaf (*Victoria amazonica*). Iaitr Keiows, CC BY-SA 3.0, via Wikimedia Commons



Giant water lily leaf floating with its rim turned up. Biswarup Ganguly, CC BY 3.0, via Wikimedia Commons

Giant water lily

ribs under a huge leaf

A giant water lily leaf can be wider than you are tall, and it lies flat on the water without sagging.

Turn one over and you find thick ribs spreading out like the spokes of a wheel, with thin ones crossing between them. That is what holds a big floppy leaf up.

A gardener called Joseph Paxton grew one of these lilies, and said he borrowed the leaf's girders for the glass buildings he was designing. The biggest of them went up in 1851.

Fold a flat sheet of paper, then stand it up. Stronger now?

NATURE'S ENGINEERS · TERMITE MOUND



Macrotermes termite mound in the Selous Game Reserve. Awinch1001, CC0, via Wikimedia Commons



Low termite mound with chimneys. Venkatraman T, CC BY-SA 4.0, via Wikimedia Commons

Termite mound

a tower that breathes

Termites build towers of mud taller than a grown-up, and it stays comfortable inside.

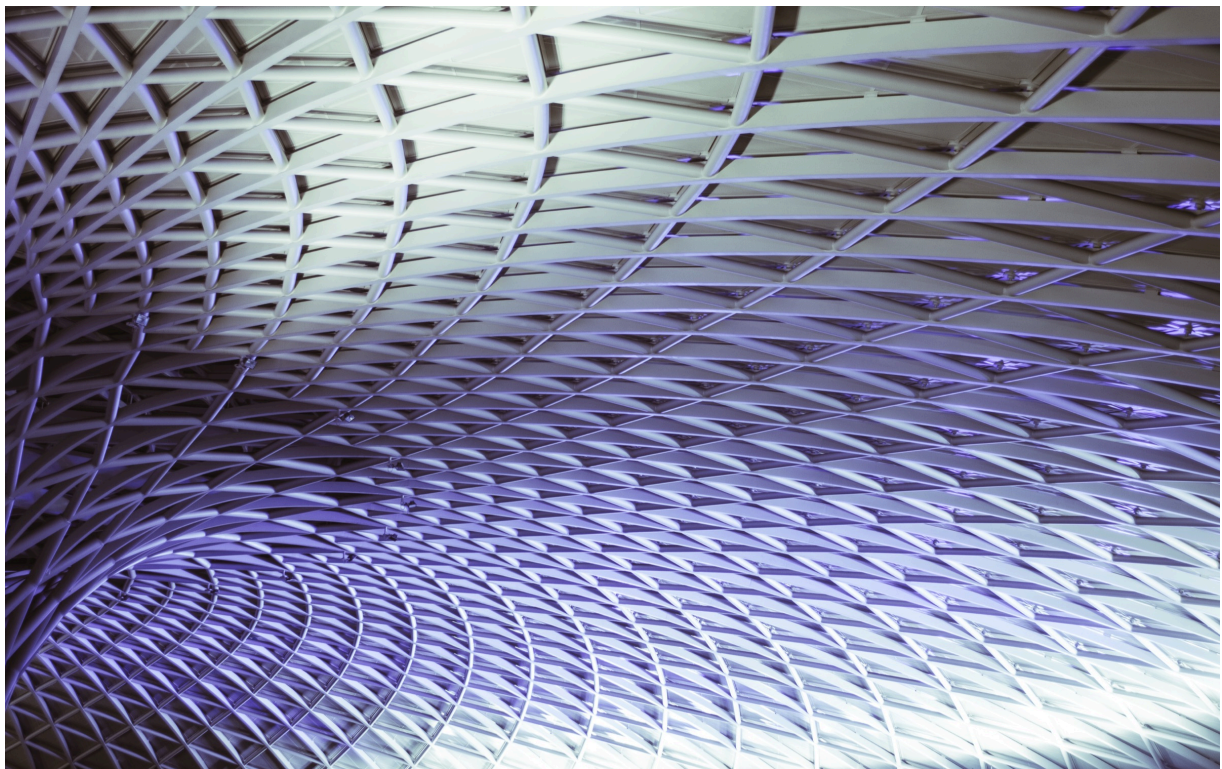
A big building in Zimbabwe was designed from that idea, and it uses hardly any energy to stay cool.

Then scientists looked at the mounds again. They do not work like a chimney with air rushing up them. They breathe slowly in and out, more like a lung.

The building still works beautifully. The story about the termites changed.



Glass sponge skeletons (*Euplectella* sp.) showing the lattice. Ra'ike, CC BY-SA 3.0 DE, via Wikimedia Commons



The braced lattice roof of King's Cross western concourse, London. Clem Onojeghuo, CC0, via Wikimedia Commons

Glass sponge

why a diagonal matters

Deep down in the sea there is a sponge that builds its own skeleton out of glass.

It is a square grid, with extra struts across the corners, a bit like a noughts and crosses board with diagonals added.

Those diagonals are the whole trick. Copies were printed and then squashed in a machine. The ones with diagonals held over 20% more weight, using the same amount of glass.

Push over a square made of straws. Now add one diagonal and push again.