

The incredible

The tricks and twists of surfers amaze us, but below the surface lies a raft of surfing science as impressive as the feats performed on the waves

By Jeremy Coles

20 July 2017

"I'm not sure if I have surfed the perfect wave yet. I'm still searching," says Jamie Mitchell, World Surf League Big Wave Tour surfer.

From highly skilled professional athletes to hobbyists after the rush of the open waves, surfing is enjoyed by people from all walks of life, from all over the planet. All you need is ocean (but not always), a board of some kind, waves, and a lot of enthusiasm.

While the tricks and twists of seasoned professionals amaze us, below the surface lies a raft of surfing science as impressive as the feats performed on the waves.

One wave could power over 30 million smartphones

Anyone who has watched waves crashing will have a sense of their enormous power and it is this power that may prove to be one of the most **promising sources for renewable energy**; potentially supplying 10% of global needs.

Waves are formed in a number of ways, but in most cases they are created by wind blowing over the surface of the ocean. As long as the wave travels forward slower than the speed of the wind, energy will be transferred from the wind to the wave.

There are **clever and complicated equations** that can accurately determine the amount of energy in a wave, but to put it simply the bigger the wave, the bigger the power and there are few places on Earth where the waves are as big as they are at Nazare in Portugal.



Undersea features at Nazare in Portugal produce giant waves that hold a lot of potential energy (credit: Aurora Photos / Alamy Stock Photo)

These monster Portuguese waves can reach epic proportions of over 100ft (30.5m) thanks to a combination of the location of the coast and the unique undersea features. Waves generated by storms in the North Atlantic are focused by a deep, arrow-shaped canyon 16,000ft (4877m)

below the ocean's surface; these deep water waves then approach the shallow waters of the shore and start to climb up, meaning the waves at Nazare can get big. Real big!

"Nazare is like a 7th wonder of the World," says **Mitchell** (who is the defending Nazare Challenge winner).

"To surf waves at Nazare is an honour. You sort of feel like you're back in the day of the gladiators when the world is watching and you're trying to survive and perform at the same time," he says.

“

"To surf waves at Nazare is an honour."

Imagine the energy in a wave that stands as tall as an eight-storey building. It is estimated some of the waves at Nazare hold enough energy to power over 30 million smartphone batteries. It could be the **ideal location for wave energy farms** to harvest all that untapped power.

Waves hide amazing secrets

Aside from Nazare, there are a few other 'big wave' spots around the world where the perfect conditions come together to create the kind of waves that surfers dream of.



The volcanic island of Tahiti is a perfect 'big wave' spot for surfers (credit: WSL / Kirstin)

Teahupo'o village on the south-west coast of Tahiti is one such place. The waves here are big and steep and with the very real threat of falling onto its razor-sharp reef it has attracted the world's best and bravest (perhaps craziest) surfers.

The waves at Teahupo'o are what scientists call "surging waves"; they aren't the tallest (the biggest waves are about 30ft / 9.1m high), but they are super thick, formed when deep water suddenly meets a shallow sharp shoreline.

Tahiti is a volcanic island and its rapidly growing reef creates a steep break (the point where the top of the wave starts to overtake the bottom causing it to spill over). This should result in large, uneven waves, but the waves at **Teahupo'o are unique** and it's all down to geology.

Fresh water running down from Tahiti's mountainous region creates channels in the ocean floor where coral cannot grow. These channels funnel water from the shore back into the deeper ocean, creating clean waves and a fast current.



© National Geographic Creative / Alamy Stock Photo

The waves at Teahupo'o in Tahiti are unique because of the volcanic island's geology and the reefs (credit: National Geographic Creative / Alamy Stock Photo)

On top of this, the water coming through the channels builds up the thickness of the wave, making it look like the ocean is rising up, rather than a normal wave's ripple. The shore is extremely steep and the coral can't grow too deep leading to a more gradual wave.

All of these conditions come together to create a wave so intense Teahupo'o is known as one of the best and most **unique 'big wave' surfing spots** on the planet.

Surfers can travel faster than city traffic

Driving through a city can be painfully slow at times, particularly during rush hour. So it'll come as no surprise that average vehicle speed in Europe's most congested cities is only around 30km per hour (18.6mph), with **London faring particularly badly** at 19km per hour (11.8mph); a horse-drawn carriage could almost match this speed!



Australian Mick Fanning is one of the fastest surfers around and has been measured at 39.1km per hour (24.3mph) (credit: WSL / Kirstin)

It was during the 2011 **World Surf League's** World Tour circuit in Australia that professional surfer Mick Fanning (nicknamed White Lightning) had his speed measured at an impressive **39.1km per hour (24.3mph)**; almost 10km per hour faster than you could drive around a city.

Ocean animals inspiring surf technology

Found on the underside of a surfboard, fins are critical to the stability, feel and control of the board. Traditionally, fins were rigid and made of wood, but advances in plastics and composite materials have produced fins that allow for greater control while turning on a wave.

Now it seems the future is in fins that mimic whale flippers.

Whales may be massive, but they are also graceful, and it is their ingenious flippers that help them stay so nimble. Their fins allow them to perform some impressive underwater acrobatics, especially in their tight, controlled turns.

Taking cues from whale's fabulous flippers is a **new type of fin that flexes** from the stiff edge at the front, which first makes contact with the water (leading edge) when in motion, to the fin's rear edge (trailing edge), with flexibility increasing as the fin tapers from front to back. It also flexes from the base to the tip, like conventional fins do, creating more speed in the turn as the flexing fin snaps back into place.



Whale flippers have influenced the design of new surfboard fins for greater control even at slow speeds (credit: All Canada Photos / Alamy Stock Photo)

A second, more radical, fin design has a **bumpy irregular surface** along the leading edge, modelled after the tubercles on a humpback whale's flipper. As water flows over their flippers the large bumps create channels of fast-moving water which let the whale 'grip' the water at sharper angles, tightly turning and circling, even at slow speed.



The fur of semi-aquatic animals is the inspiration for revolutionary new wetsuit designs (credit: Robert McGouey/Wildlife / Alamy Stock Photo)

It's not just innovative board designs that animals have helped influence, but also the future of surf wear. In an effort to create a more efficient wetsuit (key for surfers who need to stay warm and agile on the waves), MIT engineers looked to the fur of beavers and sea otters for inspiration.

These semi-aquatic mammals have remarkable fur that traps pockets of

air to keep them warm and dry when diving under water. The **MIT team fabricated fur-like rubbery pelts** mimicking this unique ability to help them understand and ultimately recreate the effect.

A furry wetsuit designed for surfers and inspired by beavers, is very nearly a reality.

Surfboards to monitor our oceans

Scientists know that the **world's oceans are changing**; they are getting warmer and more acidic, leading to rising sea levels, stormier weather, and altered ecosystems and animal behaviour.



Coral reefs are particularly sensitive to warming seas (credit: Reinhard Dirscherl / Alamy Stock Photo)

To measure our changing oceans and the effects on ocean life, scientists use research vessels, probes, sensors and satellites to collect a range of data from the open ocean, but it is much trickier nearer the shore where the waters can be rougher and much more challenging.

All this may be about to change thanks to a neat piece of tech designed

by a team of scientists and used by citizen science surfers.

Smartfin is new technology almost identical to a traditional surf board fin, but with a hidden twist. The fin contains sensors that measure temperature and location for researchers to analyse. In the future, Smartfin hopes its sensors will be able to measure pH, salinity, dissolved oxygen and levels of chlorophyll.



One day all surfers might be using the Smartfin to help monitor the sea (credit: Phil Bresnahan)

Andrew Stern, founder of Smartfin and Associate Professor of Neurology at University of Rochester School of Medicine, says a Smartfin could help monitor the bleaching of coral reefs due and the populations of shellfish struggling with ocean acidification.

"What is unique about the Smartfin technology, and why it has taken four years and millions of dollars to develop, is its tiny size and it's very low cost compared with existing sensors of comparable accuracy.

"What Smartfin offers is a new generation of sensors that can be easily deployed in huge numbers and in previously inaccessible locations," he

says.

Dolphins like to surf

Dolphins have been observed riding the crest of big waves towards the shore and heading back out to sea before it breaks; even going out of their way to repeatedly ride the bow waves of large ships and whales, often leaping into the air with what seems like enjoyment.



There are many theories as to why dolphins ride waves, but it may be they love to surf as much as we do! (credit: PhotogBarry / Alamy Stock Photo)

So why would dolphins expend energy and waste time for what looks like little benefit? One theory is that **they are playing** - the behaviour looks to us like fun, it is done intentionally and voluntarily, and is repeated. Importantly, it is not performed when the animal is threatened or competing.

Equally it could also be that using the power of the waves is a more energy efficient way of travelling than swimming underwater. The impact of entering the waves might help to dislodge parasites on the skin, or the splashing noise it makes could also be a signal or communication to

other dolphins in the area. There may also be free food when done alongside a fishing vessel, and when done in groups it may teach social bonding.

The answer could be a combination of any or all these; however, we like to think that perhaps **dolphins just love to surf** as much as we do!

Amazing aerial feats

Aerial surfing is a relatively modern and now common part of many competitions. It takes years to master and relies on the speed of the surfer as well as a light breeze over a vertical lip of at least a two-to-three-foot wave. Approach the lip of the wave at the right angle and it acts as a ramp to launch the surfer and their board into the air before landing back on the water.



Aerial tricks are a new addition to a surfer's portfolio, demonstrated by Italo Ferreira (credit: WSL / Cestari)

The faster the surfer is riding a wave, the higher in the air they'll go after launch, and the more time in the air there is to pull off an amazing feat - a backflip, a superman, a rodeo flip, or the spectacular sushi roll.



Gabriel Medina grabbing his board while airborne (credit: WSL / Smorgio)

"When you try something over and over again but don't quite get it right, the moment it finally clicks is so satisfying and you can't help but smile," says **Lakey Peterson**, World Surf League Championship Tour surfer and current world number seven.

Surfing is for everyone

Surfing is enjoyed by people from all walks of life and abilities; all that's needed is a willingness to give it a go and to love the ocean. Standing up on the board and riding those first waves will take practice, but given enough time and dedication you'll be surfing like a pro in no time.

"It will be the best decision you could ever make," says Peterson.

"Consistency is key and once it all comes together for you, you will be so happy you didn't quit," she adds.



Young or old, male or female, surfing can be for everyone (credit: Stuart Pearce / Alamy Stock Photo)

Jessi Miley-Dyer is World Surf League's Women's Commissioner and former championship competitor and her advice for anyone wanting to take up surfing is to find a surf school and get a few lessons.

"Make sure that you can swim confidently and don't be disheartened if you don't get it straight away! You will be able to stand up, but it's one of those sports where you just need to keep trying.

"Give yourself a whole summer to cruise in the ocean and be part of the scene," she adds.

You've read the science, now watch some incredible surfers harnessing the power of the waves:

