Making Waves - Popular Science for Curious Surfers

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In mid 2016 under the intense heat of the northern hemisphere sun, we began testing the waves at our second public facility, NLand, in Austin, Texas. The lucky test pilots included a handful of seasoned pros, a couple of frothing grommets, and a bunch of newcomers to the sport.

The silence surrounding the pristine Wavegarden lagoon at the NLand complex is broken by the sound of crashing waves, ranging between 0,5-1,9 m (1,5 -6,2 ft) in height. The crowning achievement is the main waves - known as the Reef Waves - which are high quality waves tailor-made for performance surfing. Breaking in synchronicity on opposing sides of the pier, the Reef Waves stand head high and unfurl for over 30 seconds.

The Reef Waves are complimented by two other distinct breaks.The Bay Waves are perfect for new surfers and children while the Inside Wave is a waist-high powerhouse for all levels of surfers. These breaks provide waves for the full spectrum of NLand's guests. The massive lagoon, spanning nine football fields and filled 100% with rainwater, is set in a beautiful natural landscape only 10 minutes east of Austin Bergstrom Airport. By any measure, it is an extremely inviting surf spot where overcrowding is not an issue as the park can safely cater for 120 or more surfers, at any one time in the different skill-based surf zones.

The long anticipated opening of NLand on October 7, 2016, falls several months after the one-year anniversary of Surf Snowdonia in North Wales, which, since its opening in 2015, has produced more than 195.000 waves. The accumulated length of these waves equates to a distance of 30.600 km (18.600 miles), which is approximately three quarters the circumference of the earth.

In recent months there has been a lot of talk about man-made waves, which has created some rather high expectations about the future of surfing outside of the ocean. Many media outlets have asked us to participate in this debate, but we have opted to maintain our silence, remaining focused on what we have accomplished and not on what we are theoretically capable of doing.

However, all surfers love the ocean and most like to know why waves are the way they are. So, in this article we share some key design features of the NLand Wavegarden in Austin and we hope you find our thoughts and insights interesting.

The Wavegarden Lagoon and its waves

The technology used at NLand is based on the movement of a blade, which we first developed in 2006 and call the wavefoil. Shuttling the wavefoil at a precise speed from one end of the lagoon to the other to create a swell that interacts with the customized bathymetry of the bottom to form breaking waves in the different surf zones, each with unique wave characteristics. The Reef Wave is bigger, faster, and more powerful; it offers sections with an almond shaped barrel, perfect for experienced surfers to practice their tube riding skills. Simultaneously, other waves break in various parts of the lagoon with less size and power, which provide long and fun rides before gently rolling onto the shoreline.

The Reef Wave

Apart from size, the verticality and peeling angle of a wave are two key characteristics that influence the type of ride a surfer is going to experience. Firstly, verticality refers to the steepness of a wave, which naturally depends on the depth of the water over which it breaks. Like the ocean, abrupt changes in the bathymetry of the bottom’s contour cause a wave to steepen as the wave’s energy surges forward. In a man-made facility, finding the optimal depth is meticulous work and has taken us years of research to understand and perfect. A change in water level, even by a few centimeters, can and does affect wave characteristics. Having a vertical face is therefore important as it affects the speed a surfer is able to generate as well as the potential of getting barreled. At the same time, too much verticality can make the wave difficult to ride, and, potentially, be even dangerous.

The peeling angle refers to the rate or speed at which the lip unfurls. A sharp peeling angle produces very quick waves and requires a surfer to maintain a high board speed so as to not get caught behind the section. The surf break in Bali, "Impossibles", is a prime example of a wave with a fast peeling angle, and, more often than not, breaks too fast for the average surfer to keep up. In a wave park, the optimal peeling angle is a precise measure between the bathymetry and speed of the wavefoil. In the designs for NLand, our engineers that specialize in fluid dynamics have paid a great deal of attention to this detail, as it has been critical to get right from the very start. The final product is a powerful wave that allows users to develop and train their full range of skills, from racing down the line, to vertical turns, cutbacks, and even some quality tube time.

The predominant winds at NLand also play an important part in influencing the surf conditions. We have four waves with distinct characteristics due to the wind, which makes for an interesting variety.
The waves fanned by the offshore wind are clean and hollow, whereas the waves with the prevailing onshore wind have a rippable lip, perfect for big snaps, hacks and aerial maneuvers.

The size of the Reef Wave
In Austin, the Reef Wave stands at 1,9 m (6,23 ft), measured from trough to crest. It can be considered a shoulder to head-high wave and is sufficiently powerful when you surf it. Some may like it more than others, but nobody will complain about the lack of power.

So, why did we make the wave this size? Firstly, making bigger waves requires significantly more energy as well as a much greater volume of water. Both factors impact the resulting energy costs needed to power the machinery and water treatment system. On top of this, larger waves require a higher initial investment, a longer waiting period between waves, a bigger lagoon size, deeper water, and a faster wave speed. As a result, everything becomes be a little more complicated to run and more costly to the end user. Coincidently, this creates more difficult waves and elevates the risk of injury to surfers, particularly for newcomers. For this reason, we believe NLand offers what we consider to be the optimum size; the perfect and most democratic compromise between an awesome surf experience, functionality and cost-effectiveness.

Technically, we can build generators capable of making any size wave that our clients demand. We can also make these waves with our existing machinery designs, which are well tested and proven. We could, for example, make a steep barreling wave between 2,4 m and 3.5 m (8 ft and 11,5 ft) in height, without needing any further technical R&D. However, it's highly unlikely that one of our clients would want to build a public installation with waves this size, simply because it would not be cost effective.

Wave quality and the influence of the wave frequency
With all foil and blade technologies that move through the water, such as our wavefoil model, wave quality depends drastically on wave frequency. In Austin, with intervals of 2-2,5 minutes, we are able to make good quality waves. And, with a slightly longer period of 2,5-3 minutes, we can produce flawlessly perfect waves.

Our in-house team developed and patented dissipative shores eliminate backwash and currents. Without this new technology, it would be impossible to have such a short wave frequency. It would be more in the range of one wave every 5-6 minutes. However, if you generate only one wave every six minutes, this means the lagoon could only host one surfer per hour, catching a maximum of ten waves, which is not efficient.

A curious fact about artificial waves is the difference in the quality of the first and subsequent waves. When the water is completely still, it is possible for just about any wave generating technology to produce one perfect wave, especially with a light, offshore breeze. When we first started making waves on a small prototype in 2006, we recognized that the first wave was always ridiculously perfect, with a flawless transparent tube. However, subsequent waves were, well, not quite the same. This fact is due to the natural currents and backwash created during the 'wave making' process. The phenomenon of the first wave illustrates the full potential of artificial waves. However, we quickly realized that the science of consistently making good waves lies just as much in the dampening system to mitigate currents, as it does in the waves creation itself. Hence, we developed the dissipative shores that reduce, almost immediately, the waves energy after it passes.

Currents have a similar effect in the sea. The only difference is that they do not deteriorate the wave quality as much, simply due to the oceans immensity. In other words, in a smaller body of water such as a wave park, backwash and currents has a more pronounced effect on the stillness of the water, simply due their proximity to the waves.

The Bay and Inside Waves
From the outset, Doug Coors, the founder and CEO of NLand, was clear about what kind of waves he wanted. In response, we created an area with a Waikiki- style slow moving whitewater Bay Wave at each end of the lagoon perfect for teaching the basics of surfing like padding and take-offs. A favorite is the Inside Wave, a long reeling point break with a consistent push that is enjoyed by pros and weekend surfers alike. This wave allows for all types of maneuvers such as rail-to-rail directional changes, whitewater floaters and mini cutbacks.

Finding the perfect depth to create Inside Wave was a big challenge. A fun wave that has a continuous push, with whitewater that builds and backs off as it moves forward, requires a precise relationship between the wave height and water depth. We were able to find the perfect mix of size and push, and these foamy sections could not have turned out better for practicing basic turns. A key aspect of Coor's vision was to create a lagoon that provided all level of surfers the longest rides of their lives and a virtually unlimited amount of waves that broke softly onto the shore. The Inside Wave also provides the most opportunity for revenue.

Why is this technology best suited to Austin?
From an economic point of view, this technology is the most efficient for creating long waves. Surfing a head high wave for over 30 seconds is a rare pleasure, which is difficult to find in nature and something few surfers reading this would have ever experienced. In fact, few surf spots in the world offer waves of this length.

In Austin, the Reef Wave maintains its power and shape to allow one to take advantage of every second. If you have the physical condition to do it. This unusual treat is one we are sure every surfer worldwide will enjoy and appreciate, from intermediates to professional surfers. The technology used is suitable for generating long and sizeable waves, which match the different skill levels of the users in each of the lagoon's distinct surf zones. The wave frequency also allows for synchronized timing between the movement of all surfers and waves in a way that each Bay & Inside Wave can be safely surfed by between 120-150 people at a time.

Technical reliability
To put things in perspective, at Surf Snowdonia in 2016 alone, we have made 147.000 waves without any problems or interruptions. Right now, as waves are being made in Texas and Wales, the day-to-day performance of each component of every machine is being monitored remotely in real time by our technicians, and an automatic diagnostic report is produced every single day.

The project and a wave park's complexity
Building a wave park requires many expert engineering proficiencies: fluid dynamics, mechanical, electrical, civil works, and water treatment engineering, amongst others. All this is necessary to create a business that is both reliable and financially sustainable. For our clients, like Doug Coors at NLand, the initial investment is significant enough that there is no room for improvisational testing or experimentation. That's why our prototype in Spain is such a key element to our success, as each aspect of a new project is researched and tested prior to construction.

The technical background and expertise of our clients at NLand has played a crucial role in advancing the project to where it is today, coupled with their vision to prioritize wave quality and overall user experience. The result has been spectacular: an enormous lagoon filled with rainwater, in natural and open surroundings, ready for all surfers to enjoy. For us, it has been an absolute pleasure to be part of this project and we feel proud of the results. Needless to say, it has had its challenges. To an outsider, it may seem like it should be easy to design a lagoon. Things get a lot more complicated when you add waves; everything becomes a lot more complex. It has taken our team over 10 years and the creation of 5 lagoons to find the most efficient way to correctly build them and treat the water. With a strong environmental focus, Doug Coors was determined to harvest rainwater.to supply his lagoon. This seems like a brilliant, yet simple idea. However, in reality, it has required a lot of planning and ingenuity to collect the exact amounts, no more or less, to maintain the correct conditions year-round that respect and coexist with the surrounding ecosystem.

Innovating is always exciting, but never easy. At Wavegarden, we remain focused on overcoming the different challenges faced in creating the most efficient solutions necessary to drive the future of our sport. We live by the belief that surfing is for everyone and, as surfers and engineers, we are genuinely stoked to put smiles on the faces of new and experienced surfers every day, giving the gift of waves where there once were none.

To check out the waves of our lucky test pilots, go to: www.vimeo.com/185604178

You can download high resolution photos here:www.wavegarden.com/photos-nland-2

For bookings & more information, go to: www.nlandsurfpark.com

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