Sue Nelson
Hello, I'm Sue Nelson and thanks for joining me on 'Create the Future', a podcast brought to you by the Queen Elizabeth Prize for Engineering. My guest this week is Sam Etherington, the engineer and entrepreneur behind Aqua Power Technologies Limited, which specialises in using wave power as a source of renewable energy. And it was for this pioneering work that in 2014, at the age of 24, that he became the youngest British engineer to enter SEMTA's engineering Hall of Fame. Even earlier than that, though, his star was shining bright, because his final year thesis project at the University of Brunel resulted in a James Dyson and Best of British engineering award. But it was during his third year on a work placement at an engineering company in the Lake District, where he's also from, but Sam first realised the power of waves. And the inspiration didn't come from the placement. It came during his time off when he decided to take up kite surfing.

Samuel Etherington
You have a surfboard, but then you add in a kite into the mix and the kite pulls you along using the wind and you can, you know, surf around as you would sail you can tack up and down winds. Yeah, it's a blend of the two flying a kite on the beach and then and then standing on a surfboard.

Sue Nelson
What sort of speeds can you get up to?

Samuel Etherington
People that can do it properly can probably get to 40 miles an hour or something like that. I'll be all over the show before that happens. I'm happy to go around 20 miles an hour. It's not really about the speed to be honest. It's just about being out in the waves and surfing around. That's what I like about it. And I love it when the weather's wild because it's quite an amazing experience. It's quite hard to explain. And you read the magazines and people say they were in the flow and they're in the zone and you don't think about anything else apart from what you're currently doing. It is exactly that. But it's very hard to explain. I'm not great.

Sue Nelson
No, I can understand that. The relaxation is from having, like you say, having to concentrate on what you're doing. And if you're doing that you're not thinking of work or anything else.

Samuel Etherington
It's is all-consuming. There's nothing else you can think about. And what was your learning kitesurf you're invariably not on the board very often, and you're in the sea getting buffeted around. So, it was I think that was probably a starting point, at least to realise the power of the waves.

Sue Nelson
You studied industrial design and engineering, what is that?

Samuel Etherington
It was a blend really between design, which was you know, making things aesthetic look nice function well, ergonomic, but also, those products, as opposed to just being concept, actually putting the engineering behind them so that they function as products, whether it's mechanical, or electrical. So, it's bringing all of it together to produce products that you might see on shelves.

Sue Nelson
And what made you decide to go for that instead of say, electrical engineering or mechanical engineering?

Samuel Etherington
I'm really hands-on and the course was really 90% hands-on. So, whether that was you know, learning CAD first-hand or being in the workshops on lathes and mills, that was really important to me. I'm not so interested in the theory, I'd like to do things, see how it works. If it fails, learn and do it again. That's my approach. And that course was really well suited to me.

Sue Nelson
Now you're from the Lake District did that landscape, the lakes, and in a way, the relative isolation of some of the parts of the Lake District inform not just who you are, but the sort of, what you wanted to do as well?

Samuel Etherington
Yeah, definitely. You're surrounded by, you know, the National Park, every road you go along, has a, you know, amazing view, all of that that goes with it. By the same token, you're also much more aware, I think, possibly about how fragile it can be, and about the efforts of conservation in these areas. You know, that's always sort of been drilled into me, right from school, I'd say. So, the idea of trying to do something that is renewable or, you know, considering the environment, it's not a radical idea, to me, it's something that's a fairly normal mindset, I guess, in the Lake District, at least, and obviously other places.

Sue Nelson
Now, you went to the University of Brunel. When did you realise that you wanted to specialise in waves was that in that year where you were doing the kite surfing or had you sort of got the maths behind it, the engineering behind it all behind?

Samuel Etherington
No, really it was in the final year, the seed was planted whilst trying to kitesurf. And then, you know, a few weeks before I was going back to university and you know what you're heading into, because you've obviously spoken to people in the year above you. So you know that you've got, you know, a project, which is your own, it can be anything. So, I wanted to just have a quick think about what it was that I was going to try and approach. And it was the weeks leading up to the first term back at university that I decided to focus on the wave, or capturing wave power to produce electricity.

Sue Nelson
So what did you actually do then, because you built something I read called the RWP001, which is incredibly catchy, but I've no idea what that actually means?

Samuel Etherington
It wasn't a very imaginative name. It was just Renewable Power prototype one. But the process of getting to that was trying to absorb wave from all axes, so that you never deflect any waves or potential forces on the structure. So, if you can capture every motion from every direction, then not only do you protect the structure itself, but you're effectively being more efficient at capturing the ocean waves and converting that into electricity. So, it's a good starting place, if you can have a structure that can absorb from every direction.

Sue Nelson
Funny enough, I have actually seen wave converters off the coast of Scotland is this because those at the time, were only sort of converting waves that were perpendicular to the device?

Samuel Etherington

At the time of me starting to work on wave power and designing the machine there was two or three major, or what I would call major at the time developers that we're still functioning as businesses. And one of them was a perpendicular device, it was a it was a flap, essentially mounted to the seabed that would bend backwards and forwards with the wave swell, though, you know, really good machines, but not necessarily in every direction. And if you can end up with a wave that's slightly offset from perpendicular, it causes all sorts of stresses. The other devices out there, there was a device which was very close to capturing wave power from all directions. But it did, again, focus in a more dominant direction. So, there was those that, you know, we're sort of setting the scene for what's out there, and what exists, what technologies they're using. And no doubt you learn from other people's devices or mistakes. So they were starting points, yes.

Sue Nelson
And go through it. For people who don't know how you get the electricity from a wave converter, what actually happens?

Samuel Etherington
The device that we're talking about the first one, the RWP, that used a hydraulic system, which at the time is a fairly standard way of at least attempting to extract wave power. If you imagine a JCB tractor, you know, it's got all the it's got the engine, it's got the hydraulics and then it's got a bucket at the end, which scoops up dirt and then puts it in a pile somewhere else. All of that power originates from the diesel but mainly the engine, which drives the hydraulic pump, which then enables the hydraulic rams to do work to move the bucket. But the way that hydraulic power takeoffs work in in the wave devices, it does that in the complete opposite, where the bucket is actually the driver and that causes the pistons to move up and down the hydraulic pistons, which then in turn causes a hydraulic motor to turn, which might be mounted to an alternator. So, you start to spin the alternator. So, it's the exact same but in reverse. I wouldn't say that it's the most efficient way to do it. And it's certainly not the way that we're converting wave power into electricity now, but it was again, a fairly standard starting point.

Sue Nelson
Your RWP then led on to a sort of small scale device called Manta, which is a fabulous name because I've seen a picture of it, and it does actually look, which is probably why you've got the name, a little bit like a manta ray, although it did remind me of the device that the main character in the film, Inception, twirls to prove whether or not he's in a dream or not sort of like okay, but that's what I thought it's sort of like a rhombus, but with side bits that looked a little bit like the wings, which is why the Manta bit comes in.

Samuel Etherington
Yes, it was about five other machines between the first prototype at university which really was in hindsight, was total ignorance. It was, you know, designed what I thought was the right idea in a university halls residence, you know, with no exposure to the sea only a test tank, so the realities of actually scaling that device up, and, you know, making it work in the sea, the cost to get to that point was enormous. It was technically quite a difficult machine, although efficient, and to raise the capital as a, you know, start-up company to try and even start the journey of developing that into a product. It wasn't achievable, especially with my age, and lack of any track record. So, you know, I was still keen to work in wave and try and get something off the ground. But to achieve what I wanted; I knew that we had to start at a smaller scale. And that led to me essentially moving towards, who is actually in the sea, and who has power that is quite expensive. Okay, who is that person and what device could work in the location that they're at? So, for a designer, an engineer, it's classic, that they just set off designing, and it is the best thing ever. But actually, nobody wants it. Well, you know, it wasn't actually designed with anybody's requirements in mind. So, it was a bit of a shift for me to do that, because it wasn't that normal at the time for me to take that approach. So the Manta device is really born out of a market, which

in my case is aquaculture, all these farms offshore with expensive power, that are operating in the sea. So, we set about developing some wave data bouys to put in the sea, their sites to understand what the wave characteristics were, which then in turn helps inform the specification of what the Manta machine should look like. And at that point, it wasn't called Manta. It wasn't anything, it was just numbers. These are the waves. These are the motions; how best can we make a structure to capture that? And it just so turned out that prior to Manta I developed a heave plate, which is a piece of kit that sits underwater and resists heaving upward motion. So, there was some underpinnings of the Manta in the heave plate. So, it was a natural progression for me to take that idea, which was large surface areas, resisting any motion to then create Manta.

Sue Nelson
And how big is Manta?

Samuel Etherington
So the current versions are about four and a half meters tall, and have wings that are approximately two meters wide, and can be from one meter to two meters long. And then two wings, obviously the side of the main frame.

Sue Nelson
So that's fairly substantial. So did you set up then a company immediately after university?

Samuel Etherington
So after university, the original design, the RWP, I entered that into the James Dyson award and it won it. Off the back of that there was some media coverage. And a couple of grant providers approached me and you know, were saying, “Do you want to continue with this development?”. You can't really say no at that point, you want to see where it goes. So yes, great, but then you need to set up company and all the formalities for all that to fall in line. So really, the company was formed out of necessity to actually access grants. And then off the back of that has sort of grown to have product lines, which support the main work we're doing in wave. But we know we're actually functioning as a business with products now, which is great. It's not just an r&d company.

Sue Nelson
It sounds so straightforward. You go straight from university, you take a project, you start a business. Was the fact that your family, you come from a family of engineers, they run an engineering business, did that sort of put you at a massive advantage in that it didn't feel like a mountain to climb, because you've witnessed it around you growing up? Or was it still daunting?

Samuel Etherington
There’s still a big mountain to climb for sure. So at the point at which I went to university was near enough the financial crash, and in that year, the business, the engineering business was actually shut down. And then it's never reopened since. So, the year I started to really get into it, and go to university to learn all about it, everything shut down. By the time I finished, you know, there was no real links or connections there anymore. Definitely growing up with engineering in the family, there's always things that you pick up, you might not necessarily know it at the time, but they do come back and help guide you in your ways forward. But there were a couple of people that spotted that article from the Dyson Award that were very instrumental in actually helping me get off the ground with forming a company, raising the investment, being investor ready, all those sorts of terms and things you need to do which, when you go and do industrial design at Brunel, you're not set up for that. You can't do everything at university, and It was just a design that we were focusing on. So, there was a whole, uphill, you know, mountain to climb is not unachievable stuff, but it's all new and quite daunting and quite scary.

Sue Nelson
And did you have to design software or any specific tools in order to build your prototypes?

Samuel Etherington
Not really no, I was using fairly conventional software, you know, SolidWorks, for the CAD and at the time ANSYS for simulation work. So a combination of those two, I mean, they are a blank piece of paper, you've got to have the idea to set off and go with it so that you can, you know, start drawing all the parts and assemblies. At the time that we were designing that no, but now, yes, there is. And we're starting to introduce machine learning and your neural node techniques into the device just to try and speed up the rate of learning on how the device performs best in certain conditions.

Sue Nelson
And what stage is Manta at now, you know, how many how many versions have you gone through?

Samuel Etherington
I'd probably say there were seven significant versions, with a number of, let's call it interim developments of certain aspects of the machine in between. So, you know, the first Manta will have had a number of different developments in there. And then the second one will have been slightly less, but some more developments in there. So it's not a radically different machine. But certain aspects are improved. But it's now at a point where we have to the commercial machine and near enough 90% of it is made in house now, which was really key to speeding up the rate of learning speeding up the rate of innovation, what have we actually got to hand? And how can we make this machine using these technologies we have on hand. And what it forces us to do is actually to be really smart in trying to be as simple as possible. It's really easy to make things that are complicated and have number of parts that are, you know, or fixing, you know, different phases of parts. So it forced us to be ruthless in our sort of pursuit of simplicity.

Sue Nelson
And give me an idea of the sort of organisations and customers that you're, you're selling Manta to?

Samuel Etherington
So we've focused really down on one market that exists right now and that is profitable. So it's aquaculture.

Sue Nelson
So by aquaculture, do you mean primarily fishing industries?

Samuel Etherington
Yeah, exactly. So offshore fish farms. That might be salmon... Tuna. But essentially, farms located a couple of kilometres offshore, in deep, exposed waters that require power to do undertake their operations but ordinarily, they're using diesel generators to do that. That isn't how we originally started, we started with, you know, assuming that the grid would accept these types of devices, these wave energy converters to help power houses and be connected to the main grid. However, there's not really a market there for that. And you're competing against offshore wind, which is really running away with it in terms of the cost of renewable energy offshore. So, there's a heck of a lot against you, the likelihood is that any investment that you may have raised will quickly run out before you actually managed to secure any customer commitments. So, the Manta device is solely aimed at the aquaculture industry. And because of that, you know, it is that size because the characteristics of the waves, typically those sites are as they are, the workboats, all of the infrastructure that's available, Manta is able to work with, which is no mistake. That's how we wanted this to work.

Sue Nelson
Now, I mentioned I'd seen a wave converter before off the coast of Scotland, and I decided to sort of look up and see the company because I couldn't remember because it was 2006, it was for a radio four series on engineering called Britain's Modern Brunels and it was the Pelamis Wave Energy System, which was sort of a yellow, long, looked almost snake like off the coast. And it had already tested a prototype in the Orkneys. And it had recently provided Portugal with equipment for the world's first commercial energy farm. So, I looked it up the company and it's no longer with us. And I was quite surprised considering all that, it had all that going for it. So I wondered why you think your company has succeeded where previous companies like that, who've done everything right, haven't quite made it?

Samuel Etherington
It was really impressive at the time, it was completely the right approach. There's sometimes a scenario where you can get too big too quickly. And your commitments outstrip what you can actually offer, and possibly that was what happened there, I'll never really know. But the devices were so big and the they had to be that big to capture the wave energy that they were trying to capture, these very long offshore ocean swells. So, there's not a great deal of opportunity to ramp up your prototype scaling, without really committing to these big machines. And these prototypes are multimillion-pound machines, straight off the bat. And everybody knows with Prototypes, there's always teething problems, there's always issues. But the people that be backing you and that are investing in you are pinning their hopes on that you get it right.

Sue Nelson
They want results.

Samuel Etherington
They want results and if they're not seeing it, they move on. And unfortunately, as ruthless as that is, it has to be like that. And unfortunately, I think the machines that went to Portugal had issues. And then very quickly, there was a lack of support to continue funding the company. So really, you know, at the time that I was at university designing our devices, or at least the beginning of designing wave machines, Pelamis was one of the ones that was in existence. And there were things that I learned from that company and their approach, maybe learning from mistakes more, definitely. That swayed my decision to actually start designing smaller devices which were commercially viable, release them into the market space, and let the company grow commercially, to then access these larger markets with bigger machines, as opposed to requiring grant financing. And that definitely was influential in that decision.

Sue Nelson
And what other lessons have you learned along the way, running an engineering business?

Samuel Etherington
For me, I spend probably 20% of my time designing. And the rest of the time actually, making sure that the company can function, you know, raising the investment and protecting the IP, finding the customer base, doing the research, engaging with customers finding out exactly what it is that they, you know, that they need, or what's their problem. And the designing but is almost quite easy if you have a very well-defined spec, because you've basically got a guideline to follow. This is exactly what it should look like, yes, there'll be tests that you need to do to ensure that it meets those specs. But if you just start off designing what you think they might want, you're all over the place. So, I spend a lot of time really honing in on what that customer wants, because there's a higher chance that they'll actually want to buy it when you've, you know, developed it. So unfortunately, although I'd like to be designing more, just because that's my, you know, passion. It doesn't work like that, in reality, when it comes to a commercial design.

Sue Nelson
And do engineering courses prepare an engineer to set up their own business, because it's something that a lot of engineers do?

Samuel Etherington
Specifically my course, no. But by the same token, you can't expect the university to try and teach you everything to do with running a business. I think the best way to do it is actually just to go and do it. Either it'll work through a lot of hard work determination, or it'll fail. And if it fails, you probably have a greater appreciation for your employer in the future, because you know, what it takes to try and do what they're doing. But I think there probably could be a little bit of guidance. But by the same token, I think you've just got to go and do it.

Sue Nelson
Is there a device that you've seen that you've thought, “Wow, that's a neat piece of engineering? I wish I'd been a part of that”.

Samuel Etherington
Not specifically, but the things that I really have an appreciation for are designs, where essentially, it's so unbelievably simple that you either think, “oh, why didn't I think of that?”, or “Oh, that's so obvious”, or “How well does that work just because of simplicity?”. It doesn't necessarily have to be a physical thing either, those products, services, whatever, that make me think like that, you know, they're what I'm interested in.

Sue Nelson
And do you still kite surf?

Samuel Etherington
Yeah, I still crash around in the sea. Not as much as I used to. But if it's really wild, then I'll go down because, you know, you get that feeling of being in the moment, that's all you can think about, you know, resets you for the next week at work.

Sue Nelson
Completely. So, is that your main form of relaxation still, or do you have other outlets?

Samuel Etherington
Yeah, I like to be out sort of doing stuff. So I've just taken up hydrofoiling as well. So, in that instance, you have your kite, you have your surfboard and then underneath the surfboard is a mast and a wing. At speed, you start to rise up out of the water on your board and hover on the mast with the kite pulling you along. If you know what you're doing then it's all hunky-dory, but I'm nowhere near there yet. I've only just started to learn it.

Sue Nelson
Sounds great and again, perfectly suited to the day job. Sam Etherington, thank you very much indeed for joining me on the Create the Future podcast.