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.
[Music]
My guest today has been called the alchemists of waste for her work creating new building materials from old waste ones. Based in Australia at the University of New South Wales, in Sydney. Professor Veena Sahajwalla is the founding director of SMaRT, the Centre for Sustainable Materials Research and Technology. The team strips waste down to its basic constituents, and then reforms them into, for example, floor or ceiling tiles. SMaRT launched the first electronic waste microfactory, but it's perhaps best known for its green steel, where millions of old rubber tires are melted down and replace some of the coke during steel production. This has saved millions of discarded rubber tires from landfill. So, I began by asking Veena how wasteful we are, as a society.

Veena Sahajwalla
As a society, I think we are really, really wasteful, in the way we've all been living life at large, so to speak, we've just become so used to consuming and throwing things away without even thinking about the impact of our actions on the planet. And I think to me, that's not okay. It's not okay that as a society we've just become used to this mindset that, you know, we can just throw things away. And I think we need to do something that's going to shift mindsets, that's going to shift habits. But yeah, all of us across the world, we just need to be a lot more considerate to the fact that we live on a planet where we have finite resources.

Sue Nelson
Most people tend to think of waste as plastics in particular. What would you say is the resource that perhaps the planet wastes most of all?

Veena Sahajwalla
I think plastics is definitely up there at the top of the list. I think the other one that I would also put that often we don't think about, even though the numbers are quite staggering, is electronic waste. So, E-waste is something that we all contribute to. And in that regard, just look at how we're communicating now. And I think the world of course now has, again, become very used to using electronic devices. But we don't then stop and think about how often we discard our electronic devices, you know, without really thinking about that, throwing away of resources, that's embedded in our electronic devices, and the fact that we just don't think for a moment that we've got all kinds of expensive metals and critical materials in our electronics. So, I would probably put both plastic waste, and also electronic waste at the top of the list.

Sue Nelson
I can understand that, because we're so used to today, getting a new phone, and it feels as though where does it go? We just throw it away.

Veena Sahajwalla
Exactly. And indeed, you know, that whole notion that, well, "we hope we're doing the right thing with it when it's disposed of", but quite often, we are actually not aware of this all-important question of, you know, should we even be thinking about it as a disposable item, clearly, we cannot. And I think to me, that's the ultimate irony in electronics, that it's such an important part of our lives. And yet, of course, you know, when products break down, or they become obsolete, we don't really have, you know, systems in place that allow us to look at ways in which we can harness those materials, those important metals and critical materials, and of course, plastics, and glass and all the important materials that are embedded in electronics. We don't really have systems in place, and we don't really have technologies that enable us, no matter where we live in the world, you know,

that enable us to actually harness those important materials. But imagine a future if we could, in a way that made sense from an economic point of view, but more importantly made sense from an environmental point of view, so that we can actually, you know, moving forward start to do the right thing. We need to harness those materials. And we need to, you know, bring them back to life over and over again in the form of new devices, new products.

Sue Nelson
Well, that brings us on perfectly to green steel, so called green steel, where did you get the idea to repurpose tires for steel production?

Veena Sahajwalla
Yeah, well, you know, it's one of those things when you look at the consumption of, you know, resources like coal. And of course, everyone, you know, is absolutely aware about the impact of, you know, use of coal and the impact on climate. But quite often, we don't actually stop to think that, you know, in addition to, of course, you know, the transformation that we're seeing in the energy space, in bringing in more and more renewable energy into the mix, we actually have not given enough consideration to how our materials, making of steel in this particular instance, has been so dependent on coal based resources. And the fact that we need to have a complete shift in the way we think about our ability to harness all kinds of resources so that we can manufacture our products, like metallics like steel, and if we can do that in a way where we can ultimately, you know, eliminate the need for coal, that would be the ultimate goal of, you know, how we actually produce these important metals, and therefore thinking about manufacturing, and the fact that manufacturing is also a resource intensive, industry, just like energy is, and manufacturing of materials relies upon a lot of traditional resources like coal, if we can do what we are achieving already, in so many parts of the world, that transformation into renewable energy. And imagine if we could start to think about all materials as renewables, and if we could harness more and more of our waste, and really use that for manufacturing, then we would have actually also well, and truly started to shift the way we think about making of our metals. And this is really, for me, the journey of green steel has been, you know, the beginning of so many other, I guess ways in which we can question the way we've always looked at, you know, manufacturing in some instances. So green steel was really born out of the fact that in my case, I'd started questioning the norm, and challenging the norm that “Oh, steel is always made in a certain way, oh, we have to have this coal that allows us to make the steel”. And really challenging that law meant that I had to have alternative solutions. And it's really very pleasing to see over the past many, many years that not only has the science, that over the years we have proven in our labs shown that it can be done. But also, equally importantly, the fact that from a commercial point of view, we've shown that, you know, industries across the world have been excited about green steel and have taken up this technology for manufacturing steel. So, it's actually been, you know, an exciting journey. And I think, to me, we're still on that journey, of course, but really, this is where the idea started, that ultimately both important elements of carbon and hydrogen, that we have harnessed out of waste tires, inside a steel making furnace has actually shown that we can indeed, reduce our dependency on coal. And of course, ultimately, for me, the goal is complete elimination of coal.

Sue Nelson
I mean, this sounds like a quite an important mindset for an engineer is to think in terms of “Well, okay, I don't have to start with the accepted ways of doing things”. Like you say think afresh, I mean, that sounds like really good advice for all sorts of projects.

Veena Sahajwalla
Yes, absolutely. And really kind of think afresh and, and rethink, and really, sometimes challenging the norm, is the only way we're going to see a massive shift in the way we do things. And, you know, the world needs that

right now. And the fact that we can, in this particular case with green steel have shown that we can not only recycle and reform millions of tires in the process of making steel, but the double benefit of reducing our dependency on coal that we have proven is an important outcome but really thinking also, about that clever science and harnessing those elements and really showing that it is possible to reform tires inside steel making operations where you can indeed, you know, produce these clean molecules of gases like hydrogen, because of course, tires are rich and hydrogen, but you want to do it in a way that is clean and sustainable. And really, to me, the exciting part of all of this has always been about the, the fact that this incredible science not only worked in our labs, which in its own right was exciting, but you know, the fact that when we started to, in fact, do industrial trials and testing and ultimately proving and commercializing it, was really such a such a massive, you know, sense of satisfaction. It's a global solution, because globally, we all need steel and globally, we're all producing waste tires. So, the fact that we can bring together, you know, what might be seen to be a problem, and convert that into an opportunity for steel makers across the world is, is an exciting development.

Sue Nelson
When did you first become interested in waste? Was it something as a kid that you sort of saw things around you and thought, why are they doing that?

Veena Sahajwalla
Oh, it's, it's quite an exciting question. Because it does take back to a lot of memories in my childhood. I was born in Mumbai and lived the early part of my life in Mumbai in India. And, you know, what was always very exciting is that, you know, when you grew up in a place like Mumbai, which of course, as people may know, that is, it's really the industrial heartland of India, where lots and lots of factories are buzzing away making things but also at almost at micro-level, so many entrepreneurs, you know, are out there, repairing things, you know, whether it's repairing your old shoes, you know, or indeed your old broken down toaster or radio. And I think, to me, that whole excitement about the fact that it doesn't matter whether you're the person on the street, who's got a little corner store where repairs are happening, or whether it's a big factory, the fact that we are, at that time growing up looking at all these products in our hands, that we're not throwing away, that we are actually repairing it. It is so exciting to think back at a time when out of that sheer necessity, where people would become entrepreneurs, where they would use their skills to pick up on a waste product that someone might have, you know, discarded because it wasn't working, but then to be able to go and fix it. And I think to me, that's such a beautiful thing. I remember growing up in Mumbai and I think it would be something I'd love to stand and watch, as to how someone would actually fix things and repair things. To me, that was that all important, I guess, you know, that was forever imprinted in my head that people are actually really creative and capable of taking all kinds of products and using it in different ways. So, it just means that really, there was no such thing as waste. That was an important part of what I saw. And I think to me, the other side of it that was really quite moving was, you know, it was a really neat way for everyone to find a job. I mean, you could earn a living, you could actually do something productive in society and you could actually, at the same time, make a living - that's so important. It is really addressing that important issue of how do you actually create jobs where, you know, everyone can use their skills contribute in a positive manner to our society, and no one is really left behind. So if you can think of a way in which waste as a resource, you know, becomes something that creates new jobs. You know, delivers outcomes for our society and ultimately for our planet, I think it would be such a fabulous outcome if we could start to rethink everything that we do in that way, you know, we could actually achieve these goals, you know, and improve lives for everyone on this planet.

Sue Nelson
I almost think that one of the positive things that's come out of the pandemic has been this train of thought, because with the lockdowns, for instance, shops were shut. And so, all of a sudden, you had a mix of either people clearing out using this unexpected time at home, to look at what's around them, perhaps think of

donating things to charity, recycling. But also thinking, “Well, actually, I can't go out and buy this, what have I got in the house that I can repurpose?” which is sort of the basis of what you're doing, looking at things in a different way?

Veena Sahajwalla
You know, you're absolutely right. I think, in a way, if we look at what 2020 has meant for so many people in the world, if we have to think in a hopeful manner for the future and say that there are things that we've all learned through this experience. I think that's such an important thing, because, you know, we will not take things for granted. And I think even just thinking about how, imagining all the all the health-related challenges that, you know, medical professionals have had to face in just sort of, you know, accessing PPE, for example, and just being able to go, you know what, if we have to value and respect our resources and our essential goods and services, that whole ability to think you know what, we need to be much more mindful and respectful of the resources that we have in our hand. And if it means that we've got to be really clever in the way we value and rethink, then that's, that's something important that we will all be learning through this experience.

Sue Nelson
Now, you mentioned earlier about E-waste the sort of electronic waste that comes from our smartphones or laptops and the sort of valuable metals that are inside and can be reused for other things rather than just being thrown away. And I read that you had been using microfactories, what do you define as a microfactory?

Veena Sahajwalla
Yes, well, you know, microfactory, for us has always been at the core of what we do. It’s all about taking predominantly waste resources and materials for manufacturing, transforming our waste materials and resources, regardless of whether they come from our electronic sources, or whether they come from simple food packaging plastics and other materials. The important thing is we've taken those resources that are classified as waste and in many instances are not being processed in a way to harness its value, or in many instances simply being put away into landfill. And converting those, upcycling those, and re-manufacturing those in a way that we are again, converting them into useful products.

Sue Nelson
So is it the equivalent of the sort of kitchen recycling bin, but on a slightly larger scale? Not as huge as a big factory?

Veena Sahajwalla
Yeah, yeah. Look, I mean, this is right, isn't it? I mean, as in, you know, what is that right scale at which we do it. And so that scale that we choose is designed to be fit for purpose. And so, it really does depend upon, what is it that you want to process? So, if you are processing plastics, to be able to convert them into plastic filaments for 3D printing, for instance, that come out of all the ways plastics in electronics. Or if you are indeed creating your waste glass and textiles into, you know, hard ceramic products in all of these cases, that scale and the equipment and the machines and the modules that we design are fit for purpose. So microfactories are very much meant to be modular. So, you have modules that do quite specific operations. And by indeed, being very selective in the way you have your modules designed, because they have to operate at certain temperatures to bring about the production of new manufacture products. Those modules then can be designed and customized to deal with these different types of waste materials, so that you can indeed manufacture highly engineered products. And that then means that it's not only taking waste, and converting those into products, but doing it at the right scale. And that's why I like to call it as, you know, ’economies of purpose’ is really the whole point of designing and thinking about how the science could be converted into technologies of micro

factories in being basically designed for a particular purpose or ultimately thinking about what we like to think as economies of purpose, rather than everything being bigger and bigger for the sake of being big.

Sue Nelson
Now, your mother is a doctor, your father's a civil engineer, what made you follow your father's profession in terms of engineering rather than medicine?

Veena Sahajwalla
Um, well, you know, my father, you know, as you, as you correctly pointed out, you know, was an engineer and, and from my point of view, you know, I just saw what both of them did, because fundamentally, it was relating, of course, to science at the core of it. And that was important. And, and I think, to me, again, having that ability for any person, and particularly as a young person, when you're looking at things that are happening in the world around you to just be inspired by what's happening, so you can make your own choices. And I think, to me, the fact that I was far more attracted to breaking things, repairing things meant that I think engineering was more my thing. I wasn't all that keen on looking at how, biologically how my mother kind of fixed her patients up, so to speak. If a little kid had a broken bone, that didn't quite excite me as much as the physical things that I could break in and put them back together again, which I found was really exciting, because I could have multiple goals, if I got it wrong many, many times. So, I quite enjoyed the challenge of the unknown in trying to get things back together again, but I have to say, I also enjoy the challenge of breaking things.

Sue Nelson
As you mentioned, brought up in in Mumbai, you studied engineering at the Indian Institute of Technology, you did a master's in Canada, a PhD in Michigan in America. And now you're living in Australia, where you started this Centre for Sustainable Materials Research and Technology with a wonderful acronym 'SMaRT'. Does this global travel, living in different places, inform how you look at engineering and thinking of all things on a potentially global scale as well?

Veena Sahajwalla
That's a very good question. And I'd say absolutely, yes, because I think in a way, you realize that, you know, really, as people, no matter where we live on this planet, we actually have a lot in common, there are lots of things that we all care for, as much as, yes we've got different challenges and, and we've got different environments in which we live. But I think there are certain things that we all, you know, care about. And I think one of the things that we are talking about today in terms of how we, you know, think about, you know, utilization of our materials and resources, and making that available in a fair and equitable manner to everyone, no matter where we live, we all care about that we all care about providing support and services to everyone. It's been very important for me to be able to have that privilege and that experience of studying and living in different parts of the world. Which means that, you know, I can when I talk about the science and the work that I do, for example now with our microfactories, you know, have that ability to interact with so many people across the world and be able to relate to what it means. You know, so when somebody wants to have a chat to someone who's in Brazil, and in fact that happened only about a week ago who reached out and said, "You know, I'm really interested in your work on microfactories for E-waste" and just to be able to get to the core of it, where I felt, you know, the fact that here's somebody from all the way across the world has reached out interested in E-waste, but the core values were very much about that, people who are going about collecting E-waste, do not have for the opportunities for really processing E-waste and for manufacturing something out of it. Those traditional large factories are really, really out of reach for a lot of, you know, communities across the world, but the fact that we might be talking about solutions, like microfactories that could well be applicable, whether we're talking about, you know, places in Australia or in Brazil, or in India or anywhere in the world, where you want to be able to create solutions that make it possible at a local level, to bring about that

transformation is so important. So yes, it's a global society that we live in. And we understand the fact that our goods might be produced in different parts of the world. And of course, we consume resources in that way. But that doesn't mean that we can't, you know, in terms of looking at recycling solutions, that we can't just think about how we might be able to localize our activities in a meaningful way that is fit for that particular community. So, I think to me, it's been a very important time in in my life, where the ability to have that opportunity to come to Australia, going through all of these different parts of the world, but really work here at UNSW in Sydney and to really have the privilege and the opportunity to set up our own microfactories, at UNSW as a demonstration facility, to show that, you know what, we can do this, if we can do this in in a university setting, then we can actually do this anywhere in the world.

Sue Nelson
Where will you set your targets next, in terms of waste?

Veena Sahajwalla
One of the important things that we're starting to work on is really addressing the all-important issue of waste batteries. Batteries, of course, again, are such an important part of our life, no matter where we live, in all kinds of machines and equipment that that rely on, on the use of batteries. So that's an important thing for us to be looking at and considering because of the fact that the materials that go into making our batteries, again, are limited and therefore we can't afford to see that as simply a throwaway item. Whether we're talking about rechargeable batteries, or whether we're talking about disposable single life batteries, the materials that go into making these batteries are going to be very important for us to preserve, we've obviously started to do this work in Australia. But again, it's something that is relevant for people across the world. But we have to address the challenge here in Australia, because, you know, we really want to make sure that we can start to take local action. So, you know, we can really accelerate our ability to bring this change. And we indeed have been awarded a research centre that allows us to focus in on micro recycling of batteries. That's going to enable us to really move forward in developing the science around how we transform some of these materials into, you know, more useful materials that are fit for application again and again.

Sue Nelson
And what would be do you think, you know, the most important lesson or the most important bit of advice you could give to a budding engineer?

Veena Sahajwalla
The most important thing you have to think about as, as someone who's interested in engineering and, you know, I always say that, you know, it's a privilege when you can bring together your head, which is the analytical side, but you can bring together your human centred, you know, skills, your heart, into what you do. And that's what engineers can do, that we can bring together, our passion, and our analytical skills and bring together that ability of both your heart and your mind together to deliver impact is something that, you know, we do as engineers, and I think, if a budding engineer is thinking about all kinds of things that they'd like to achieve, I'd say that, absolutely find a pathway. There are many, many pathways, and you can actually create massive impact on the lives of people. So, it is an absolute privilege and an opportunity. And there are absolutely no limits and no boundaries to what you can do.

Sue Nelson
Veena Sahajwalla thank you very much indeed for joining me on the Create the Future podcast.

Veena Sahajwalla
Thank you so much for having me. [Music].