RioTinto

Transcript

Things You Can't Live Without

Episode 2 – Rudy Garcia-Tolson's prosthetic legs

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Dr Anna Ploszajski [00:02]
Hello and welcome to Things You Can't Live Without the podcast where I, material scientist, Dr Anna Ploszajski, am joined by a special guest to discuss the one thing they can't live without, and a host of experts to run us through the true impact of our obsessions. I think for me, probably the item that I can't live without the most at the moment is my spillproof coffee cup because I have to walk my border collie, Spud, first thing in the morning rain or shine, mostly rain. And every morning when I'm getting out of bed. I'm grateful to the modern world of manufacturing for making my morning coffee on the go possible. And I have to say, I certainly wish that I picked a different example now because I'm pretty sure that my guest this episode is going to put in my daily routine to shame. With me today to talk about the one thing that he can't live without is five time Paralympic athlete, Rudy Garcia-Tolson. Rudy won his first Paralympic gold medal aged just 15. And he's been breaking records ever since, including being the first double above knee amputee to complete a full Ironman Triathlon. He's also a proud ambassador for the Challenged Athletes Foundation, whose goal is to support physically challenged athletes to pursue active and healthy lifestyles. Hello, Rudy, and welcome to Things You Can't Live Without.

Rudy Garcia-Tolson [01:19]
Good day. Excited to be here. Good to see you.

Dr Anna Ploszajski [01:22]
You too. Now, please tell us really, what is the item that you can't live without?

Rudy Garcia-Tolson [01:28]
Well, my item is slightly different than yours in which I use them a little bit more throughout my day and my life. My item that I cannot live without are my prosthetic legs.

Dr Anna Ploszajski [01:40]
And can you describe them for our listeners? What do they look like? How do they work?

Rudy Garcia-Tolson [01:45]
Sure. Well, you know, I've grown up with my prosthetic legs since I was about 5 years old. And when I was a little kid, and still today, little kids refer to my legs like how I used to, they were my my robot legs, you know, that's kind of what they look like, but the medical term and the professional term are my prosthetic legs or my walking legs, because one of the many perks of being a double amputee is that you can have multiple different pairs. So it has a foot, it has a prosthetic knee, and it has a socket, that is up top. And so I have 3 components in my legs, which are connected by adapters, and they weigh about 9 pounds. And they are pretty high-tech because my knees specifically are bionic, which means there's computers inside, there's a battery inside,

and I have to charge them at nighttime, similar to charging your cell phone and your computer. So there's a lot of charging going on at night to get me ready for the next day. But my prosthetic legs, my walking legs, are something that I put on every single morning, especially when it's time to go take the dog out for a walk, though the legs go on and they usually stay on for all the way until past dinner.

Dr Anna Ploszajski [03:09]
Amazing. And it sounds like there's quite a lot of very high-tech engineering that goes into these prosthetics.

Rudy Garcia-Tolson [03:15]
Yes, there is, there is a they've come a long way. The prosthetic industry over the last 20 years have seen a substantial upgrade from where we were and, you know, thinking about the whole history of prosthetic legs, I would say 50 years ago prosthetic legs were primarily made out of wood. So you can imagine they were heavy. They were not comfortable and not very customisable and probably very easy to break. And now they, a lot of the components, are made out of carbon fibre, titanium, high-grade plastics, and now they are smart. So over the last 20 years, there's been a lot of advancements in the quality of the prosthetics. And with prosthetics, you're not only given somebody who has a disability with limb loss, the opportunity to walk again, and live a active healthy lifestyle. You're giving them an opportunity to live a life without limitations. And what that means is because I'm missing both of my legs above the knee, when I get up in the morning, I need to put my sleeves on, my socks, and then I put my prosthetic legs on and because I have that, that capability of putting my legs on, I'm able to go to work, I'm able to drive my car, I'm able to go and essentially sustain myself and not need somebody to help me live my life.

Dr Anna Ploszajski [04:53]
Okay, well, I think it's fair to say that your prostheses are just incredible feats of engineering and definitely wouldn't be possible without some pretty sophisticated materials. Later on in this episode, we'll be hearing about the origin of those materials from Marie-Pierre Paquin, Chief Advisor of Discovery at Rio Tinto. [muscal interlude]

Dr Anna Ploszajski [05:15]
How many prostheses have you had throughout your life? Do you think?

Rudy Garcia-Tolson [05:19]
Well, I guess, I guess I could start by asking you, how many pairs of shoes do you think you've had throughout your lifetime?

Dr Anna Ploszajski [05:27]
Oh, good question. 50?

Rudy Garcia-Tolson [05:30]
Okay.

Dr Anna Ploszajski [05:31]
70.

Rudy Garcia-Tolson [05:31]
I would say I'm probably about in the same ballpark. It's a hard, hard number to remember, especially from my first pairs of legs when I was about 5 years old. Now, when we're talking about the feet, or the knees, they can be reused. And so just because I'm growing doesn't need, it doesn't mean, I need new feet or new knees. But what I do need are the sockets, which is these top parts here. So the sockets are the parts of the, of the prosthetic, that a user will need to get a new one of roughly every 1 to 2 years as the person is growing. So when I was a little kid, I had to get a new socket, about every year to year and a half because my leg was growing. You know, I

remember we would be I would be in 1st grade at school. And I would get back from recess. And I would notice a screw or a piece of my leg missing. So we would always have to send a search party out to the recess playground to find a part of Rudy's leg and, and, and it just became a normal routine and during my early years in school, but thankfully, throughout later in my life, I got upgraded prosthetics, and now they, they hardly ever break, and they're a lot more stronger. So I don't have to worry about sending search parties out to retrace my steps and find the pieces of my legs so.

Dr Anna Ploszajski [07:07]
Well, that's very good, because I know that you're prone to running marathons. So it's good that people don't have to run after you.

Rudy Garcia-Tolson [07:12]
A lot of different sports. Yes, marathons. Ironmans. And thankfully, when I swim, I don't use any legs, so I'm able to take them off, but everything else I do, I need my legs.

Dr Anna Ploszajski [07:24]
And now you're working to help other kids in that situation or similar situations to be able to have that feeling too, right?

Rudy Garcia-Tolson [07:30]
I am. I work for the Challenged Athletes Foundation and our mission is to provide sporting opportunities for individuals with permanent physical disabilities around the world. You know, a lot of times, insurance companies will provide a person with a disability a new walking leg or a new everyday wheelchair to live life to go to school to go to work. But a lot of times that, that racing prosthetics, the sporting legs and sporting wheelchairs, they consider that a luxury. And we all know that sports is not a luxury, sports is a right for everybody. And, and so that's why we step in and we fill in those gaps because the prosthetic legs for sports, the racing wheelchairs for sports are very expensive. And we help fill those gaps to get kids and adults what they need to get out and live an active, healthy lifestyle.

Dr Anna Ploszajski [08:27]
So it sounds as if you've seen prosthetics change a lot, even over your lifetime, as you described them developing since you were 5 years old. But I'm wondering, do you know much about the longer history of prosthetics, you know, how old do you think the first archaeological evidence for a prosthesis is?

Rudy Garcia-Tolson [08:43]
You know, I'm not too, too knowledgeable about the history, you know, of prosthetics. You know, I do know back in the day, when there were pirates, we all know when a pirate was missing his leg. He had a peg leg, which is typically just a piece of wood that went down and it made a loud thumping noise when he was walking and, you know, that's kind of our vision of a pirate. A pirate has an eyepatch.

Dr Anna Ploszajski [09:10]
That's how you know, it's a pirate.

Rudy Garcia-Tolson [09:11]
He has a parrot and he has a wooden leg. And that's probably about as far back as I know of my history about prosthetic legs.

Dr Anna Ploszajski [09:19]
Yeah, no, I mean, I think you're not actually that far wrong. I did some digging. And the earliest archaeological evidence that we have for any sort of prosthesis is apparently a 3000 year old ancient Egyptian mummy, who was found with a prosthetic toe that was made from wood,

unsurprisingly, and leather as well. And yeah, later on, I think actually, as you say, for the vast majority of history, wood was kind of the go to material it's, it's kind of amazing. It's got the very strong and very lightweight combination of materials properties that is quite rare in materials and so if you want to put the whole weight of your body onto a wooden leg, it's, will mostly stand up. Okay, but as perhaps people have found over history that would, eventually will, will not perhaps be as good for the job. And we've talked about the kind of high technology involved in these prostheses that must come at a cost, right? What, what are the most expensive aspects of this?

Rudy Garcia-Tolson [10:16]
That is one of I guess you could say one of the downsides of the ever evolving prosthetic industry. And when new components come out, when new knees come out, that are smarter, that the battery life lasts longer, maybe a new foot with a different type of carbon fibre angle, that gives you more energy return, the costs are going up, and because my knees are computerised, one knee costs upwards of $30,000. And you know, that's not including the feet, that's not including the sockets, that's not including my, my socks, the suspension system. And you know, in a lot of instances, this knee that I have is not the most expensive, they now have newer versions, different versions that give you even more energy return to assist you in a lot different way. And those will cost even upwards of you know, 50 to 100,000 dollars. So we start to see the prosthetic industry integrates in our body, and what we call bionics. It's, it's going to even skyrocket. So that that is one of the challenges and that is because of the materials that titanium the carbon fibre, the computers inside of them. [muscal interlude]

Dr Anna Ploszajski [11:41]
Let's talk about titanium a little bit more. And to help us understand the role of titanium in the modern world. We're joined by Marie-Pierre Paquin, Chief Advisor of Discovery at Rio Tinto. Welcome, Marie-Pierre.

Marie-Pierre Paquin [11:52]
Hi, Anna. Hi, Rudy.

Dr Anna Ploszajski [11:54]
First of all, tell us more about Chief Advisor of Discovery. That's an incredibly cool job title. What does that actually involve?

Marie-Pierre Paquin [12:01]
Isn't it, eh? It's the coolest job title. My task is mostly to look at new technology, innovation, and everywhere that can be found. So in university, in startup, and big companies, and to bring that innovation inside of Rio to solve some of our most difficult challenge or to grab also interesting opportunities. So a lot of it revolves around the energy transition and everything carbon but also to achieve those big targets. We need metals and we need materials, and how can we produce those material and those metal in a sustainable way to achieve the energy transition. So there's also opportunity in there.

Dr Anna Ploszajski [12:01]
And you're responsible for finding those opportunities. That's very cool. Can you take us back to the beginning, how long have we known about titanium for?

Marie-Pierre Paquin [12:52]
So we've known about titanium I guess for a very long time, it's been used in different application across history. From the beginning, it was already known to be a material that resists at very high temperature. And initially it was thought of to use as a inside of the light bulb because of the high temperature resistance of titanium, but it's a very difficult material to form and to produce. So utilisation of titanium across industry has been growing but it's not been like it. You have the copper ages you have the iron ages, you don't have the titanium ages.

Dr Anna Ploszajski [13:32]
Where might our listeners have met titanium in their daily lives, what sort of thing do we use it for?

Marie-Pierre Paquin [13:36]
The biggest use of titanium, the upside is, to is using paint, it's a pigment. So let's say you move into this new flat this new apartment this new house and the previous owner had the great taste of painting all of it in bright red, and it's not quite to your taste, and you're trying to paint it white. So you must buy the the paint that has the highest titanium dioxide content. So you will get away with only two coats of paint. So if you're two or three coats of paint, that means maybe the level of titanium dioxide in the paint that you bought it is below. You will find it also in sunscreen, toothpaste, Oreo cookies.

Marie-Pierre Paquin [14:20]
Oh wow.

Marie-Pierre Paquin [14:21]
It's an additive in the plastics to get the colour or the opacity to plastic also. So there's a lot of application of titanium dioxide in our everyday life.

Dr Anna Ploszajski [14:32]
Why don't we make everything out of titanium?

Marie-Pierre Paquin [14:34]
The cost. As Rudy alluded to, it's, it's a very expensive metal. And the reason it's very expensive, it's the way to produce it. It's challenging. It's not an easy metal to produce. So to manufacture like very precise pieces like those that will go into a prosthetic. You need a lot of machining.

Dr Anna Ploszajski [14:55]
And is titanium itself a scarce resource? Like is there enough in the world that were the costs to come down, we would be able to use it in loads more applications.

Marie-Pierre Paquin [15:04]
In fact, titanium is the 9th element in abundance in the Earth's crust. So there's quite a bit of it, just to give a reference is about 100 times more titanium in the crust, then there is copper.

Dr Anna Ploszajski [15:18]
Oh, wow.

Marie-Pierre Paquin [15:18]
Yeah, so there's throughout, there's a lot of titanium. In the earth crust, there's a lot more titanium dioxide out there to be, to be recovered.

Dr Anna Ploszajski [15:30]
If for some reason, for some reason, these processes were deemed, you know, not green enough or too expensive, or we just can't make titanium anymore. What impact would that have on you, Rudy? Like how would modifying your prosthetics so that they didn't contain titanium effect you?

Rudy Garcia-Tolson [15:48]
You know, earlier in our conversation, we mentioned that prosthetics used to be made out of wood. And although having a wooden leg would probably allow you to walk down the street, walk around in your house and give you that mobility that wouldn't work best for activities and sports. Now, when it comes to the prosthetics nowadays, as we, as we talked about, you have the carbon fibre which is a very lightweight and strong material, but you also have the, the insides of the knee that the frame of the knee which are titanium, and now the attachments which are titanium as well, how does the knee attach to the foot? How does the knee attach to the socket? And these attachments, adapters are very important for, for me with prosthetics because I need to make sure if I'm doing, if

I'm running, or if I'm jumping off a big rock or a ledge my leg is not going to crack and split. So I think without, without titanium in my legs, I don't even want to know what type of activities I likely would not be able to do because of the forces that come with having prosthetics.

Dr Anna Ploszajski [17:07]
Right. So we we never want to go back to the wooden legs, is what you're saying.

Rudy Garcia-Tolson [17:11]
Exactly.

Dr Anna Ploszajski [17:13]
But it's interesting that you know, titanium, although it is very abundant, it does come with some challenges. And Marie-Pierre I wonder if you could outline for us, what are the key challenges that you're finding at the moment in terms of ensuring that we do have a sustainable future with titanium?

Dr Anna Ploszajski [17:15]
Titanium all the way.

Rudy Garcia-Tolson [17:22]
Exactly.

Marie-Pierre Paquin [17:28]
There's many challenges around titanium but in around the mining and metal extracting industry in general, and a lot of them are common, but some of them are specific to the titanium. One of the specific challenge to titanium is that there's only a fraction of it that we can recycle. So everything that is like a prosthetic for example, end of life, you could recycle the titanium out of it. But for all the paint on our walls, we don't yet have like the technology to scrape the paint and recycle that titanium dioxide that's in there. So you would say above 90%, 95% of the titanium that is extracted from the earth will not be recycled. So if I was to say like, what's the big challenge for the titanium but the mining industry in general, is how can we propose projects that are acceptable for the community that owns those project that the community feel that this is bringing value, and this is a positive thing that comes their way and don't look at it like a negative project. For that we have to design project in a different way that they were designed 50 years ago and make sure that we take into consideration that concern and the total impact over the full cycle of the operation, either the mine or the refining facility. All this will integrate into the community, how will it be closed? Because it's from day one, we know it's going to close at some point. So always is going to be closed at the end of life. How can we make sure we do that in a responsible and sustainable manner?

Dr Anna Ploszajski [17:28]
Sure. And it's sustainable from a human perspective, a societal perspective, but also an environmental perspective, right? Is there a decarbonisation aspect to the equation as well?

Marie-Pierre Paquin [19:20]
Absolutely. That's a big one. Every step of the value chain of producing titanium or titanium dioxide, there's an impact on the energy consumption and the greenhouse gas emission. So if we think from the beginning, so you have exploration, then you have the mining. So in mining, what happened then you have the diesel in the mobile equipment, so you have those big haul truck to carry the rock, they are burning diesel, so how should we think about those, how can we decarbonise those truck? One other aspect which is really critical and can make a big difference is how we improve the recovery? So if you were to disturb a piece of land to extract a valuable metal, how can you extract all of it not leave anything in the waste or in the tailings, then you need to go to smelting. But in the process of doing that you are emitting CO_2. And it's an integrated part of the process. So if you want to remove those process emission, you really need to think about how you're going to change the whole industry, how you're going to change the whole process.

Dr Anna Ploszajski [20:25]
So we know that in a sustainable future, all of the things that we're producing, and buying and making and getting rid of all of those processes are going to have to be less carbon intensive, we're going to have to massively reduce the fossil fuels that we're kicking out in the atmosphere, etc. In this highly complex system that you've described for us, what are the opportunities for decarbonising? What's the stuff that you're working on that you think is gonna make a big impact to reduce those carbon emissions?

Marie-Pierre Paquin [20:54]
One example I could give you of, we have a great team working on it at the moment, the smelting of ilmenite, that we're using carbon, so how can we replace carbon, it's not just a matter of putting energy into the process, we need the chemical power of removing how to generate from the iron oxide. So how can we do it in a different manner. So we're currently investigating the possibility of using the CO gas, which is a byproduct of the current smelting process to remove one more oxygen. So the CO has the potential of becoming CO2. So could we use that as a reductant. And the way we look at it is we are going step by step. So when you want to make sure it works, we will most likely do a proof of concept in the lab, some basic experiment to make sure the reaction happen that the the energy balance work, then we'll do bench tests, probably simulation and calculation before we go full steam with the full investment because those process are very expensive. So it is a really a systemic approach that needs to be taken to make sure that we're doing the right thing.

Dr Anna Ploszajski [22:10]
Rudy, listening to our conversation. A lot of this is new to me, and I'm sure there's lots of aspects of this that you've probably not even contemplated or heard of, is the sustainability of your prostheses, something that has ever crossed your mind?

Rudy Garcia-Tolson [22:25]
You know, I guess you can say, I've been quite naive on how my legs have been made, and what it takes to get just a little adapter made and the processes that it goes through. So it's quite interesting to hear, where we get it from, how it's made, and how can we make sure that we're, you know, being smart about how it's made, and to reuse it. And, you know, one thing about prosthetics is that, you know, although the components, the sockets are custom made for one individual, the adapters and the feet and knees can be recycled and reused to other individuals. And I think that's an important part of our industry, the prosthetic industry is to make sure that, you know, when someone no longer has a use for the foots, or the knee or the adapters, that we're able to find somebody else to use that because they have a long life, and they're very strong still. [musical interlude]

Dr Anna Ploszajski [23:31]
So as we've heard in our conversation, you know, prostheses have come a very, very long way from the wooden legs of pirates, certainly on to sort of Rudy's Paralympian adventures. And it sounds as if these technologies are not slowing down in their development anytime soon. Marie-Pierre, what can we expect from titanium in the future?

Marie-Pierre Paquin [23:53]
I think there's great thing to come, while I'd like to mention is additive manufacturing. But if we are able to make the additive manufacturing more useful and widely used for this type of part, like the 3D printing, for example, that would allow titanium to be used in a lot more application. And by using more titanium and different type of application for mobility, for example, you would decrease the weight of the truck or the car or the plane. And by reducing the weight, you also have an impact on greenhouse gas emission, everything becomes more efficient. So I think there's a lot of application that will become more affordable, we'll be able to use more titanium, but we have to be able to do it in a sustainable way. So all of the work and the challenge I mentioned to you there's a

lot of very smart people working and looking at it and I'm sure they're going to solve it but it's going to be challenge and, but I'm very hopeful and very enthusiastic about the future of titanium.

Marie-Pierre Paquin [24:17]
And Rudy what's next for you?

Rudy Garcia-Tolson [25:08]
Well, I will continue on my mission of making sure that when individuals are new to being an amputee, that they understand what will be next, how we can support them along their journey and really get them back into the game of life and continue surfing and skateboarding, swimming and doing what I do. So with my prosthetics.

Dr Anna Ploszajski [25:33]
Awesome, thank you for being with us, both of you. Thank you.

Marie-Pierre Paquin [25:36]
Thank you.

Dr Anna Ploszajski [25:37]
This has been Things You Can't Live Without with me Dr Anna Ploszajski. Follow Things You Can't Live Without on your favourite podcasting platform and join us next time for more material stories on where our stuff comes from.

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