**Katherine:** Welcome to our latest IOM3 investigates. This podcast is based on a webinar from the IOM3 Elastomer group and this podcast we hear from an established company, Elvis and Kresse, which specialises in creating luxury products from waste, a company that is just starting out, is harder. Biomaterials which creates leather substitutes from brewing by products, and finally a PhD student looking into the issues of sustainability surrounding trainers.

If you want to learn more, please listen to the full webinar, which is available on demand and the link in the show note first up is Kresse Wesling CBE.

**Kresse Wesling:** So this is a tiny island and we are still landfilling about 40 million tonnes of material a year.

I think that should tell us we don't need anything new, that all the stuff we already need is already here, especially when you go to some of these landfill sites. We just completely lack the creativity to pick up the materials that we need and use them for whatever purpose we've got.

So the first material I fell in love with was a fire hose. I saw that at a landfill site and I thought why in heaven's name is I here? So I went to Croydon, which is where in the UK all fire hoses go to die. They are all sent to a hose and line shop in Croydon where their semi-retired fire service personnel, they look at each hose, if the hose was extruded 25 years ago, they scrapped it. So that's the health and safety life. If it was extruded less than 25 years ago, and they can repair it, they repair it and send it out again. If not, that's it. It goes to landfill. Or it did until 2005. The reason why fire hose goes to landfill is because it's a double wall nitrile rubber jacket that is extruded through and around nylon woven core and the way that process works.

I've seen it so I can't technically tell you what, but it's actually a mush that gets squeezed through the nylon, so you can't strip that back, shred the whole thing and start again. It is as one. I thought this fire hose is very fascinating.

In London, we probably go through about 3 tonnes a year. If we're just talking about natural end of life. Scrappage. But that is up to 10 tonnes a year that we've had. If there's lots of fires, so the worse it gets for London in terms of fires and riots, the better it gets for me in terms of raw materials.

I spent a lot of time down the road at the Business and IP Centre at the British Library and I was trying to get to grips with what is nitrile rubber. What can I do with it? What are its properties?

What I found at the British Library was one piece of paper that sort of changed my life, and it was about two French luxury brands that use nitrile rubber in their collection and have done since the dawn of complex polymers. And I thought I can make luxury goods.

Then I started looking at the luxury industry and if you think we've got problems in waste, luxury has real problems. Because it's an industry that masquerades us extremely creative and is actually inherently destructive, it's bad for people. It's bad for planet, and I would call it a structural failure.

Financial success underpinned by total societal collapse because that is what its success is predicated upon.

This took us about five years to make. We started with belts. They were long and straight, very, very easy to do, needed a very minimal amount of equipment, effectively an electric pizza cutter.

We made our first rentry bags and actually, we made our first bag. I sold 200 pieces by going to events and saying I can sell you this bag in six months If you buy it upfront.

The other interesting thing that we do, and I know this is not very scientific. It should be. I should write a case study on this.

We donate 50% of our profits to charity. 50% from the fire hose range goes to the firefighters charity. A lot of people think that's a lot of money and too much money and maybe not a sustainable amount of money. It's entirely sustainable and probably why we still around and why we're successful.

There's 66,000 fire service personnel in the UK. They all have friends, they all have families. There's websites like uniformdating.com because people want to date people in the fire service. So we're talking about a community that is filled with heroes that people want to associate themselves with and that was the community that we built our business at the heart of.

So from day one we had that cohort as brand ambassadors. You cannot buy that, but you can acquire it through goodness and generosity. So there is a business case for generosity, which over 18 years I think we've probably proven to be accurate.

And we get to 2010 and we had solved the firehose problem. So as long as we keep going, we can rescue all of Britain's firehouses. No problem. That's the sort of scale of where the business is.

And that made me think, well, let's take on a new material. So to give you an idea, now that the company is at 12 materials that we rescue on a daily basis, but in 2010, we were still just one and we started looking at leather waste. The reason we started looking at leather waste is because companies cut out the shapes that they want.

This is generally true of pretty much all textile manufacturers and the off cuts go to the cutting room floor and largely earn incinerated or landfill.

We started receiving a few samples of other race I made a few phone calls within about 5 days. I realised that there was probably 125 tonnes of leather waste a month that I could pretty easily get just get for free, instead of coming up with a brand new material.

We came up with a geometric shape that you can interweave to create pretty much any size of hide that you want. The biggest piece that we've made from leather scrap is the back wall of a hotel lobby in the states that is 10 metres high and 40 metres long and the cool thing about this is that I suppose in 2010 when we started doing it, people were talking about the circular economy, but nobody was really designing for it.

And the best thing about this rug is that when you don't want a large rug anymore you can take it apart down the middle and make small rugs. If your dog chews one piece out of the corner, I can replace it with another piece. You can take high traffic piece high pieces from high traffic areas and move them to low traffic areas. So even before you recycle this or reuse it into a new item, you can make this again and again and again.

You can make cubes. Which are not super interesting, but that was our first thing we did. That was 3 dimensional with the leather waste and it is stuffed with the smaller bits of leather waste. So they're super heavy and make great door stops. We can upholster furniture and we can make bags.

We give 50% of our profits to Barefoot College, where we create scholarships for women to train as solar engineers. These are largely women who've had no education ever in their lives, no access to education. We do not do seasons. We do repairs for life at cost, which means any repair is. The cost of the repair is just time.

And our aim is to keep things in service as long as possible. If you have one of our belts and you lose a little weight or gain a little weight, we do not ask you to buy another belt. We extend the belt. When we shorten the belt for you and we have it, we have a way of finding you. If you own one of our belts and you try and order the same one again, we have set up a algorithm so that an e-mail. Those two and says what in heavens name happened to your first belt because they should last a very long time. So we're not actually trying to sell more stuff. We're trying to change what culture defines as aspiration and success. And it isn't stuff really. Although at the moment if you go on to social media, that's what it looks like.

**Katherine:** So, if we have enough stuff already, what else can we do with waste? TJ Mitchell talks us through a search for a solution to by-products.

**TJ Mitchell:** And so today I'm going to talk about my journey becoming an entrepreneur, founding author and our innovation. New grain leather, an animal and plastic free leather alternative derived from the proteins in waste grain.

So I finished PhD, went travelling for a bit and I came down to London and I joined this programme, Entrepreneur First, and in this programme I met my Co founder Brett and Brett is brilliant. He is from the biotech space, specifically on alternative proteins and he understands all the innovations, all the crazy ideas going on there, all the different lab growing. All the ways to just alternative protein for plant-based burgers and things.

And Brett was looking for a synthetic biologist. He wanted to, he he's the CEO of our biomaterials, he was looking for synthetic biologist but found a chemist and I came in. I came in with a whole different series of ideas to allot these problems and together we teamed up quite quickly and we wanted to work in the sustainability space.

So we were coming up with different ideas, really trying to work out where we could find our niche and the programme itself was based in South London in Bermondsey and someone said “oh, you're in Bermondsey. Go chat to the Brewers because there's eighteen of them in the line on the Bermondsey Beer mile”.

So, we went down, chats, Brewers, good lads to give some free beer and they told us all about this problem. They have spent grain, so the breweries for about every hundred litres of beer they produce, about 20 kilogrammes of spent grain.

They've extracted the sugars to make beer and they leave behind this protein rich biomass and actually the small Brewers themselves pay to get rid of it. It's a big problem. Large Brewers have so much of it, they can actually leverage it and sell it ss cheap animal feed. So we're thinking, OK, this is cool. There's a whole supply of this material that is being undervalued and it's protein rich and there really aren't that many waste sources that are protein rich. So initially we explored OK, let's extract this protein and use it as a feedstock for plant-based milk, plant based meats, easy peasy.

The industry is looking for new protein sources because the two main ones, pea tastes bad and soy, it’s an allergen, and it's linked to deforestation, but it quickly became apparent that there was a whole series of things that would make that incredibly difficult. First of all, turning waste into food is a regulation minefield. The next thing is apparently doesn't even taste that good once you've extracted it and then the feedstock itself is quite variable and varies too much to make it suitable for food which needs to be incredibly standardised, especially for the applications and plant-based milks and plant-based meat.

So we're thinking, OK, food is just a material that we eat. What other materials are there? There's fur. There's silk, there's wool and there’s leather.

And interestingly, because this is being used as cheap animal food, it's already going to the leather supply chain and the more we looked into leather realised it's a quite a nasty process. There are so many different elements in the industry which aren't sustainable.

So first of all the grain itself is being fed to the cattle. Billions of animals every year of animal agriculture, and it is a misconception that leather is a waste product. It's actually, a by-product, about 10% of the value of capital can be derived from the sale of the hide.

So all of the different components that come from the cow are subsidising the continued use of animal agriculture. Furthermore, taking those hides and again putting them through the modern tanning industry is incredibly resource intensive and uses a lot of toxic creations. Things like chromium salts. Often this is done in the global Soith where the regulations aren't strong enough.

And the chromium comes off in the runoff water into the waterways. It's often used as irrigation poisons people and the crops, so they need that.

What alternatives to leather are there really? The first one that comes to mind for most people is that you can leather surely exists it's plastic.

It's just plastic, really, and it's not biodegradable, contributes to microplastic pollution. Actually, designers hate it. No one really likes plastic leather.

But there has been a series of quite amazing alternatives that have been spoken about things such as mycelium leather since using mushrooms, the roots of mushrooms to grow materials, and this is a remarkable bit of biotech and it's been used for lots of different applications.

But about 10 years ago, hundreds of millions went into this application. It hasn't come to scale. It's a difficult process.

Yes, it's expensive and it will be almost probably trapped in the premium space if it actually does get to commodity markets. And then before that, you've seen in the last 20 years loads of exciting leather alternatives and these are great stepping stones to sustainability. Things like apple leather and mango leather and any of these food or cellulosic feedstocks, but unfortunately they are mostly polyurethane and plastic derived.

And then you also have lots of the cool biotech turning ones, things like completely lab grown leather taking the cells from a cow and actually growing it in a lab and again hundreds of millions have been sunk into companies doing this. But it's just so tough. We are many decades off this working and even lab grown meat itself is struggling and incredibly expensive.

So what if we could turn this spent grain to leather? Funnily enough, we're actually in a place called the Leather Market. And so this is down in the south of London. And this is actually where they traditionally turned an exchange for leather.

So Bermondsey for those who know itself, London apparently used to stink for hundreds of years because that's where they turned hides to leather. But those those industries have been lost, left these shores long ago, and it's now replaced by the modern day brewing industry.

So the Bermondsey beer mile, we can go down the road and collect our feedstock of spent grain.

So we can emboss with different patterns, we can use different leather understandings of how the material actually works, going beyond the lab characterization into looking at things like stitch strength, how it drapes, how it feels, and how it just works in the same way that traditional vegetable tanned leather is edible.

And then we cast into sheets, and then we can apply different finishes for the dyeing and backings.

Katherine: And now María Munguía-Romero describes her research findings related to footwear.

**María José Munguía-Romero:** How big is this market? So actually the market value of the trainer industry is valued on 75 US billion dollars. This is a big, big amount.

If we compare it with the luxury watch market, it's eight times bigger. Is this a worldwide industry? Well, it actually is. The three countries that manufacture the most are Vietnam, China and India and who are the people who consume it the most? China, the US and the EU.

We as consumers look for comfortability in our trainers. We want trainers to be resistant, to be light weighted, to be flexible, to be durable, and all of these characteristics are they are fulfilling specific things in specific parts for trainers. So if we want our trainers to be flexible, we want this flexibility to be on the Rover so they can be comfortable. We also want this to be breathable in the open.

And on the lower part, we want them to be resistant, OK, so trainers can be divided into upper part, which the upper part will give the comfortability to the body of our feet. We have the two legs, the over the throw box, the thong, the lining, the padding, the core and the heel. These are mostly the most important parts of the.

But the water they are made of, it's it can be later cotton, polyester, polyurethane. All stain or PVC as you can see there are many materials involved in the manufacturing of a pair of trainers and it's only for the upper part. Then we have the lower part, we have the midsole and the outsole.

And water the materials in gold on it. Tippu Rubber 88 and PVC. But what do we need so many materials in the manufacturing of a single?

Each of the materials involved in these specific products have different properties, different characteristics of fibres. We have leather, we have plastic, we have elastomers. All of these materials have different properties. As I mentioned, and in order to have the best shoe and to be able to fulfil all the properties we need for them to be functional, we need to consider different aspects of our materials. So what is the big problem about?

With different challenges across doing this study, the first one was the deconstruction. Because of the high number of materials on a trainer, it's difficult to tear them apart to separate them each of them. The second was the adhesive. Why? Because adhesives, they are meant to stick materials together so they are not supposed to tear apart or separate easily. That's why it's so hard to separate them, but in a way, it leads us to material recovery, which means all of this material, even if I get to separate them, I cannot recycle them.

Because they are all covering these six or coatings. And as I mentioned before that the construction was really hard part of it, if I want to recover the material separate and classify them to recycle them, it's a big challenge. So how can we solve this problem? Sustainability is based on three pillars, planet, people and profit.

We can separate them and then we can translate these ones on real cases. We can have materials, manufacturing techniques and design. So first the materials, most of the materials I found on this study were petroleum based materials.

Most of them can be recycled, but because they are not meant to be, they cannot.

Be happening for this also all the materials involved on the manufacturing of trainers require a lot of energy to be produced. Energy that at the end ends up on landings. Then we have the manufacturing techniques. How we produce trainers, how we make them more sustainable so we can start.

Looking on how can we do this? How can we reduced the amount of energy and resources we put on them and also how can we make them more recycle? Finally, we have the design that talks about the deconstruction we are meant to design for deconstruction in order to recycle the things we produce. Design can also have a big impact because if we think about.

How much of the things we're using and how? And it it begins. Everything with the design. If we are not thinking on these problems at the beginning, then it will hardly be solved. So all of these things I have guided you through there?

Connected together the answers and that solution for this problem is not a one single thing. It's a mixture of materials of design.

How can we improve? Would like to share with you some solutions. Some cases that are based on the things that I discovered as I was going through this research. First of all, repairability take one element that is not working and then put another element to repair it. Then we have this Assembly first this robot that can be disassembled, trainers and.

Why does this robot can do it? Because they were meant to be made to be disassembled. There's also recycle.

Areas most of the materials we saw during the case were petroleum based, so there's a way to find recycled materials to use within these trainers. Another example is the disassembling. As I mentioned, this trainer that you can see they are not made with the basics, they are just made to be.

These assemble putting put out and they have no coatings, no basics on them. As I mentioned, another solution would be more material products. This will mean that we can recycle the whole material.

Do it more precisely and we won't need any disassembling. We won't need any extra steps to make this happen, because we will be able to have the same material on the same product. Most of them forget that. The important thing that is disposal, what happens at the end of the life.

Of all of our products and I think this is the main issue with everything we have and specifically with the fashion industry as consumers, we have a lot of trainers, we have clothes, but we really don't take in acknowledge what happens when these are disposed.

**Katherine:** All three talks show the need to make better use of resources and think carefully about manufacturing processes to find out more, please view the full webinar. Links are in the show notes.