

UKRI Interdisciplinary Textiles Circularity Centre [EP/V011766/1]
Materials Circularity Research strand
WP 2.5 Integrated textile fabrication and circular design
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Redacted transcript

Activity 1

Group 1 participant A

Facilitator (F): Do you want to share with you what materials you have chosen.

Participant: so we can start with those feedstock, because it starts with the feedstock.

So we kind of ranked, but not particularly in any order, but we prefer to use textile waste, because we already have an infrastructure for that with our joint future partners.

We already have, like pre-consumer waste accessibility, and then they have mechanical recycling capability. What we felt there are certain drawbacks in man made cellulose comes from mechanical recycling, but we can eliminate those through this step, so we can access to more refined cotton with maybe higher degree of polymerisation, which later can be used for further mechanical recycling or can go through the same process.

I think just to add on to that, there's like, I guess some broader circularity element there's an opportunity for us to take accountability for textile waste that we might be creating as a brand and the ability to recycle that.

On crop residue we would have a preference if possible, for like second or third generation, so that we're not competing with other food streams, and not getting into those very complex challenges, and then also municipal waste; it's not really a hierarchy, necessarily, but it is just a way of ranking them all.

I think the third one completely depends on logistics and infrastructure.
That probably presents the most challenges from a refinement perspective [the municipal waste].

The material that we chose is the bacterial cellulose derived regenerative fibre.

And then, with regards to some questions around, what clothes and accessories could you use the material process for?

We kept it quite broad to be honest, and thinking that it could be any replacement for cellulose base material or product. But generally more kind of MMCF derived materials, and they have tons of different use cases across apparel and accessories.

Where do you like to go to manufacture or source this material?

We've put Europe. Because it's close to our manufacturing so there is some kind of lower impact associated with that the logistics would hopefully be more simple.

And there's existing supply chains. There's also the greatest scientific expertise in this space in Europe rather than in the rest of the world.

It's great to existing infrastructure and then, if we're thinking about textile waste there's also going to abundance of textile waste that we're generating in in those areas as well.

And then the durability, we kind of have divided the durability into 3 aspects; First the durability we consider during before manufacture it has to go through a certain set of textile processes that the material should be able to withstand but that it is characterised based on the end product.

And then the next one is product durability, when you wash it, when you use it, what's the rubbing durability, what's the washing durability and stuff like that?

Included emotional durability. How do you associate product lifecycle, trend analysis, creating a product that people want to use for a long time, so the materials durability and product durability and then within that there is different facets of it as well so not necessarily a simple answer on that one unfortunately.

How durable do you think it would be?

It depends entirely on the manufacturing method and the use case of the product.

The next question was around whether we thought the material or process would be expensive or affordable?

With any of these new materials very expensive in the first instance when being produced on a small scale, but hopefully could become cost effective. Which kind of links into the next questions around consumers?

This is the question around how it would be different from existing material you work with?

So if it was able to be a drop in to existing man-made cellulosic for example, at a pulp level in terms of the cost of it, theoretically could be cheaper when scaled, because you wouldn't need to create a whole other supply chain. When it comes to affordable or expensive, I think the strength 'of a full-sized apparel-focused brand' [redacted] has is its communication channels with consumers. So if a 'full-sized apparel-focused brand' [redacted] can make awareness about the science, or the newness of the material, and how it affects the whole ecosystem of environment or waste. So I think generally people might buy into that? So once you scale it up, you replace the existing man-made cellulose infrastructure you would assume that other manufactures will sort of move to this space rather than sticking with viscose and lyocell. I think that kind of answers the question about how your customers would react.

And do you explain about the impact side, the process impact?

No, I guess. Yeah, an interesting question, open question which relates to *what else would you need to know about the material* and *do you have any other questions about the impact of all of these different processes?*

Yeah, But if we are adding like 2 processes in front spinning. So you have a dissolving step to extract sugar, so what sort of chemicals can you use? So what is the impact scenario for that?

And then microbial cellulose, microbe part. Are you using GMOs or non GMO's for that and whether you use multiple microbes? Or would they use multiple chemicals based on your input, so like what the visibility or provenance?

So the last one. *What else do you need to know about this material process?*

So, but we also felt, so let's say, we have existing spinning infrastructure so if you need to build two separate plants for sugar extraction and microbial cellulose production you know

that there would be like huge capex involvement like if you are creating a startup then your start up would need a lot of money to build these plants

But if you can use existing infrastructure or chemical engineering infrastructure to derive those chemistries then happy days.

So the second bit we circled design, adapt and remake so it's like more of a circular idea.

So the designing process we started out with our cotton waste that then it goes sugar to cellulose and then sort of in links with the adapt part, because there can be process limitations so you might have to consider that when you're designing a certain product. But if you can overcome those limitations so you sort of have to link the product with the process, then you have a tech spec and should be able to read that.

And then we'd have to adapt our designing process to make it more circular. So if we are using the same process to extract microbial cellulose from it so we need to make sure that it goes through a monomaterial approach. Otherwise the whole chemical degradation of sugar becomes a lot more complicated process if we include traces of polyester or other synthetics in it so we think we should educate the whole on this process.

The third is a remake. So basically we collect a pre and post consumer waste from this microbial cellulose textiles then send it again through the same process to rederive microbial cellulose.

Facilitator: great, you designed the process.
Thank you very much.

Group 1 participant B

I also went for the bacterial cellulose; kind of selected both the wet spinning one and the growing one.

Just because, I couldn't decide but ended up being a bit more interested in the growing one.

But yes, similarly to 'a full-sized apparel-focused brand' [redacted], I was kind of thinking it could be a replacement for any of the MMCFs we use at 'a full-sized apparel-focused brand' [redacted]

We are like a very cellulose heavy business probably over 80% of our total fibers use is cellulose based and 65% of that is, Viscose, an MMCF [man made cellulose fibres].

Yeah, that was quite broad, so what we're known for at 'full-sized apparel-focused brand' [redacted] is socks so I kind of went down the sock route and intimate apparel, because, that's part of the reason we use MMCFs is because they're absorbent and comfortable and soft and lovely.

So I feel like that's where we would wanna use a yarn like this. We would properly want to, ideally we would use our [company] products again would be great, because they have a really high cellulose content.

So, Yeah. And then sourcing-wise, similar to everybody else we have all of our, we have long standing supplier relationships and supply chains set up in places like Turkey and Portugal. And so, yeah, being able to source the materials from there would be useful.

But then also a lot of you know the feedstock. If we were, it was coming from our post consumer textiles those would be in the UK so there are some challenges there around sourcing materials.

And then, same as everyone else, in terms of affordability it is going to be pretty expensive to begin with.

But hopefully, you know, saving on using virgin materials like bamboo and trees is gonna be saving money in the long run.

We find we struggle with durability with our MMCFs. We often have to blend our viscose with other materials, to make it kind of more durable, or to perform in the way that we need it to. So that would be a concern. But interestingly, talking to you earlier about different ways that you could, you know, impart more strength into the yarn and construction techniques would be really interesting.

Yeah, our customers are quite engaged.

But we tend to find things like circularity and sustainability are nice to have; they are a nice bonus but the product absolutely has to be right and has to perform, and has to be comfortable and has to be at the right price.

So those would be the key things that our customers would be looking for rather than circularity. I don't think a lot of them still understand what circularity is to be honest.

So, yeah, that was that. And then other questions I had were: yeah, like around durability. How would we get the yarn to be more durable?

If we needed to blend the yarn or the fibres with other fibers, how would that work?

And how would we get around the challenges with the supply chain for that?

I'm really sorry I drew a really silly sock. I was just kind of just in a similar way to you guys thinking. Could we take the cellulose out of our socks, which often have kind of 7, 80% or more cellulosic content? Could we extract the cellulose from that turn it into bacterial cellulose and then turn it into this yarn and then knit it back into a sock. And yeah, I thought that was really interesting, that you're saying about the mono material, because yes, 80% silly less at the moment but we use a bit of nylon and elastic for the strength in the sock.

So if there was a way that we could look at getting some of those performance attributes from this yarn. That means we could eliminate the nylon and the elastane , or if we could look at the knitting technique or the construction of the sock that would allow us to eliminate those elements of the composition then, and we could do, make a monomaterial sock that could just go around forever. That's it thank you.

Group 1 participant C

So I chose the hand spun bacterial cellulose yarn.

So I thought that the fibre could be used in quite a few different ways at the studio, in like a tight weave for more of a shirt or kind of like a sample that you showed, like a denim sort of feel. And then looser weave with the plain weave and pulled thread which is this sample for more textile based pieces.

And also did wonder about the potential of knitting with it as well, because there was another similar yarn that might work like that.

Then, in terms of where we'd want to be able to where we want to be able to manufacture and source of material from, I think, in an ideal situation, it would be the UK in terms of keeping everything within our immediate vicinity. I'm keeping the fibre supply chain miles low.

And then, yeah, in terms of working with any new materials, I think that would be a very nice thing to incorporate. If that could be where it's made and then obviously there's the producers, that are mainly UK based at the moment.

In terms of durability I thought they would be quite durable

But I think it'd be interesting to consider how well it would last in terms of washing, and customer care and also in terms of the repair of it as well.

Because I guess in terms of like if people wanted to patch it or anything, it might not be a readily available material and yet, its longevity in terms of a garment I guess as well.

I'd expect it to be expensive, as he was saying to start with and then potentially if it was scaled that the price might decrease over time. I assume that the handspun bacterial cellulose yarn is quite labour intensive, because it's handspun so I'd assume that would increase the price as well.

And in terms of whether it would be different for us to work with. I think the questions would yeah first would kind of be the cost because of the handspun I assume that would make it quite high. And the fabric care would be really interesting to think about in terms of we like to think about how our customers can care for their garments in the lowest impact way to the environment possible. So like what's the suggested care for this material when it's made into a garment. And then like, yeah, then, like how the locality sourcing so whether it could be made in the UK or in the southeast of England.

And also in terms of maybe I'll come back to that in terms of the feedstock, as well.

I think customers would react really well to it, and would be really excited and interested in it, because especially with the hand spun bacterial cellulose yarn in my mind, it's sort of like fusing the 2 things of like, the obviously the hand done labour intensive fabric fibre and then also this kind of you know the idea of like new fibres and how not new yarns and how that could be made. And I think that's quite exciting, and so on a customer side yeah, because it's sort of those 2 things that could be quite interesting in terms of the future of different fibres.

And then in terms of what else we would need to know about it again. I think the costs in terms of the financial viability, and the process involved in creating it, which I think you guys touched on like the chemicals or any development processes that might have come into that process of making it.

And treatments, and like what kind of chemicals might be used, or anything like that?

And yeah, that and also the original source thing. So that takes me back to the feedstock.

So I think ideally, the bio-municipal solid waste. Like in an ideal scenario, it would be amazing if that was close to the place that it was then made so in terms of communicating that to customers as well, and also like what that bio-municipal solid waste is, whether that's like food waste whether it's mixed whether it's from.. i know it says municipal but is that from

like cafes? Is it from like people's homes I think that could be quite interesting in terms of thinking about that and in an ideal world the output of that would be from the same place where it was then made, which would then be close to where we were then making the [garment?] common] and selling them.

And then I guess this is like a sort of second choice.

The post consumer textiles could definitely be interesting. But I think when we tried to do work with post consumer textiles before it is quite challenging sometimes. Sometimes it is the supply streams and the crop residues. I did have a thought that we're working with a lot of natural dyes, and if it was natural dye crop residue that could be quite interesting but again then it's like trying not to be in competition with things that could be problematic.

Then in terms of the application. I was thinking that it could be interesting to make designs from the archive and kind of trial out designs that are already in existence but with this new material and also incorporating zero waste pattern cutting as to not waste any of the [inaudible] as it is a handspun yarn. I couldn't stop thinking about knitting with it, but I know that that might not work.

But yeah, definitely like trying to think about creating like knitwear and knitwear accessories with really low fibre miles, and from the bio municipal way seems like a really nice story.

And then, yeah, exploring new designs that might only be specific to this kind of fabric, which I guess this really beautiful plain weave and pulled thread. I don't know, it just seems like it could be really applicable to some really interesting, like experimental textiles, or like kind of more like a concept kind of pieces.

Thank you.

Group1 participant D

So I chose the mesh electrospun cellulose and the clothes and accessories. I was trying to think more like about the scale of it, the bio reactors that would potentially be able to make it.

And so I put down tissue paper, medical absorbent curtains, dressing gowns, and burn wound dressings.

I think, because you're developing it in a bioreactor there is a really good opportunity to be able to impart extra components like micro encapsulated specific molecules that could be used for special things like burn wound dressing so you can impart essential amino acids or other things in there.

I would hope that it could be manufactured in a local drug phase to empower local supply chains.

But then, also, if you have smaller scale bio reactors that could be used at any location, so it could be used in space on the international space station or into the new frontiers is or even on the battlefield, it might be that someone needs to spin a specific wound dressing with certain embedded ointments in it, and they need it there and then.

How durable this material? like I was asking questions about how weak it is like how would it do in ambient conditions? How long can you keep the cellulose in solution for in a stockpile ready to be used? Hopefully, it could be manufactured from waste, food, and biomass.

Do you expect this material process to be affordable and expensive?

I expect it probably will be, at scale I imagine it's incredibly affordable, but the R & D journey and the capex to get this to scale and then down to smaller size reactors might be quite long and expensive.

Curious about the biodegradability, the toxicity, the strength when wet, and the ability to embark in part molecules into the material cell.

Other questions related around bacterial fungal growth on the material itself, and whether there are any residues of the bacteria in the process and manufacturing of it, and in the electrospinning how easy is it to impart other things into that.

So I have a little drawing here of someone being dressed by wounds cause they're a burn victim, quite sad, but hopefully they are on the mend.

Group 2 participant E

Yes, so I did 3d printing. I thought it was a really interesting process, and it's kind of spun from, there was a 'international university' [redacted] lab recently did like a 3D printed textile that was really really flexible. And I wanted to see how this could be applied with the material that we're using because we're also using like a polymer. And so it'd be interesting to try 3D printing so trying and see. It is hard because the company that I work for we are a B-to-B business, so I think what we're trying to do is understand the limits of our material, because it's never been made into a textile before, and so trying to understand the different processes that can be used with it. And we haven't really tried 3D printing yet, so I wanted to just explore it a little bit.

And so once I saw looking at the cards there was like the potential for accessories, and being able to just apply directly onto the fabric without having to sew, and all that kind of stuff.

But then understanding some of the difficulties that could be: like in the fashion and textile industry it's a very established thing, and they don't really like change because that costs money, and that costs time and all that kind of stuff. So trying to think how you could kind of go around that, whether it's like you work for these kind of 3D printed parts, you work with independent designers who use 3D printing, or trying to work with kind of the scalability or kind of stuff like that.

Trying to see what I wrote. I can't see it from this because it is so small. Small scale. And I think the one part of it, so I don't really understand 3D printing. I understand like the process and stuff, but I want to understand, how can you modify it?

Because I mean I come from the textile world. So I know about fibre spinning, I know you can change the fibre cross-section, and you can change how many filaments, and all this kind of stuff. Could the same be done with 3D printing? And how can you exploit those elements to make it, not just beneficial for like the textile industry, and fashion, but could it be for like GeoTextiles, could it be for more industrial processes, you know. Could that be the kind of realm that could benefit more industries than just fashion. That's the summary I guess.

Facilitator: was it also the apply...?

Oh yes, I think the applying it was, I was just also thinking of like corset boning, and like just hats, things where you need something a stiffer material or like shoulder pads or something like that is kind of a little bit more inbuilt.

And then I had like make and adapt, which was, you know materials that could change, you have got like 4D printing now that changes depending on, changes after it's printed, or like, if it's kind of something that's more modular or like smart kind of pattern cutting for clothing.

And then like on the repair side like, could there be, cause I saw a bit about the finishing of the material, could it be like targeted kind of colour repair? Cause you do have those kind of sweat spots where you have like a bleach stain could it be like a targeted area that you can restore something back without having to dye the whole thing again or stuff like that.

Yeah, and a way to repair components without having to like, if you have to redo a zip, you can just repair like one part of it, instead of taking the whole zip out.

So those are kind of the 3 main parts.

Group 2 participant F

The process I chose was nonwoven and the material is natural agricultural biowaste. And I think I was just saying that nonwovens are used in a range of industries, and, particularly with Covid, with masks and things like that the real issue is that it's made with plastics so we are actually producing more synthetic plastic as we try to be more healthy to protect people, you know. So, but that also applies to clothing so I'm quite interested in looking at more natural nonwoven applications of fabrics.

So it could be used in clothes, It could be used in accessories, it could be used in handbags, it could be used in a number of applications not just for the fashion industry.

But the problem that you have with nonwovens is not really durable unless you use a synthetic polymer to re-enforce it in the nonwovens and so, and it is quite expensive, and laborious if you want to research and develop natural solutions. So that's kind of where the thinking is.

In terms of its applications, again it could be used for a range of designs, coats, clothes, but depending on how it's designed, you can have multi-functional uses of the fabric for example from you know wearing it in the city to having a modular kind of adaptable piece that can be used for outdoors, because a lot of people are interested in that kind of in having less but more multi-functional types of clothes.

And having a fabric or material based on the fibres is an interesting concept in terms of a non-woven and then also using nonwoven as a repair process. So you know, if something is kind of worn out then you actually use the process to repair the garments and that reduces.

Yeah, so it's just exploring all types of aspects of nonwoven from the actual fabrication, to design, to the repair and adapting it as well.

Facilitator: Is the repair like a nonwoven darning kind of thing?

Yeah, yeah, yeah. I mean because you see that a lot in the crafts market. Like when you have a pair of socks rather than actually you know, try to redo it. You just actually do a nonwoven repair if you have access to fibres, and imagine, if you can, apply that on an industrial level to clothing.

Group 2 participant G

This is the 3D printing. I would imagine we give an opportunity for having a novel new weaves and highlights and things like that could really make products stand out, and that would be really really interesting for us.

More broadly, I think the ability to kind of take these and actually give the product these unique characteristics. I mean like that slide you were showing of, you know, making the fabric kind of various thicknesses at various points so it falls in certain ways, or you know, reacts to moisture or heat, in kind of novel new ways.

I mean that would be really really powerful from our standpoint, because we're really looking at having exclusively these types of products, these types of materials. And so if we can kind of weave that into the brand of what we're doing, that would be super powerful really.

And then on the manufacturing side, I mean the biggest thing about 3D would be it opens up the door to actually doing kind of bespoke on-demand production, which could be an enormous boon for consumers, because you can then say, I want this particular thing, or whatever, you could be very specific about it. But it, you know the amount of waste in the industry is I'm sure, you know, is just unbelievable, and overproduction, where all these things are made, and you know 30 or 40% of them don't sell, either have to get marked way down or just disposed of.

And so if we could use this process to actually get to a whole new production technique and drive the industry in that direction that would be just enormously impactful.

Group 3 Participant H

So we chose circular denim.

So again it was a bit tricky to answer the question because we don't have any testing on these materials.

So a lot of our decisions normally would be based on: *How durable the material is, or like the care instructions?*

Because we both make clothing so a lot of those decisions always are guided by what we know of the material. In this case we don't know so much but in terms of feeling, and it feels quite sturdy similar, maybe, to linen and hemp before being washed a bit like banana mesh has that sturdy feeling so we thought it could be really good for maybe crinolines or hats. Maybe garments that you don't wash so much, and then, if it could be washed, and it would feel like supple like linen or hemp, maybe it could be made into tops, bottoms, outerwear, shoes, bags, other accessories before washing like bracelets. Or applications that are more sturdy in undergarments.

We would like it because we're both based in the UK. We would like to be able to source or manufacture this in the EU or the UK, and at local local mills, just because we're based here, basically could be maybe processed in this area of the world.

How durable do you think the material would be and why?

We don't know. If it's similar to linen and hemp maybe could be durable if it's not washed.

We think if it's washed and it's similar to 'large fiber company' [redacted], or it has bamboo in it, maybe it won't be as durable, we don't know.

So which feedstock? This is from bacterial cellulose.

Do you expect these material process to be affordable or expensive?

We think it's gonna be expensive maybe similar to what linen cost if it's made in the UK or EU. And we think if it can be developed by you know a big fibre company like 'large fiber company' [redacted] maybe could lower the price down, as a fibre and and yarn potentially, but if it's gonna be made in small productions it is gonna be quite expensive we think.

Do you expect this material process would be different to work with? What questions do you have?

We have many questions. We are very curious about the washing and how it would react. We would also like to see rubbing test, see the durability of it over time. We also would like to know about color fastness when you dye this material, and how it would react.

How do you think your customers would react if introduced to this material?

We think the reaction would be really positive. Mainly for the conscious consumer. We expect that people would question the price if it's too expensive, and the way it looks, I guess similar to hemp and linen. Or jute or sisal, these materials, but overall we think that the consumers are becoming more precious, so we think it's gonna be really positive, and they would wanna pay for it. We hope.

What else do you need to know about this material?

Quality test, we want to know about the circularity, so once it's in a garment or product, and then what happens at the end of the life of that product. Recyclability. The sourcing, so for instance, if it has some bamboo or viscose in it, where is that virgin material gonna be sourced. Manufacturing, location, price, and whether these material can be made with renewable energy in its process.

How do we need to talk about this question, too, as well?

Question 2 is what we can make from it. So basically we thought about the accessories, hats and even the upholstery. I'm gonna talk about sofa maybe with some cushions, and that makes sense for home maybe laundry bag something like and yeah, furniture, well, it's too much about yeah like because it's very stiff without. Maybe the hats, the bucket hats with some kind of design. with stripes. You can cut this fabric into some kind of stripes like that. And then just gonna add to the hat here. Or maybe you can add to the jeans as well.

Design regards to design. We thought we just can, we can add some volume to the fabric, because it's quite flat. So maybe if you do something like smocking, if you know, it is just gonna scrunch the fabric, something like this and if you roll it like this, you can actually create some kind of dress. Yes, so it can be held with some strings, webbing, maybe chain. You know something that, of course, it's going to be transparent, but maybe, if you can wear something underneath, for example, like undergarment underdress yeah, on underdress or how you call it.

Yeah. Regards the *repair*.

We thought as well. It can be used like applications, some pockets on it only to cover the holes for example, so there's some holes in the jeans as well so I can cut it in a round shape, or like a triangle, shape or whatever shape you want like a customised one. Well the footwear as well, appliques, and on the bag as well, and some accessories I think actually make it from there. It's quite good actually it just needs more development maybe and see there, as we said earlier, the test, the rub test here, and how it, and maybe when you saw it like you see how it goes as well.

Group 3 participant 1

Okay, so we spoke about the mechanical recycling of long fibres. And as almost broadly we spoke about how that sort of process would be input into a brand's sort of pre-existing processes.

Relating from the design to sort of the, which we call it the customer journey, the experience, the kind of post-purchase, post-wear almost customer experience.

We both come from brand perspectives. So a lot of what we talked about was how this would be a beneficial process on a local level in terms of cost effectiveness, environmental

impact, and then sort of being close to points of sales, and being close when when garments are being recycled in this process, being closer than being able to try them back into textiles.

Hope this is making some sense and then a lot of what we talk about is durability and then also perception of durability. We know, like the existing processes that exist for this it's hard to maintain the same level, you know, same fibre length and same strength of fibre in in turning into a textile.

So we said ideally, we're trying to, we would like to see this technology reach the point where you basically get on the same standard of fibre pre and post process. And then, in terms of defining durability, we looked at it both from, you know, a lot of how we see durability with garments is that they maintain the same structure in the same form. Basically looking as new as possible for as long as possible. But on the same side there are fabrics and textiles and garments that we think about as durable. When we've actually seen them have been worn and still maintained 'garmentness'. So things like leather, which patinas, or denim which, wears over time. So those sort of 2 flip sides of durability. Both looking new and looking used how those give us the same sort of perceptions about the textile or about the garments.

There's no feedstock obviously in the same way because you're using, you're turning garment back to fiber.

We still think this is like a pretty expensive process. We did not chat a lot about that, it is expensive and that's sort of it. We assumed. But there is definitely, you can definitely see, avenues in which this becomes a much more affordable process, and I think a lot of that would come with the local aspect to being able to do this when you almost downsize the process to being to an almost individual garment level that you can break things down. How that could end up becoming more affordable, more streamlined through that sort of I would it sort of a more personal process of recycling.

More like on this question about the expecting of the material processes.

We continue to speak about how it would be beneficial to have that being done on a local level.

And then customer perception I think one of the there's a couple like it's largely positive I think, and and the view for recycling is it's hard on the surface level to say is that much bad about it. I think there's definitely quality questions from a customer level about the expectation of a recycled fibre or recycled textile and the cleanliness of that, as well, I think often like the triggers that we think about when something is recycled is that it's not as you know, it's come from a different source so is it necessarily as clean? Whatever clean means I think you do consider those things, you know. If you're wearing a recycled textile it's been a textile before what's happened to what are the processes that it's undergoing and then it's and that feeds into quality as well, and being assured that as you've seen something breakdown, and then sort of reincarnate. Is that still a quality obviously you've got an expense as well. So is that quality, can that quality live up to the expense?

We didn't fill out the last slide. But yeah, I think essentially just the like cap it off. I think we were also trying to think of it in terms of what would our customers really want to see in a recycled garment. And I think a lot of it is, what would they expect from a customer journey? And I think one of the things we discussed was, could you perhaps sell that customer journey in a nice way where at the end of life of pair leggings or a shirt, they already know that when it comes to the end of life, that that will already then be maybe recycled into something as a different use perhaps, as you know, an item that they can then have within their home, or they can then make that into something that will clean the home, or maybe something that will be worn in a different way from a leggings to at top, but they know that then that that life cycle isn't ending, and it's just being recycled into something else.

So it would be about the storytelling around recycling, which I think would be the interesting bit which I think it's something which I at least from my brand's perspective, I think, would be a huge sell, which is perhaps quite consumer led. But it would be really interesting, I think, from that point of view. So yeah, it's possible that that'd be sweet.

But we just said that the way that this can be applied is obviously from the design point of view is you know, the fabric use it would make you think okay, should I use elastane, should we use cotton, should we use polyamide, and maybe that would be more of a educated design point of view. And then you said also about like the pattern piece.

We think about feasibility, if you're in the situation we discussed like if you're taking in the garments to directly be recycled, and if you can see that process. How efficient the recycling process can be depending on how the garment has been cut and depending how many pieces you're being used because you're obviously breaking down fibres you would think you'd want the largest sort of, uncut pieces to be going in. So if those design decisions have to be considerations how do you input that into the very beginning of the design process, to think what's going to be most efficient, actually coming out of the recycling process.

And then I guess the most obvious application is to remake something so for us was you know it's gonna be re-made into clothing, or if it's gonna be made into a new experience for the customer and the customer journey around that garment and I think that is something which we were just talking about new considerations of what you can make from certain textiles. So it's trying to change the perception of this kind of garment can be remade into this type of garment which I think is the interesting bit.

Group 3 participant J

Cool so we both come from a more early stage R & D building textiles out of agricultural waste or sunflowers in her case. So we chose a kind of different method we're not used to. It's called growing bacterial cellulose to produce yarns.

So what's cool about it is the experience. It's rough, it has compression, bending, and heat conductivity and also other characteristics. It's abrasion resistant, stretch, tear resistant, crease recovery, and dimensional stability. And we also talked to Roberta. It's her research area and she was saying it's hydrophilic, which is a big characteristic we focused on.

So for the first question, what clothes or accessories could you use the material to make?
So we've first thought of the whole medical hospital area, so could we use it for bandages, because if it's hydrophilic and it's absorbing the water, it's not very useful, for like rain clothes, or things that are exposed to rain. But what about bandages or some sort of medical yeah. And from there we went to like period pads, because if this is recyclable and biodegradable, what if we could use them for period pads or pants that absorb this material or, this liquid. Or, if not, we thought the same area mattress protectors imagine like kids, they're sleeping to protect the mattress. Could you have some sort of blanket made of this material that you could then wash or yeah to protect the mattress. And we thought of diapers same as pads. Kind of another thing it's heat conductivity so what about like electric blankets. Same kind of like medical area and then thinking of like we edit it to have more properties: what about like sun protective clothing or UV or radiation protective clothing. So that was our brainstorming.

Then where would you like to be able to manufacture or source this material from?

So the closest we can to the feedstock sources so we can avoid any transportation costs and carbon emissions and stuff. So if you can be anywhere just close to feedstock so if we're here, so hyper localised.

Then how durable do you think it is?

So for us durability was that it's not damaged in daily life or daily use.

Whatever it uses, and what is it like? Are we able to repair it? Can we reuse it, and does it maintain the form through like wear and wash? Cause of the washing was a big area for us with the hydrophilic. And then it's so this one is abrasion resistant and tear resistant so good durability. But then, what happens? Our biggest question, like what happens after you wash it? Does it dry and like, maintain those properties? Do you have to dry it in some sort of special way, can you, can the consumer just shove it in the washing machine or is it self cleaning.

I mean. Which feedstock would you like to make it from?

So thinking short term, maybe post consumer waste, because we currently have a lot of it, so might as well use it like repurpose it. But thinking more long term we both agree that crop residues because they're always gonna be there we're always gonna eat. It's something that's never going to go, so in the ideal world where we build textiles that can be reused we won't have that fashion waste. But the crop residues are always going to be there, and we're not gonna use any more land or any more water to build them or get them.

Or can I give them? So do we expect it to be affordable or expensive?

So we think about it we're not using raw materials so there's no money there.

We're not using more land. Well, it doesn't take very long to produce it's 2 days.

But you can do smaller turnaround, so avoid waste, and you have less manufacturing steps.

So, although it seems very sciency and expensive, maybe it is in the end cheaper than current processes but we don't know.

And then questions we had.

So how does it react to water? The biggest one. Is it irreversible like, does it, can we go back to how it was? How does the feedstock need to be pre-treated? Are we still using those chemicals for the crop residues like, how do we get those to be feedable into this process? And then thinking of a like characteristics, or things we could actually like.

Could we add UV protection, or like antiseptic. If we think about bandages or hospital area, of course, like color pigments. And the customers, like the hand feel, the drape, the vitrate the driver, of course, important.

And then thinking of the end of life like, is it recyclable?

Again. the feedstock format like, What do we need to fit in? Is it expensive, scalable? And what type of infrastructure is needed?

Yep, and then moving on

So we decided to make either. Well, just disposable was nappies or pads. But we hope that you could put into for a single use, but then can be put into a recycled scheme.

Compression, bandages, bandages for hospital use and also UV protective clothing if you introduce something to it.

Group 3 participant K

So my material was the wet fibre spinning process, and the functional dyes. So started with lots of ideas.

And so what clothing or accessories would I use this material for?

I'm looking at the card and all the description I have taken the assumption that at the end of the day the fabric that comes out of it, or any material that we're making has got the same property as any other cellulosic textiles like 'large fiber company [redacted] as you said or it has got the same, or specially it has got the same properties in terms of comfort, and you know it can be knitted or woven, or whatever. Taking the assumption that it's either knitted or woven and then the fact that it's a wet processing and you're actually adding the dyes at this stage of the when the cellulose is processed, and then actually spinning at the end of it, and making the yarn out of it. Anything yarn dyed, basically, anything that has got a bit of a you know melange yarn, dyed colored effect that you want you can make anything out of it in that case. So started with the idea of what is closest to my current process. That's you know and the fact that you can add functional properties to the chemicals or the dyes that you are adding to the wet processing side of it. You could make anything yarn dyed, you can have the prop the fabric can have any kind of property like antibacterial, I don't know a microbial hypoallergic whatever properties you can add to.

So I'm not a master in dyes and chemical since my sort of thought processes is quite restricted but materials products sorry, run tops, you know any kind of T-shirt, yoga, or you know, cycling, or run. And then I thought, actually, no, it can make pretty much any kind of product. It could be nightwear. It could be kids clothing and then my brain actually went to home textiles and I'll explain why my brain went to home textiles a little bit later.

Where would you like to make it? I think Europe. But, as I thought about it, more and more so at the end of the day. It really depends whoever cellulosic textiles are produced all over the world, so it could be any place which has got the end of the product which is closest to the product manufacturing side of it. Could be, EU could be Asia could be anywhere basically.

How durable do you think this material would be?

And again, imagining that this will be like, I have assumed that this product is going to be like any other cellulosic textiles which has got quite a long life but knowing that this is more, you know, regenerated or a material, imagining you should have at least 3 to 5 years of, durability to me means longevity after the wear and the wash process that should last the customer at least 3 to 5 years.

Feedstock?

I chose the post consumer textile, but then I agree with the thought process there they could be basically long term. It could be any of the feedstock that is closest to the manufacturing hub.

What do I expect this material process to be affordable or expensive?

So that's where kind of a brain went completely in a different direction. So I, my previous experience with yarn dyed materials is that every time you wanna do you wanna add the dyes to the beginning of the process, the end result is a lot of material. My experience is that yarn dyed the minimum order quantities of yarn died, not just because of the process, but also the machinery that's involved the anything that's involved in it. At the end of the day everybody's MQAS [Model Quality Assurance System] are really high, and it ends up making a lot of material.

And I said, oh, where would you use that lot of material?

Because a lot of material and having restrictions on buying a lot of material means that it's unaffordable for small business practices. And then that's when I've been saying that okay, where can you use a lot of material? And that's where narrowing down the thought process into home textiles that a lot of cellulosic textiles are now being blended into home textiles. And then the end result is really lovely. The really consumer centric, and it has lots of other

properties to it. Home textiles make most sense if there's going to be a lot of material at the end of the day, but pretty much if that's not the restriction could be used anywhere.

And yeah, I do think that should be a more affordable process than a lot of others, because cellulosic textiles at the end of the day to cost less than some of the other type of processes.

Do I expect this material process to be different to work with? No I didn't really think that. I think I just questioned the commerciality of the process itself.

And if you're adding the dyes in the chemicals, then is this a commercial process? Is this viable to replicate or not?

And then I had loads of questions like you know.

What is the end result? How much raw material are we talking about? Is it too difficult to process? Is this, what kind of dies and chemicals? Is there enough innovation in dyes and chemicals in that end to be used with this kind of a processor or not. And at the end of the day what is the longevity of that functional element in the dye and chemicals? How long does it last? Is it forever, or is it a few washes, and where? And it loses its effect.

What do I think about the customer?

I think the customer would react, you know, really, positively towards it. But else do I need to know so much what's the handle the strength, the mechanical properties pilling washing, fastness, abrasion depending on that end result of the product and what's the level of comfort? But I think the most important to me, knowing that it's cellulosic and regenerated. It's like the impact on the energy sources that at the end of the day. I associate anything coming from anything cellulosic to use a lot natural resources, whether it's water at the end of the day, or during the process, or whether it's energy, or whatever. So my thing is is it actually helping other than the circularity of the raw material. How how else does it save energy and natural resources?

Products, I thought kids wear, because how hypoallergenic, what you can do with chemicals and dyes, and where you can save? And is it some solution that you can propose to anybody with sensitive skin solutions. And then home textiles and then anything which is, and because you can add functional properties to the fabric through dyes and chemicals, it is that can it be used for other low impact activities. Any kind of activities run yoga cycling with the t-shirts print anything, basically anything.

Activity 2

Group 1 participant A

So we selected our 365 hoodie, the multi-colored thing we have, the famous one.

So we divided **material and processes** into two so the end goal is to create a 365 of 'a full-sized apparel-focused brand' [redacted] brand hoodie with 100% cellulose, and the end of life is 100% recyclable or biodegradable

accidentally if it's thrown into a garbage bin and we want to have natural dyes, and I should also quote natural finishes. And if we need to blend, it needs to be compatible with the whole cellulose as well as end of life scenario. Even if it doesn't come compatible with cellulose it should be compatible with the whole biobased storyline.

Then the **process** we are going to use pre-consumer waste regenerates. Then we derive microbial cellulose from it and one of the questions we had whether it is possible to get the same hand feel of a hoodie we have at the moment from this. So instead of going for continuous filament, we would probably go for staple fibres.

And then, depending on the properties required, you will look at blending it with other biopolymers. Most preferably blending it in the slurry or dope state.

And we also know that there's research going on to dye this using natural dyes in cranfield. So kind of added that instead of dying afterwards, what if we can dye during the dope stage?

And then the last one is adding natural finishes to it at the dope stage, maybe encapsulation, depending on what we want to do. Maybe it is slow release of anti-odor finishes. So that's the whole process that is kind of linked to the material and product as well, so the process should address all the requirements we have in the product.

And then the last one is a redefining of **the process for the end of life**. So we currently do not have any take back schemes. So we should create a separate business model and logistics infrastructure to bring everything back.

And then, once we have everything back, assuming that this is a sort of a biobased material kind of thing. So it doesn't necessarily need to be cellulose because in theory the re-purposing and process one is waste to sugar, so if there are sugar sources in the material, cellulose or any other biopolymer, you should be able to extract sugar.

So the repurposing process 2 we don't want to stick to just cellulose. There are other ways to use sugar to derive other materials. So depending on our product portfolio or product requirements we sort of redirect sugar into different directions.

Maybe microbial cellulose, maybe other microbial derived materials or maybe certain components of polyester then it all goes back.

Facilitator: so yeah totally circular again,
Yes.

Group 1 participant B

Earlier I was thinking about the possibility of using the grown cellulose yarn to darn a pair of socks and fix a pair of socks, which you could do, but nobody darns their socks because it takes too much time.

And so I was thinking about whether you could use like something like the electrospun method to maybe repair a holey sock somehow. I don't know how you would get it to stick or yeah, how it would be scaled up into people's homes, like microreactors or something in people's homes that they could put their sock in, and could just like spray on some cellulose to fix it.

Yeah. That could potentially make socks last longer. Whether that would be like a cost effective thing to do I have no idea, but yeah, holey socks are definitely an issue so maybe there is a way to use that cellulose to repair them.

And yeah, that's pretty much it on that one and then just with the kind of ways to improve it. I was kind of thinking about how to how to make that circular sock again, and thinking about whether that would be ways to add stretch and recovery into the material; how you could make it finer and stronger; and also how you could ensure that it was super soft and had the luster and the drape and basically would be, you know, up there with a 'full-sized apparel-focused brand' [redacted] sock in terms of comfort, and suitable for for what the customer would need.

So those are the 3 things I would need from the yarn I suppose. And then I was also thinking about quick drying as well. But that was going off on a bit of a tangent. But yeah, that would be another way I would improve the material.

Group 1 participant C

So I was thinking more about starting *here with the developing [worksheet]*.

The new possibilities I think was something I was exploring earlier in terms of like the new possibilities of the design process so zero waste garments to kind of you know use all the material, and knitwear, and potentially like some more experimental textiles.

And in terms of the process/the material having impact, and how long the products would last for?

Hopefully the material would be really durable. And we'd want to test it first to check that it was durable because I guess the other thing is that this material wouldn't be widely available to repair or kind of remake the garments.

And so I was also thinking that hopefully we could provide repair opportunities, potentially with the garments. Like whether that's even just giving a little swatch of the material with the garments so that people could repair it more easily and have that material available to them. I guess unless it was so widely available that you could just quite easily find it.

I think it could create a point of differentiation for the brand, because of reducing fibre miles and also the kind of the story behind the fibre being supplied and sourced locally and also if it was kind of developed from the local bio municipal solid waste as well.

And then in terms of the future materials, products and manufacturing scenarios where the application of the material..

And I think yet again, it would be the current products remade in this new material so it will be like, maybe existing shapes, and existing silhouettes and garments remade in this material almost like a new line of like, exploring that material maybe as like a capsule collection or something like exclusively made from that material. And I think that would be really nice in terms of communicating that to a customer and like exploring the material and the possibilities of it as well in different applications so whether that's in like yeah a more woven application in a shirt or whether that's in a knitted piece or a textile piece and then it's like look at all the different ways that we could use this hopefully. And yeah zero waste garments and I guess also thinking about the duality of that meaning like zero waste in terms of pattern cutting but also potentially zero waste because the fabric is coming to waste.

And then I think I didn't get as far with this one but *improving the material and process*, I think durability would be really important, because the material cost would probably be quite high. So I think that that would be something that we would be really thinking about and the ongoing care of garments.

And then also I was looking at the textile experience and it did mention roughness here so I was thinking about the softness and that feeling against your skin, and whether it would be a material that would work for lots of different garment applications or not.

Group 1 Participant D

So further to the last points I made. So I was like at the process, and if there were smaller scale reactors, you could have the electrospun cellulose produced like in frontiers, so like harsh environments, space, battlefields and the author point of care manufacturing, so in the hospital they need it to be produced. So the products then essentially would be used for one off. And that can be done because it's got a cheap feedstock, and it doesn't really have much labour required for it. Of course, there's a whole R&D journey to get to that point.

And then for the design what would make it better? And so I kind of saw it as these three stages. There is the solution before it's electrospun, and you can play around with that

solution to impart different components into the material itself. So the route I went down is with micro-encapsulation. So, whether for delivering specific molecules or absorbing from the environment, you could have these micro-encapsulation agents embedded within the material. And then, for the point of care, I would hope that there are microscale reactors. So I draw a picture here with a microreactor for every family, a happy family with a little micro reactor.

Yeah, that's it.

Facilitator: Thank you.

Group 2 participant E

See, this is on the develop side of it. The new possibilities for the material. Yeah, I think it's mainly based on the cards about altering the material properties, which I thought was quite interesting. And how you can have, maybe like one basic basic textile that can be, you know, changed like the surface can be changed for like multiple different industries. And that could be really interesting in terms of if you make it stiffer, if you make it more fluid, or kind of stuff like that. And kind of creating this kind of buildable and customisable library for manufacturers, brands, customers, whoever they want.

And the process impact on how long the product lasts?

Yeah that's kind of hard to say depending on how it's used, and kind of who uses it? But say for like the altering material properties that could be you know, the durability, could be an issue if it's like in a garment form, because it's being used quite often, and because it's a raised surface it's very, very prone to kind of abrasion and it being washing away. So that's I guess, another kind of care element that hasn't been considered yet, depending on the use.

Differentiation for brand or role?

Yeah, so like in one way it's, if you could see kind of measurable benefits to it being in, as a production side of it, whether it's kind of through an LCA or it's through energy, and how much is being used, or stuff like that would be good, cause I know, like with, yeah, so that would be fine.

And then I guess secondly, it could be the relationship with the customers, and building a kind of greater brand recognition. So say, with like the repairability side of it, you could have like these kind of repair workshops, where they have like on-site 3D printers, and you can repair it how you want, and that kind of builds that you know emotional durability to a product, which kind of hopefully leads to less waste, but who am I kidding.

And then I guess, with the future materials, products, manufacturing scenarios?

So I thought kind of at scale I mean it's again like building materials, and I mean it's already being done like creating modes of transport and stuff like that. And how they could be kind of shared globally. Say like with 3D printing, maybe you only need to share a file, and that you reduce like shipping, and hopefully Co2 emissions along with that, and kind of there is little things I think you can do, like associated with manufacturing, that are kind of more beneficial.

Group 2 participant F

For the nonwoven methodology of fabrication I just think it would create a new fabric. And then, once you have a base fabric, you can apply all types of possibilities on it: laser cutting, kind of 3D printing. But until the fabrics are there you can't really explore possibilities. But also, I think it enables different aesthetics as well. And also the process of making the fabric as a process of repairing as well.

So in terms of whether or not the process will have an impact on how long the products last? I think, it could again, the life of the product can be extended because the repair method is the same as the methodology of making the fabric.

And the impact for my brand and our role in the market?

Most definitely because we're centered on natural materials and biowaste in agricultural industry, and the brand is also known for fabric innovation. So unlike most brands that actually have to source fabrics or work with a third party to make fabrics, we start with the material, and then make the fabric, and then sell B-to-C, and B-to-B. So, it would really help the brand, and it would also help us to help other brands.

In terms of what this can enable in the future?

I think it definitely can enable new manufacturing supply chains, new machines, new lines of fabrics for the industry, and also offer more transparency and credibility, and looking at ways of being more sustainable and more collaborative within the industry by having this type of process.

Group 2 participant G

This is the 3D printing. I would imagine we give an opportunity for having novel new weaves and highlights and things like that could really make products stand out, and that would be really really interesting for us.

More broadly, I think the ability to kind of take these and actually give the product these unique characteristics. I mean like that slide you were showing of, you know, making the fabric kind of various thicknesses at various points so it falls in certain ways, or you know, reacts to moisture or heat, in kind of novel new ways.

I mean that would be really really powerful from our standpoint, because we're really looking at having exclusively these types of products, these types of materials. And so if we can kind of weave that into the brand of what we're doing, that would be super powerful really.

And then on the on the manufacturing side, I mean the biggest thing about 3D would be it opens up the door to actually doing kind of bespoke on-demand production, which could be an enormous boon for consumers, because you can then say, I want this particular thing, or whatever, you could be very specific about it. But it, you know the amount of waste in the industry is I'm sure, you know, is just unbelievable, and overproduction, where all these things are made, and you know 30 or 40% of them don't sell, either have to get marked way down or just disposed of.

And so if we could use this process to actually get to a whole new production technique and drive the industry in that direction that would be just enormously impactful.

Activity 3 part 1

Group 1 participants A and C

We started thinking about the bacterial based yarns for fibres um textiles and then, we started with our original kind of flow through. And then here we've worked in the post consumer textile waste from a theoretical take back scheme and then developed that in the fabric and the textile.

Facilitator: do you want to talk us through your original process flow first.

Yes. Okay, so we started off with thinking questioning weather the textile aligns with the designer's values and ethics at the beginning happens in tandem with the design idea and

then the kind, of like textile choosing with all the kind of elements of that, like whether it supports from ect., happening in tandem with the design sketch and drape and form. So those things are happening kind of at the same time.

Then, at the same time that the textile has been chosen, creating the pattern and then sewing a a toile, and then going into sample production and approval, tech packs, volume production, with a sort of offshoot of recycling from any off cuts from volume production, and then going around to distributing to stores, purchasing by consumer and then shipping and then the use, disposal, landfill. So this is kind of like a very typical, with like a small offshoot of recycling.

A very linear model.

So in this instance, using the bacterial cellulose like starting with, I guess, where the textile aligns with the brands ethics and values, that's why we then chose to go with that. Then the collection of post consumer textile waste, extracting the sugars from that, feeding the sugars to the microbes, from the bacterial cellulose to get the spinning and then the yarn formation. So then you kind of, I guess, it is changing it from being a design led idea to more of a product led in terms of, or a material led, sorry. In terms of we have decided this is the material we're going to work with. So from that point then we do all of those kinds of questioning suitable for the proposed form, and the kind of desired handle and stuff like that. And then we settle on the specific textile from that material composition that we've chosen, and then it goes into a similar design process, very similar sampling, and tech pack and all of that kind of stuff, same distribution stores, same way of purchasing but then the addition is that we have a takeback scheme, and as part of that takeback scheme, you either have the donation or not really we're not focusing on donation too much.

We focus on resell or recycling. So those that can't be resold go to recycling and the recycling then obviously goes back to the very top of the post-consumer textile waste helping to close the loop within this process.

Just to add one more thing: At the spinning and fabric formation, we have the freedom to consult designers and R&D team just to have an idea on what sort of product it's gonna look like, rather than pushing what are the materials that comes out of bacterial cellulose. So you can basically refine these 2 steps to maybe derive multiple versions of fabrics so then you can as [team member] said.

Group 1 participant B

The green Post-its are the second task when I was thinking about the cellulose. So all of the white ones are just the current, our current process, which is, yeah similar to yours, pretty linear.

But we start with the concept, or the need for a product, or the opportunity for a product, commercial opportunity for a business, and that's where we always start. And then we will end up doing research around the concept or around what fibres and fabrics, whatever we might need for that product. But then, rather than, I think a lot of businesses start, maybe with a more detailed design concept, but we will always start with the fabric, with group B. And we have very specific records requirements for our fabrics. They have to contain bamboo based MMCFs. So we'll select a textile, or what happens more often is that we'll develop a textile in collaboration with the supplier or fabric mill.

And then that will go, these are the squiggly lines, because it's usually an iterative, and it goes around a few times, and we yeah, we usually have to do a few different versions of textiles, and we kind of assess those, see whether they're suitable, then we start the design process again, kind of keeps going around.

This is like in person, as messy as it is on this board usually, the development process. It goes like round and round, everyone pushing, pulling, trying to figure out the right thing. We always include wear trials and lab testing in our development process as well, and eventually it gets approved, manufactured, to the customer. And then, yeah, I do have a donation bit in there because at the moment we offer like a free charity prepaid bag for our customers so that old clothes can go to a charity. But yeah, eventually, the vast majority of them, apart from our fully recyclable outerwear are not recyclable so they will eventually end up, probably in landfill or incinerated.

And then, although I should have put that in there, actually, we do have a range of fully recyclable garments. So they would get, so we have a takeback scheme for them, and then they go get recycled, back into fibres.

Anyway. Then I went into the cellulose. So I was kind of yeah I was thinking we wouldn't have any landfill anymore. And customers would either, we would offer a takeback scheme, so clothing would come back through us, or potentially in the future it could be disposed of through like a normal textile, like a normal recycling route and end up like a taken to a charity shop, and end up at a clothing aggregator, or sorting facility, and then get sorted, and then end up at the place where it will be all turned into bacterial cellulose, and then that will end up going somewhere where it can be made into new fibres. And then I kind of made a link here and here. Cause this is this would be crucial for us is that our manufacturers who we are developing fabrics with, and who we are manufacturing fabrics with, must be able to source these fibres, so we somehow have to make that link. But yeah, if we can make those links, then those fibres can go back to the start again.

And then I also just added in when in the second part of the task, I was talking about the electro spun idea with the cellulose maybe being able to repair a sock or something, so we can potentially, have a repair system in there somewhere, and also, if we could just do like a spray on sock or spray on dress, then you could potentially produce on demand instead of doing volume production.

Group 1 participant D

So this is in regards to the material we're developing. So it all starts with the farmers, and they produce grain, which is going to brewers, and the brewers use the grain and they make their beer but they also produce brewers' spent grain, which is a barley extract well, essentially just barley with the sugars extracted from it.

We're able to produce new grain prototypes which go to customers so fashion companies who have ideas, they take these prototypes, they do vigorous testing to see whether it's acceptable, whether it's not, it'll go back to prototypes and exchange the specs and this is a feedback loop.

But when it's ready they will put it into production and approve the sample, and then we'll know the iteration of the material we will need to make, and then we'll be able to start mass producing some of that in pilot facility.

Manufacturers will make orders of the material we produce. They produce their items, their garments, and then eventually they go through to disposal, whereby you can go through anaerobic digestion, it could be sent to landfill where it would biodegrade, or it could actually be tilled right back into the fields where it would be decomposed and act as a fertiliser and so the biodegradation fertiliser feeds all the way back at some point back to the farming and the loop carries on.

F: Do you want to talk about the electrospinning? [and how this could feed into your process?]

I tackled the electrospinning to some part, which is actually quite funny because this arrow here, didn't mean to pass over, but really this does feed into the bio-reactors. So there are larger bioreactors and there is R&D to get to smaller, micro, bioreactors. These smaller bioreactors can either be implemented straight into hospitals and other frontier spaces like space, or Mars or somewhere where they don't have the production of material. However, it might be that actually from these bioreactors you just send them sheets of biofilms. So either they produce the biofilms themselves, or they get sent to biofilms, and with those biofilms they can electrospin it into materials they need with additives, which would be additives, so that could be like encapsulating agents or other additives.

F: So that bio waste could power a bioreactor?

Yeah that wasn't intentional. It was just that I was running out of space but then I realised that it actually does work.

F: Do you also consider other kind of more resource-sparse areas?

Yeah it could be anywhere, if it is space, like a desert or environments like that.

F: Thank you

Group 2 participants E and F

Yeah, you wanna go ahead. Ok. So this is kind of how we saw the current state of the fashion industry where they start with an idea, and then it kind all flowed from there talking about what kind of textile they want, and then kind of usual process of creating a pattern, tech pack, and having that all go down to mass manufacturing, and just giving it retailers and customers as well, and yeah, kind of what happens at the end of life is kind of, all of it, does inevitably just end up in landfill. That's just kind of the base of it at the moment. Yeah, but everything kind of just goes down to that lovely state and so we kind of thought if you could start at the end what could that look like.

The whole idea was to prevent what we create from going into landfill so how can we create something that's disposable, recyclable, with the take-back, renewable, and repairable, and then design based on that and with the material innovations in mind.

And introducing that into the end product, and aligning with this premise of the brand, and then choosing the fibres, the textiles that support the braces of that with longevity in mind, designing and creating the pattern but instead of volume production, it's small scale production.

And we did go into depth even about the toile, just doing just one rather than versus many, and then using that as a basis for all the fabrics, proving it, and then going through a kind of made-to-order manufacturing process.

And meanwhile educating the consumer all throughout the process and once it's delivered to the end customer. Then they're also educated on how to repair and mend it, and if it's still not wanted, then they can donate it, or we sell it. And it, you know, comes back to the original design concept in the brand values. So that is what our circular business model will look like.

Group 2 participant G

So we're just thinking of this in terms of not how we would design and make the products but how we would cajole the brands into making and designing products that are regenerative and can go through a circular process.

And so the idea is that we get the brands constantly reviewing and analysing everything new that's going on so they're fully informed about this. And then they are able to gather data on kind of consumer preferences about certain materials, how these materials feel, kind of durability they tend to have, all that kind of thing.

And you know we're trying to force them into kind of an ethical basis around circularity so that they make that priority in their selection process, and how they're incorporating all the different aspects of the product. And then they actually start making the selection. And then you know the exact textile and then these are all kinds of you know the key questions they are asking when they get to that point. You know, can it be constructed to be repairable and regenerated? Right, the handle, all that kind of thing.

And before we get over here, where they pay that selection.

You know our process is really, you know, very straightforward in the sense that, you know, as people go to acquire the items, we give them the ability to find a product, and then we have new and used, side by side, and buy or rent, side by side. So for any given product you could either buy or rent a new or used version of that product. And with that we also communicate to them very clearly what the sell back value of that thing is, and the idea that they can capture that sell back value without any effort at all. So we actually weave this into the checkout process so then paying for this, I'm able to use previous purchases as real time currency, so that they're able to make that connection right up front.

And then there's a whole kind of use interaction phase we didn't put in here, but everything's tagged within the C chip. Everything is kind of engaged with, so that we have a fighting chance of getting actually a 100% take back here, and everything goes back through, and then to the maximum extent possible we're cycling back through to this phase which comes back to how is that product designed? How is it built? You know, is that material something that could be easily and efficiently cleaned, repaired, put back into use.

And then ultimately things will reach the end of life, and then we bundle them and take them not just to a recycling centre but to the specific processor that was chosen up here to provide that material. So everything is going to become a contracted player that actually regenerates it for the next generation of garments.

Once we introduce this fabric [3D printed lattice]. Yeah then we're kind of looking into specific questions, can we make it unique? Can we actually do it on an on-demand basis, and not as a mass production. Can we do interesting things with it if you know, giving it certain patterns, or weaves, or whatever. And you know, can we do certain treatments that will make it longer lasting? Will work through this process in a more efficient, productive way.

Group 3 participant H

I would start from visual search. So basically, where I get the visual search is exhibitions, art exhibitions, trade shows, online research, something like that. The trend as well, is very important as well for me.

Participant: Can I ask what kind of brand you have?

It's like more urban, clothing, accessories, some belts. I could make from scratch or I could make from the recycled materials as well. I can give you the page.

Yeah. So basically design idea and then here it's like, if it's coming with my brands as well like, if this fabric is good for the brand as well for my ethical values.

This one if we using this material here [circular denim], and then I would do the sample production as well. So to try how it is like, with the stitches. You know I need to just see because it's a new material so I would do research more here and then it goes to final pattern.

But basically, as usual for me, design sketch here of the idea design sketch, and then buying the fabrics, doing the pattern, sewing, or checking the quality of the garment.

Then I need to do the photo shots as well. Because I need to put everything on an online store, or sometimes in the social media, usually in the social media as well. In here sometimes. I do rentals as well for photo shoots, working with other stylists and designers as well. Collaboration.

So when it's done online store then ship to the customer, and then they give the feedback. This is completely new option because I'm not doing that yet. I'm not sure if I'm gonna do it. But maybe I'm gonna do it later. It's not there.

But recycling yeah, basically they send it back the old item. Depends how the item is like, if it's damaged. Of course you cannot recycle again, like, because well, for these like major recycling, you need like the big manufacturer or something. So if you are alone like you're doing everything yourself then basically you can upcycle some bits from here into recycling items.

Cause this one is a new item from the new material here, and this is from the old one, I mean from the charity shop, for example, they can buy from the charity shop as well, or recycling materials, remake reconstruction here, add some details as well, sewing garments, I still need some photoshoots and online store etsy for example. And the rest is the same.

Oh, basically. yeah, yeah, I know maybe it's easier than the others there's no big manufacturer here. It's like I'm alone here. and i'm doing everything. Yeah, that's why it's like this one now basically.

Group 3 participant 1

We did a kind of collaborative approach. We were kind of, did this flow. But it kind of sits very much in line with both our brands it is perhaps more seasonal and more pieces we have a 6, 7 piece collection So it wouldn't happen that often but we are both solo founders. So a lot of it is working directly with suppliers or manufacturers directly.

So I guess the initial bit was coming up with the design idea and then trying to ask yourself questions around does it fit with our ethical values? Does it have the right fibre content for a T-shirt or for a legging and trying to figure out with myself and my production manager, maybe with your suppliers. And also does the textile support the proposed form. And I think also, quite crucially, being like consumer-led brands also how does it feel, and I think that leads a lot of the decision on what textiles to use and then that goes on to trying to actually do the drape, the form creation, creating patterns. Myself, I would not manage that bit. I have a production manager that takes charge of that as I don't know what goes into it. I think like I don't know personally, I'm not experienced in that.

But it helps them figuring out what kind of drape works for us. It would be different sizing. So how should it fit on the woman's body trying to see how a larger size would fit and then so. And then also trying to actually then put through the order. For us we manufacture in Portugal, so getting our initial purchase order form, and then hitting go and paying the deposit and that would feed down to sample production. So we're trying to get few samples

and move in here, put back and forth, because basically, as often the case, as you design something, if you try it and actually have to tweak it, and that can be several several times, that you go over and over and over and over until you find the right fit and then you just go ahead with one, because you're never gonna get it perfect basically. So you just gotta go with the one that feels the best in your gut, and then you do hit go on sample approval, the final pattern and then here is just we kind of fed into a bit kind of get your photo shoots organised ready for your website, or if it's for wholesale depending on which which business model you have, and one thing also we tie into this space is packaging.

So trying to make sure you've thought about you know are you gonna be using what kind of hang tags, what kind of care labels, also your the actual bag like if it's compostable paper. All the little add-ons as well within your actual shipment to the customer. And then you start making them basically. And then that would be distributed to either D to C directly by the websites. We upload everything for e-commerce for us it's Shopify. It's a pretty easy transition, but still take the time trying to make sure you upload all the right images and the right quantities, and then and then you hope that the customer buys basically. Purchase by consumer.

And I think here was the use phase yeah so here's where it basically depends on the model for for us. We've got a takeback scheme which we've worked with partners called [redacted] and then we also work with the seam. So they're London based and they're a visible mending based service. So that you could just sort of invisible or visible mending which will be more about what customers start using which should be really exciting to try and get them to use more on leggings, to try and get like some visible changes to them if there are holes or anything that seems to happen.

And then to try and avoid it going to the bin and into landfill, it would go offshoot like that.

And then, with our proposed process, was recycling. So mechanical recycling into long fibres. We said that here would be, the main difference would be maybe through this take back scheme it will go to a local recycling point ideally within the UK so that we keep that control from the product. So we don't lose control completely and for it to stop going abroad, and we don't know what ends up happening with that. And ideally we would like it to be in a perfect world just our product. So there's not there's less infiltration from lots of fibres that you just don't have control over. So it would be a customised output maybe so well haven't figured that out. But yeah, it's a lot of like, finger in the air and the yeah recycling, and then that would be straight back up to the top, which either goes back into let's say the same type of clothing or maybe I think in a better way, would be made into something different, like a T-shirt, or yoga mat, or something. So it would take a different form, which I think would then stop feeding back through the same cycle about testing and all the above.

Group 3 participant J

Because it's a more R&D stage of fabric manufacturing. So we started with ethics-led design. So what plants or crops are good for the planet, and then we go down to, and sort of the bio manufacturing. It was very similar to the bacterial cellulose that we had, and I've lost where I am going now sorry cause we swap the over from what we had before.

So my process is really about extracting the cellulose from the crops and then testing it, and that's the stage I'm at at the moment, and I think it's similar with you which was very similar to the cellulose. Sorry I'm very bad at explaining.

So for mine I started with like farmers grow their crops to eat and then the agricultural waste is extract, or we get that, and then we extract the cellulose from that right now we would go into the dissolving phase, and after a dissolving, spinning process, and then we would get the fibres, fibre characterisation, and then we would test the tensile strength, elongation,

diameter, everything, and then we would distribute instead of the stores to another, to other businesses, so we really focus on the material and getting up to the fibre, and then that someone else's problem.

If we put the bacterial cellulose in instead of the material we're using now and the process. It would take the cellulose extraction, dissolving and spinning steps out, and instead would have the feedstock preparation from that agricultural waste, and then growing the bacteria on that feedstock so to get the fibres, so we would be positive because you wouldn't have all those chemicals involved with you still have to prepare the feedstock, which I don't really know how it works. But yeah, no, that's what the rest of the process would stay the same, basically.

And I think we looked, and we said that the design phase comes in like several different steps in this as well. So it's like designing the feedstock preparation as well as designing, like how the bacteria grows as well as designing like, and then how it is then made into something else like is it knitted, woven or nonwoven. So the design idea is basically what material to use and the process. So in this case, the bacterial cellulose instead of like, I'm gonna create a T-shirt with these characteristics. Material-led then, yeah exactly.

Activity 3 Challenges and opportunities

Group 2 participants E and F

I guess like when we were just talking it was like there's a lot of stuff that's like outside of the realm of this space where it's like making sure there is effective communication and collaboration depending on who you speak with, how you need to change. So you have an idea you need to change how you speak about it to investors, to different scientists, like engineers, you need to speak about it to different people, so that can be like a huge challenge as well as value alignment. As a small business you need to try and find investors that align with you but you also want money. So it's just really tough, in a way.

And then we saw there's like a lot of value in like the design kind of side over the human kind of made something that's human-centred design as well as new processes with the technical, and of course, the value of the environmental using existing waste and creating value.

There's a lot of challenges I guess that with the existing culture that this would exist. So it's against the established status quo. And I guess with the kind of material innovation side of it, it could be the scalability, it's a niche process. And you know how does that affect the current landscape? And then of course like with the design, a lot of people haven't been educated to think of this holistic way of thinking. So I think the whole comes down to the whole education side of it.

And then, the value potential with the human would like not using volume production. You kind of have increased health of workers and kind of hopefully no cheap labour although it always finds a way into the society. Then you've got consumer education of it where you have kind of increased awareness and kind of this whole design activism side of it. And with the kind of health and wellbeing but there are challenges in terms of like trying to communicate kind of goes back to the value of kind of what they're doing and of course like affordability, although I've put that in brackets, because if you really want something, then it is doable, it is just trying to, of course, trying to change that behaviour, that kind of established behaviour.

Apart from that, it's all good. I don't think there's anything else that you wanted to add. I think you captured everything.

And then, of course, like the circularity potential because maybe it's just not the product that is being circular, but also through education it's having that circular mindset with the consumers, which is I guess is the most important thing, anyway.

Thank you.

Group 2 participant G

So starting with just the basic *economic* benefit here, is that we're really giving people far more value for their clothes. Everything you're buying actually is being regenerated so you're getting the full value that you don't get today by any stretch.

In terms of *social* benefits, you are really, kind of, you're creating this consumer mindset where everybody feels like they are part of this movement. I'm part of this team that is actually moving the world forward.

On the environmental side, it's, you know, enormous what's going on. I mean, the 'circular foundation [redacted] determined that if you extend, if you double the life of an item, double the use of an item, then you actually reduce greenhouse gas emission by 44%, so it almost is 1 to 1, double use cuts it in half.

Right now there's a dump truck full of fashion going into landfill almost every second, and you would eliminate that completely in a closed loop circular system.

You're also reducing water pollution, water use, all those kinds of things. So the environmental side of this is just unbelievably compelling.

From a human standpoint you're creating, in a circular environment, you are creating a lot of local jobs because you're actually collecting these things, you are processing them within that kind of environment. So you are kind of supporting these jobs and communities. You also are giving people this greater sense of connection with their things where we have this really kind of distorted mindset as consumers today of the things of these things, they don't have any real inherent value or connection to me, I just use them, and I dispose of them, and now you are kind of shifting that whole mindset.

From the technologies in the challenges, right?

Technology challenges that you've got to make some really major changes here. You've got to get NCS tagging on every piece of clothing. You've got to change your whole new data structure, your data structure from a kind of SKU inventory system to SKU only systems. You need to get circular ID, block chain tracing, all of those aspects have to come into play.

From the money side. And I'm very familiar with this, right, getting funding for unproven business models and processes is always really hard. Everyone says, you know, yeah, I'm a risk taking venture capitalist but show me three other businesses that have done this successfully before, right. And if you're really trying to charter new territory, it's difficult to get people to step forward and do that.

And then, from a cultural standpoint, and this is maybe the underpinning to me of all of circularity, is you have to move an entire industry from a mindset of sell more stuff to a mindset of power more use and monetising that use. And that is a fundamental shift that changes your entire business model, I mean you know, the way we model it, more than half of our revenues are coming from resale, rental, repair services. It's not from selling new things and right now, everything about the industry is focused on selling new things.

Group 3 participant H

New thing. So we have like here a challenge in money, which is understanding the cost of manufacture and material, so that the customers know sometimes it's the value as well yeah it of the value of products so they know where it's from, it came from how it was made as well so in that case they will think, Okay, so maybe it can be more expensive, but they know why it's more expensive.

I mean it's a reduced price, sorry, time for production as well. This is the opportunity. Because you know the material, you work with it, and then we tested it already. So we know how the partners should be made.

Culture wise we have a deeper understanding of material for people so they can explore more how it's made. And from that it can be potential that is, this material, because they know the customers, they know the quality of the material will be attractive to buy more of the item as well.

Recycling option's circularity potential is great. And yeah, the technology so basically all these options are good for recycling with this material and saving the planets.

Oh, yeah social media. So basically, I thought maybe more ads about this material as well on social media that the customers know about it. So as they get to know more this material they can make you buy, or, you know, advertising It's very important.

Group 3 participant I

So I tried to put in some of the challenges and values. I would say the clearest sort of potential of this type of recycling would obviously be environmental. That's the number one. Obviously second would also be the circularity so closing the loop so try to avoid clothing going to landfill some of the challenges.... (audio cut out)

I mean, I think the glaringly obvious ones are like how feasible will this innovation actually be, and how. Actually something I didn't put on, for a small business how easily will it be rolled out for us. Is it going to come at a premium versus me just using my normal manufacturing system. So that would be, that would be a big one, is really sadly, often comes down to cost, and how quickly it can be implemented.

But I definitely would want to do it if it was more of a if it, if it was made easy, more easier to try and and implement. But yeah. All the obvious challenges. Just money, time and if there is a place for it in the market yeah, which I think there is.

Group 3 participant J

Okay, So we did value potential. Well, first and foremost the problems that we have money problems for developing a new material. You always have to find funding and investment.

And then, and then because we are starting with the crop. We have the advantages to farmers are that it brings them an extra income. It's also great for the soil and can be grown with other food crops or is the by-product of the food crop. And it's great for biodiversity.

But, on the other hand, they might have to invest in new harvesting equipment, or they have to work out a new way of collecting waste. And then at the extraction phase there's also the infrastructure problem which is a common theme throughout.

And also for processing as well as as extraction the benefits are there's no pollution as for dew retting there's no chemicals used it doesn't take up arable land, so that you can use it other like food crops.

The extraction process gives you better fibers, and the shorter time frame and the process is circular as well.

And then the manufacturing stage. You can go. Okay. That is, can the fibre use existing infrastructure, can it be a drop-in or do you have to create new infrastructure for it, which then involves a lot of cost, time and investment.

And then there is the design and performance limitations. Does it perform as a replacement or is it a new fabric with new properties?

And then we have the designer so it is a bit beneficial for them, because it's an ethical textile. And they might actually one day run out options if they are using finite resources.

But then there are also limitations with the performance, and it's like adapting your skills to design with the new fabric. And then, finally, the consumers I think we worked out that if you're using something up here which is beneficial to the planet and the ecosystems that you live in, it is going to be beneficial to human health.

So then it's gonna have a social impact and environmental impact. But to get the consumer to buy into it, they might have to spend some more and then it's also promoting another form of consumerism, which can be good can be bad.

Was there anything else? Oh, yeah it can improve water quality as well. If you like not using any fertilisers. Has a lot of benefits. And then health benefits like If you're using natural fibres they're nontoxic so maybe like allergies or any sort of. Yeah, no plastic pollution or chemicals polluting your body.

Yeah, there's other values and changes by stakeholders basically, yeah, cause we thought it was easier. Thank you.