

**Can I Borrow Your Printer? I'm Fighting a Pandemic
(Science During A Pandemic #2), with Jess Cox
Not Another Science Podcast
July 15th, 2020**

General Introduction

Intro music

[Tom Edwick]

Hey guys! Welcome back to *Not Another Science Podcast?!*, I'm your host, Tom Edwick.

Every episode we explore fascinating themes and ideas, talk to cool researchers about their work, and find out about the science being done by our very own staff and students here at the University of Edinburgh.

If you'd like to get in touch with a question, suggestion, or if you want to be featured on the podcast, you can reach us on our Facebook page, Edinburgh University Science Media, or at our twitter, @eusci. You can also drop us an email at eusci.podcast@gmail.com

I've just had a cup of tea, and I'm ready to go.

Specific Introduction

Today's episode is part 2 of a 4 part miniseries on coronavirus, in which we're exploring what it's like to do science during a pandemic, and diving into the incredible response from scientists and students from the University of Edinburgh. Last time I chatted to Max Fourman from the Baillie lab about how our genes can make some of us more severely affected by disease than others, and about the huge open-source study investigating this with COVID-19. It's pretty cool. And if you haven't listened to that episode yet, what are you doing here? Go and listen to it. Okay you can listen to this one first, but promise you'll go back for

episode 1 alright? And make sure to subscribe on your platform of choice so you never miss an episode.

Intro music ends

Before we start, I have to confess I've been a bit of an idiot. After recording the interview for this episode, I forgot to save the audio from my end, and consequently it is now lost forever, somewhere in the digital afterlife. Thankfully we still had the other person's audio, and we've got a great episode for you - there just won't be any parts where I'm asking questions, or making weird noises like 'mmm' and 'ooh' and 'aha?'. Do I feel like a mug? Yes. Will I cringe over this moment 50 years from now? Almost certainly. Anyway, let's get on with the show.

Main

As the pandemic wages on, nurses, doctors, pharmacists, carers, and all the other medical staff are out there on the frontlines, treating thousands of patients and saving lives on a daily basis. Big shout out to our NHS by the way - keep doing what you're doing guys.

Anyway, to protect themselves and to stop the spread of the virus, medical workers need personal protective equipment. These are single-use items such as face masks, gloves, and gowns, designed to be disposed of after every interaction with a potentially infected person. There are also some items that can be disinfected and reused, like a face-shield.

As you probably know by now, there have been serious shortages of PPE in the UK and around the world as a consequence of COVID-19. Well today, we bring you a story of a group of people who saw this problem, and felt like they could do something about it. Because thankfully when it comes to the pandemic, unlike PPE, there is no shortage of good people using their skills to help those in need.

[Jess Cox] Okay, so... Do you wanna ask me - I don't know how this works exactly.

That is Jess Cox.

[Jess] My name is Jess Cox, I study biomedical sciences, I'm in fourth year, and I'm the social media and marketing lead at Augment Bionics.

Jess is part of Augment Bionics, a medical device start-up led by students and alumni from the University of Edinburgh.

[Jess] Augment is - usually - a company that 3D prints prosthetic limbs.

Now you might have noticed there that Jess said that 3D printing prosthetics is what they "usually" do. But as you might have guessed, coronavirus has put a spanner in those particular works. Thankfully they found a way to put their skills to good use, but we'll get to that. For now, prosthetics.

So, normally the team works on creating prosthetic limbs with a focus on sustainability, affordability, and comfort. Jess told me that prosthetics can be really expensive, and these costs can add up when, for example, you take into account that a child will need multiple prostheses throughout their lifetime.

Sidenote: 'prostheses' really sounds like a cool sci-fi film title. Ridley Scott, if you're listening - get in touch with my agent and we can hash out a deal. Yes, my mum is my agent. No, she doesn't know she's my agent. Is she getting paid? Also no.

[Jess] The gap in the market that we identified was that current prosthetics are upwards of 8 grand, for a starter. Which is really difficult. Of course, you know, there is already an inequality gap - people who have disabilities earn less anyway. And especially growing kids might have to have five or six different limbs. We're very interested in working with technology and innovation to help solve inequalities.

This is where 3D printing comes in. The plastic that they use is cheaper and lighter than conventional prosthetic materials, and the designs can be published for open access, meaning anyone can use them.

[Jess] It helps us cut costs because of course, the reels of... Sorry, I'm not a technical person, but the reels of plastic that we use for 3D printing are a lot cheaper than – and a lot lighter too, critically – than the metal that is used for a lot of other limbs. But we are interested in 3D printing because theoretically, anyone with a 3D printer could use our designs, in the future, and create their own limbs. So we're really interested in figuring out how we can get that to developing countries. Like Vietnam has a big need for forearms, as in Uganda.

Unfortunately, when it comes to prosthetics, all too often affordability comes at a price. You might get a limb that looks the part, but isn't very functional. Augment Bionics want to change this by creating a prosthetic arm that is controlled by the wearer's own muscle signals, and gives tactile feedback. These are the things that non-amputees take for granted, and would make the day to day use of a prosthetic so much easier.

[Jess] I think our engineers are absolutely incredible. Of course, I'm meant to say that. But I also believe that because they are so interested in figuring out the ways to make this as light and efficient as possible. And to have haptic touch sensing, and myoelectric sensors on the muscles, so when the stump flexes, the hand recognises it. The technical team do like to keep their secrets to themselves, but there is a lot of innovation that goes on. We don't just copy what other people are doing; there is no reverse engineering of other limbs. We are trying to figure it out from our own standing point.

This is all part of a longer trend towards prosthetics that are designed for what people want and need, rather than what

we think they want or need. At the end of the day, prosthetic design shouldn't be for anyone else but the wearer.

[Jess] If you look at the history of prosthetic limbs, it's very interesting because of course, people have needed them for as long as we have existed, but in the start they were often things that were very heavy and dead, but they looked like arms. The limbs were made to make other people feel more comfortable around the lost limb.

When you speak to people who use prosthetics now, they're much more interested in stuff that doesn't look like an arm but is actually very functional, like a hook for example. Or there's this thing called the Mitt¹, which I think is really interesting, which is a couple of different limbs that you can switch out. One's got a fork, one's got a knife, one's got a wine glass holder, you know? And I think that really figuring out what... Focusing on functionality and what people need rather than what we think they need, is really important to us.

I for one love the fact that forelimb amputees can now get a wine glass holder. Not only does the wearer get to enjoy a cheeky glass of red, but I think this signals a welcome move away from pure utilitarianism in prosthetics, and in design for people with disabilities in general. Designing for wellbeing and joy is equally as important as designing for someone's explicit needs.

Also, a potentially controversial opinion, but white wine is terrible and overrated. Red wine is vastly superior. Those are just the facts and we're moving on. Don't question me. Though, do feel free to send me bottles of wine if you think you can change my mind.

Anyway, back to the story. So the team at Augment Bionics decided to take their 3D printed prosthetic arm to a medical conference, which planted the seed of an idea.

¹ <https://www.wearmitt.com/about-mitt>

[Jess] In February, we took the arm to the 3D printed medical conference in Maastricht. A lot of people were doing really interesting stuff with 3D printing medical equipment there, and I think it wasn't directly related to PPE but it definitely planted, like, "We're doing something interesting, there's a whole community of people doing interesting things." And of course this is before we knew the scale of the coronavirus and how it was going to change our lives. I mean, I remember my infectious disease professor was like "Oh, they're going to close the Uni", in February, and I was like "No way!". You know, how naive were we then?

But when COVID hit crisis levels in the UK and a countrywide lockdown was fast approaching, the team found themselves unable to carry on with their work.

[Jess] So come March, of course everything changed really quickly. The Uni library was closed, our workplace was closed, this team which is already really delocalised was not able to access any of the workshop that we make our stuff in. And obviously, as a medical devices company, we really wanted to help. But it was really unclear on how we could help, because there was so much information – no one knew if this was going to blow over in a couple of weeks... Anyway, it was very difficult. But, as engineers, as recent graduates, as creative people who normally have a lot going on and were suddenly left in the lurch, we had a lot of talk amongst ourselves in these early weeks in March, trying to figure out how we could help.

It became apparent that there was one area in particular that they felt their skills could be really put to good use – personal protective equipment. At the time, PPE shortages were particularly acute – a combination of poor planning and an international gold-rush for limited supplies had left the UK with its personal protective trousers down, and the government was scrambling to find manufacturers.

[News clips from various sources] It is the barrier that can mean the difference between life and death.² It is inevitable that the demand and the pressures on PPE, and the demand for PPE, are going to be exponential.³ There is of course a global supply issue.⁴ Stocks remain critically low.⁵ Health workers have for days been warning of shortages.⁶ But they still can't get what they need.⁷

[Jess] So, one clear point coming from the noise and confusion was: there is a lack of PPE. We were hearing this from the news, but also from medical professionals that we work with, who, as prosthetics specialists, were having to go back into work with Covid patients. Then someone in the team found and shared this article about 3D printed PPE with us, and immediately we were like "Oh, this is where we can help." We had, I think, basically... Was it on Monday, that we saw the article? And then the whole day we spent talking about designs, how we can enter this, and the next day we started our GoFundMe, our fundraiser. And three days later we had more than doubled the goal.

I mean, there's so many different 3D printed PPE organisations going on at the moment in the UK. And I think it's amazing because we're not competing, we're all just trying to figure out: how can we make this product to help? And there was this clear sense of, we want to, we want to be part of this but we don't know how.

So the next question they faced was "what can we build?". Jess mentioned the community of 3D printers all working towards the same goal, and one of the advantages to 3D printing is the ability to share designs. There are a multitude of websites with loads of open-source designs, free for anyone to use with their 3D printer. Using this community fed resource, the team

² <https://www.youtube.com/watch?v=WCRhHuuiaQE>

³ <https://www.youtube.com/watch?v=-1MKPAkL1Zc>

⁴ <https://www.youtube.com/watch?v=Sq3FdcnZfO4>

⁵ <https://www.youtube.com/watch?v=lgLsftCKyzs>

⁶ <https://www.youtube.com/watch?v=Sq3FdcnZfO4>

⁷ <https://www.youtube.com/watch?v=lgLsftCKyzs>

settled on a design for a piece of equipment they felt they could have the greatest impact.

[Jess] So at the beginning we were trying to figure out how to make face masks, but it turns out that wasn't really achievable. But the thing we could make in high volume, high quality, was face shields. For those who are not experienced with PPE which is actually probably less than you would think at this point in time. Yeah everyone's an expert on everything! Epidemiology, virology... Anyway, they're pieces of equipment that can be worn over a face mask to improve protection from any droplets. These can theoretically be used to make face masks last longer when they're in short supply, as they are here. And there is some potential that they can be disinfected, which is obviously really great. They can be re-used.

But if the university lab with all the 3D printers was closed, where on earth would they make the face-shields? Well, thankfully the technical director and co-founder of Augment Bionics, George Dzavaryan, knew just the place.

[Jess] Our technical director, called George, went to his old school in south-west London, and started printing the base for these shields using the huge suite of 3D printers which of course weren't getting used in this school. And that's our workshop now.

You know, fair play to George for heading back to his old school, I don't think I could do the same - I still have nightmares about my GCSE drama final performance. There's a reason I went into science guys.

So anyway, they set up a GoFundMe, and George, along with brother Alex, and Finlay White, another former pupil, went into production almost immediately. They had made their first shipment by the end of the first week and within three days of setting up the donation page they had more than doubled their original funding goal. As of recording they have raised over £100,000 from various sources.

[Jess] We are a small student start up, and we don't have a lot of funds. We do have obviously some which we use for equipment, and for travel and stuff, but we didn't have the kind of resources that we needed in order to make as many shields as we wanted to in the first place.

I want to say – we were fully prepared to use our resources to buy the materials. I think a lot of people were also looking to help, they wanted to help, they wanted something very concrete to donate to, instead of just like, a nebulous “Coronavirus is happening. I don't know how to, you know, coexist with that.”

We are still very interested in making this a donation. The NHS is of course overtaxed, we already know this, and we wanted the stuff that we made to go to places without it being another strain.

I think, a week after we started the GoFundMe, we started production, and then stuff started going out to workers, and we started getting pictures back from doctors wearing them, and it was the most amazing feeling to realise that we were able to intervene in such a short period of time in this critical point.

Originally they were taking orders directly from doctors, who could head to their website and fill out a form with what they required. But with donations far exceeding what they could have ever imagined, they were able to scale up production hugely.

[Jess] At the beginning we had requests directly from doctors. But now, since we've scaled up the operation – which I'll talk about in a little bit – we're now using injection moulding. We are not taking official contracts from NHS and governmental organisations. I think we have a contract with Hammersmith Hospital in south-west London, and a couple more which I can't remember off the top of my head. But yes, the government is now asking us to produce, because we've

upped our production from, I think it was 1000 a week to now 10 000 a week, which is really a different scale.

By switching to injection moulding, they were able to go from 1,000 face shields a week, which by the way is already a metric boat load of face shields, to 10,000 a week, or in terms our American listeners will understand, roughly $\frac{1}{3}$ of a football field. Probably. Don't fact check that.

Anyway, the change of production method wasn't their original plan, but the huge success of the GoFundMe campaign allowed them to take this step. Jess explained to me why injection moulding is better, but also less accessible.

[Jess] So at the beginning, when we were 3D printing, which is obviously... That's where we had our experience, and that was where we had the 3D printers so that was of course useful. It's actually a lot slower than injection moulding, because injection moulding involves a mould in which you inject plastic, so I think each base to the shield now takes 10 seconds to make, instead of 10 minutes, which is a completely different scale. But it also requires a special mould to be made, so there's quite a lot of organisation and capital that has to go in the beginning of this, which is why a lot of people have stuck to 3D printing around the UK, because it can be something that's happening from someone's bedroom, in a 3D printer in someone's house. But yeah, injection moulding is really really interesting and of course now the whole team has become experts on injection moulding, as well as 3D printing.

I recorded the interview with Jess back in April, when the UK shortages were really acute. Obviously a lot has changed since then, but we spoke about what interesting things this crisis had revealed about our society. I relayed an incredibly boring anecdote about flour shortages, and how it wasn't a lack of flour that was the problem, but that mills couldn't get them into the small bags quickly enough. It made me realise just how fragile modern life is, and how we're just a complex mass

of interdependencies. Take away one piece, the whole system collapses. Thankfully, Jess sympathised with my baking woes and got on board with the discussion.

[Jess] One thing that we can take from this is a real understanding of how interconnected we are. Each part of our normal functioning lives relies on so much extra work. And like the flour being needed to be packed into different sized bags, right?

I don't know, I think that supply chains and especially globalisation is something that I've become very aware of, recently.

Societal revelations aside, back in April the team had no idea what the extent of the PPE shortage would be, or how long the crisis might go on for. They just saw a problem that needed solving, and like true engineers they got down to it. Thanks to their incredible work, as of recording they have donated just over 92,000 face-shields, and they aren't slowing down any time soon. With demand for PPE in the UK decreasing, Augment Bionics have set their eyes on another prize - delivering face masks abroad to countries where the coronavirus continues to reek devastating effects. If you want to support this amazing project, Jess let me know where people can find them.

[Jess] Our website is [augmentbionics.co.uk](https://www.augmentbionics.co.uk)⁸, and we have a specialised coronavirus response page on that, where you can see the designs for our face shields, get in contact if you would like to receive face shields, and a donation button to our GoFundMe. We're also on all social media at Augment Bionics, in which you can learn more about what we're doing, and hopefully how we're going to keep this momentum up after the pandemic.

Stay safe, everyone!

⁸ <https://www.augmentbionics.co.uk/>

Outro

Outro music starts

So, here we are at the end of episode 2. I still can't quite believe we're actually doing this, so thank you so much for listening. Now, I hope you've all been keeping it science like I asked, and trust me I know who has and who hasn't. I have a naughty list just like Santa, and I'm not afraid to set Neil DeGrasse Tyson on any of you who haven't kept it science enough.

Huge thanks to Jess Cox for talking to us about Augment Bionics and what they do. Head to their website, augmentbionics.co.uk to get updates on their progress and to see how you can donate. You can also find them on Facebook, Twitter, Instagram and LinkedIn - as usual links will be in the show notes.

The coronavirus miniseries is an opportunity to get your feedback: what you liked, what you didn't like, and what we could do differently, so please don't hesitate to get in touch.

The podcast is brought to you by the Edinburgh University Science Magazine. You can find the show notes and the latest issue of the mag at eusci.org.uk, that's E-U-S-C-I .org.uk.

This week's episode was a really cool story of people repurposing their knowledge and skills to pivot in response to a crisis. Next time we talk to Professor Jamie Davies, who did just the same. Tune in to find out the juicy, juicy details.

This podcast is edited by my partner in crime, Helena Cornu. The awesome podcast cover art was designed by our EUSci co-editor-in-chief, Apple Chew. The intro music is an edited version of Funkorama⁹, and the outro music is an edited version

⁹ <https://incompetech.filmmusic.io/song/3788-funkorama>
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of Funk Game Loop¹⁰, both by Kevin Macleod, links in the show notes.

I've been your host, Tom Edwick. Until next time, keep it science.

Outro music ends.

[Helena Cornu] So Tom, tell me about this GCSE drama performance you did.

[Tom] Oh god, please Helena don't make me relive it.

[Helena] I would argue that the people want, nay, need to hear it.

[Tom] *sigh* Alright, all I will say is that it involved my character crawling off stage, crying over his beloved pet chameleon.

[Helena] I wouldn't put it past you to have a pet chameleon.

[Tom] Then as a final cruel blow, the song Karma Chameleon by Culture Club started playing over the top.

[Helena] Oooh that's rough.

[Tom] Yeah... Oh, and my friend who was also in the play came on at the completely wrong time and messed up his lines. We just had to carry on to the next scene like nothing had happened, the audience must have been so confused.

[Helena] Yeah, I think you made the right call going into science

[Tom] Definitely. The dress-rehearsal was such a success too. Oh well, as they say the show must go on...

¹⁰ <https://incompetech.filmmusic.io/song/3787-funk-game-loop>
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*Sample from Karma Chameleon, by Culture Club, plays.*¹¹

¹¹ Song length: 4.52 seconds.

Reduced quality.

Source: https://en.wikipedia.org/wiki/File:Culture_club-karma_chameleon-28_sec.ogg#.

Songwriter(s): George O'Dowd, Jon Moss, Mikey Craig, Phil Pickett, Roy Hay.

Performed by Culture Club.

Produced by Steve Levine.

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