
SHORT BRIEFINGS ON LONG TERM THINKING – EPISODE 5

WILL INDUSTRIAL BIOTECH BE THE NEXT MAUFACTURING REVOLUTION?

MB – Malcolm Borthwick

KG – Kirsty Gibson

MB Hello, and welcome to *Short Briefings on Long Term Thinking*. Thanks for joining us. I'm Malcolm Borthwick, managing editor of Intellectual Capital at Baillie Gifford.

Curtains, clothes, fridges, face creams, soap and shoes – the ubiquity of oil-based products is astonishing. We live in a chemical world, based on the assumption that whatever nature can do, man can do better and cheaper.

But industrial biotech could turn this on its head. More and more, companies are exploring how they can use biology instead of chemistry in products. It's a topic that fascinates Kirsty Gibson, joint manager of Baillie Gifford's American Fund, who joins us in our Edinburgh studio. More on industrial biotech in a minute, but before we start the conversation, some important information. Please remember that as with all investments, your capital is at risk.

Kirsty, nice hat you're wearing, tell me more about it.

KG Well, thanks very much for that introduction, Malcolm. This is my hat known as the Cap of Courage, and I was given this by a company in the industrial biotech space. As you can see, it looks like a conventional hat, but what is very different about this hat is that it's actually made from 40 per cent spider silk, and this spider silk was not produced directly by spiders, it was produced through fermentation.



So, it's produced using yeast, reprogramming that yeast, and allowing spider silk to come out as a consequence. The protein that the yeast produces is spun into fibres, and it can then be used in a way that's similar to natural silk, which as you can see, despite the fact that this hat has some rather unusual ingredients, it looks like a hat, it's very much conventional.

MB It looks exactly like a hat. I mean, does it feel any different?

KG So this is mixed, actually. This is the mix of both wool and spider silk. So, yes, it's very soft. But it feels very much like a normal hat.

MB So Kirsty, how expensive is the hat?

KG So the Cap of Courage retails at \$198 at the moment, but I think what's really interesting is the potential for someone like Bolt Threads to add additional properties to this hat. So, could you add spider silk that has a waterproof membrane, for example, or could you make it extremely light but extremely warm?

So one of the things that's really interesting about spider silk is it's tensile strength, I think, is stronger than steel. But unfortunately, spiders – if you try and have a farm of spiders to produce spider silk, which they have tried before - they just tend to eat each other when they live in close proximity, so you just can't achieve that volume. Whereas if you can do it this way, you can maybe harness that kind of tensile strength. I think it's – is it Kevlar? Yes. If you could do something with spider silk, theoretically it could be stronger than that.

And I think those kinds of things would make it appealing for someone – those properties are the things that they're willing to pay more money for. And if you can get all of the properties that you desire in one hat, yes, that hat upfront might seem expensive, but ultimately it saves you buying five or six hats for different things, and I think people might be willing to pay that.

MB So you've explained how the hat is different but give me a broader definition of what industrial biotech is.

KG I would probably define industrial biotech as about embracing nature's preprovided toolkit. It's about gaining understanding of the secrets that she's hidden over vast timescales, and humans are learning how to use those to their advantage.

MB It's not a new concept, is it?



KG No, I mean, if we really think about it, industrial biotechnology is not new. I think it was in about 6000 BC that Neolithic man fermented grapes to make wine. And, I mean, since then we've had – we make yoghurt, we make cheese, we have beer, we have wine – and then there's also things like we have enzymes within washing powder, and that in itself is utilising industrial biotechnology.

MB And typically, what are scientists looking to find in industrial biotech in terms of the genetics?

KG I think what they're looking for is they are trying to break down what parts of a genome cause certain outputs. So, a really good example would be if I was looking at something like a flavour or fragrance, and I want something like lemon scent. I need to be able to understand which part of the lemon's genome is responsible for scent. And then I can use the tools that we have in this day and age to remove that part of the genome and then I can insert that into something like yeast, and then allow that to ferment over time and produce the lemon scent as a consequence.

MB And how hard is that to do at the moment?

KG I think what has happened over the past sort of 10, 15 years, is that we as a society have gained far greater understanding in things like the ability to read, write, edit and generally understand DNA, and that has meant an increased step change in our ability to harness biology to our advantage.

MB Some people are still thinking about GM, Monsanto. How do companies overcome those ethical challenges, or what are those ethical challenges?

KG I think the biggest thing is consumer perception. So, these companies, in their products, you know, they've been very cautious in the words that they've used. It's interesting. I've got the box here for the hat we were talking about earlier, and there's nothing on it that says that this is natural, and yet everything about this – by the current definitions of what is natural – could be defined as natural. But I think the companies in this space have been very aware of how people can make assumptions based on the words that you use, and so they are just very cautious.

We've discussed this before, I think, that a bicycle is very clearly not natural; a spider, on the other hand, is very clearly natural, but red wine is kind of somewhere in between, it's natural because it's made from grapes but there's some degree of processing, and it's in a glass bottle. So, I think it's going to be how you talk to consumers, and how you advertise these products, and how I think it comes back to this idea that you need to be honest.



The genetic modification ones are a really interesting thing, because just about all of the areas that we've discussed already today with regard to industrial biotechnology do involve genetic modification in some area. But what's different about this genetic modification, in comparison to the kind of worries that people have with the Monsanto 'Frankenfoods' etc, is that this is what would be known as, like, closed genetic modification. So, the genetic modification that they make is confined to the lab, the output is not a living organism. Genetic modification of seeds results in a living organism which can then go on to impact the ecosystem with which it exists. I have a hat here. It's been genetically modified in one respect, but it's not really going to make any changes to the ecosystem that we currently live in.

MB And the interesting thing about industrial biotech, we've talked about the fact that it can potentially replace petroleum-based products but there are potentially new areas, where there are practical uses for it?

KG Yes, I think the use cases of it are quite clearly defined at the moment as to what people are looking at: the food, the fragrance, the agriculture and the materials. Then there's a sort of next step in terms of things like wood, for example. Like surely, we could create wood that's better than growing a tree, [which] comes in a tree shape, and has to be cut down, and it has knots in it, and is not as easily processed?

Could we not produce that through yeast? Now, I mean, it's probably worth being clear here that I'm not talking about a piece of two-by-four coming out of a small piece of yeast. There's going to be a degree of processing that's required afterwards, and this is very much the case with what you see with both Bolt Threads and Modern Meadow, that the yeast produces an initial substance and then there's a degree of processing that's required. Whether that be in Bolt Threads' case some degree of spinning to make it into a yarn, or in Modern Meadow's case some degree of processing to make it into a sheet of leather.

If you imagine that the wood industry is completely changed, so the timber industry is completely changed, that has massive impacts on so many areas - shipping, for example. Well, if you don't need to ship so many goods because you make so many things locally, we reduce the number of ships out there. We then don't need the container ships, and we don't need the containers themselves.

It also has an impact on financial markets, because people do a lot of trading in things like wood futures or timber futures. That means we suddenly get to a point where the supply is much more consistent and much more stable. So, I think the impacts of this could be so much broader than the products that they produce.



MB Looking at Ginkgo, one of their founders, Tom Knight, is a fascinating character. He's been driving a lot of the change in industrial biotech. Tell me more about him.

KG So he's often referred to as the father of synthetic biology, and I've been very fortunate that, actually, last time I was in the US meeting Ginkgo, that I got the opportunity to spend about an hour with him to just pick his brains about what he thought the future of industrial biotech might be. And he has a really interesting background. So, he started off in the sort of computer programming, science side of things, and he'd begun to realise that something like Moore's law, which is the idea that every few years you see a doubling in computing power, he thought that that was going to end at some point.

And consequently, he thought that the area that was most exciting in order to replace that might be biology. And I think this came with the sort of advent of these tools that we talked about earlier, the ability to read and write DNA, that was emerging at the time. So, he decided, I think he was in his 50s, to go back and do an undergraduate degree - or at least some undergraduate courses in - biology.

And so, he sits at this kind of hybrid of being a kind of data science guy, but he's also got this biological background. He set up Ginkgo with a variety of evidently very talented PhD students that had worked under him, and they are the founding management team of Ginkgo Bioworks.

Ginkgo genetically engineers microbes to make a range of products from something like flavours and fragrances to agriculture or food, and anything else is theoretically possible in the future. Their ambition is to become the sort of Intel of biology, the foundry, so to speak, where Ginkgo helps customers design a raw material producing microbe, and then they would licence that microbe, or the recipe for that microbe, to the end customer, and the customer can then produce what they want.

MB I was reading one of your research notes where you mention that this is probably the most exciting company that you've come across in your research. Tell me more about why.

KG The progress that we've seen in this area has been dramatic, but the fact is the opportunity left to go for is just unbelievably vast. The reason I'm really excited is it's an analogy, almost, to finding something like Alphabet or Amazon when they're [a] 250 million, half-a-billion-dollar company, [with] the opportunity for them to get close to a trillion-dollar company in the future. I just think there is just so much opportunity for these businesses, and specifically something like Ginkgo, that we just haven't even scratched the surface of what's even possible.

And in investment, that's just really, really, exciting. I think we really are on the cusp of another industrial revolution, so to speak.



MB So, probably best known is the burger industry, we've seen with Burger King not so long ago, they've brought in a burger which is based on plant-based substances. It looks, it tastes, it even bleeds like meat, and we've seen Silicon Valley companies looking at this. What's your view on this area of growth in terms of food substitutes?

KG It's a really interesting area. You've seen massive progress in these sort of burger companies, and ultimately people are willing to pay for them. And they're not significantly more expensive, you're maybe talking somebody paying a couple more pounds or a couple more dollars to access them. The more challenging area is, probably, in some of these companies that we've seen trying to do egg or maybe even dairy replacement. And that's challenging because cows and chickens are really quite efficient at producing milk and eggs at quite a low price already, and you really need to narrow that price differential in order to make these things mass market.

People will try things on a one off, and pay \$10, \$15, more for the novelty. But this is not about these products being novelty items. It's, long term, them being mainstream. And so, they need to reduce prices, and part of that is releasing them to the market and hoping that you get the volume that helps bring prices down over time.

MB A lot of people have questions about how long it may be for some of these products to appear in the high street and change from niche to mainstream. How long do you think that will take?

KG We're already seeing, in the areas of, sort of, burgers that that is already happening, and we're seeing much more [in the] mainstream. I mean, you don't get much more mainstream than Burger King, in many respects. When it comes to products like the hat I'm currently wearing on my head, it kind of depends on whether the company wants to remain at that kind of higher price point, and ensure and protect themselves as a more luxury brand, and, you know, carve out their market in that way - or whether or not their desire is to bring the price down and make it more of a mainstream product.

But, I think, is it going to happen in the next two years? No, probably not. But in the next 10, we probably will have seen more progress than we could possibly imagine today.

MB Thanks for joining us on this podcast, Kirsty, I hope you'll join us again soon.

KG Thank you.



MB You can find our podcast, *Short Briefings on Long Term Thinking*, on iTunes, Spotify and on our website at bailliegifford.com/podcasts. We hope you enjoyed it, and please spread the word.

In our next podcast we'll be exploring whether space is the next frontier for investors. And many thanks to Lord of the Isles for the music – the track we've used is called Horizon Effect, which was released on Permanent Vacation. Until next time.

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