Kitty Liao: The Last Mile of Vaccine Delivery

RAMA CHAKAKI: In the US alone, more than 15 million COVID-19 vaccines have reportedly been thrown away in 2021. Reasons include cracked vials, dilution errors or issues with freezing. And so, one of the biggest challenges of distributing vaccines is their storage and delivery.

KITTY LIAO: And so for me, it was just really... shocking. I just became aware of this issue and that was seven years ago before the COVID, way, way before the COVID. And so imagine what number that has become now.

RAMA CHAKAKI: This is Kitty Liao, founder of Ideabatic and a former engineer at CERN, the European Organization for Nuclear Research. Ideabatic is working to ensure that all children, wherever they are in the world, have a fair chance at life by innovating a vaccine delivery system.

In today's episode, we'll talk to Kitty about her scientific approach to addressing the problem of vaccine delivery, and the specific mechanics of her innovation.

I'm Rama Chakaki, and you're listening to Innovate with Purpose, the official podcast of Expo Live, an innovation programme by Expo 2020 Dubai.

[INTRO STING]

RAMA CHAKAKI: The name Ideabatic is based on the scientific term 'ay-diabatic' which describes a process in thermodynamics where no heat is lost or gained.

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KITTY LIAO: Yeah, that's where this name comes from. That means whatever happens to the business, the startup, whether there is pressure, whether there are obstacles, we will still innovate and then come up with ideas to solve these critical challenges.

Before I founded Ideabatic, I built — well I designed and built very, very cold systems in the Large Hadron Collider place. It's in Switzerland. And how cold you might ask? So minus 270 degrees C.

RAMA CHAKAKI: Kitty was working at CERN in Switzerland when in 2015, she attended a humanitarian hackathon. The event brought together people from the Red Cross and other humanitarian organisations to present some of the most pressing issues they are faced with out in the field.

Then, the engineers and scientists were asked to come up with solutions to these problems. Specifically those in low- and middle-income countries.

KITTY LIAO: One of these problems was that vaccines become spoiled before they arrive at the destination during transport, and this is happening at the last

mile. That is where vaccines need to be kept between two and eight degrees for all of the vaccines before injection.

RAMA CHAKAKI: For families living in remote and underdeveloped areas, the vaccine delivery process can be difficult. It often involves trekking through unpaved routes, carrying ice boxes on donkey back or on boats. This "last mile" can take up to a week.

Now before this, Kitty was working with really, really cold systems.

KITTY LIAO: So I thought there must be a way to solve this. And so, yeah, that was kind of where all of these things came about.

And until I met some people in the hackspace at Imperial College, Advanced Hackspace in London — so I told them what I have been doing — that was for the first time that those people just instantly got it, and then they loved what I was doing.

And so then I became a hacker in residence. Two months later I kind of presented what I built, and the hackspace people were very impressed.

And then the most... the big, major funding I got was from the Expo 2020 so the Expo grant has been just super, super helpful. Without that grant, there's no way that we can be where we are today.

With that money, I was able to go to the field to see how vaccines were really delivered, not just at the last mile, but from the top, from the state level down to different hospital clinics and villages.

RAMA CHAKAKI: It's that real world experience that makes all the difference, isn't it? Out of curiosity, where did you end up going to get a better understanding of the issue?

KITTY LIAO: Oh, I went to Nigeria, so remote villages in a state called Kano State. Because of that, it really helped kind of giving me the real picture behind all the things I studied or researched, because I felt that even though it was very helpful to speak to people who work in the NGOs and these kinds of things. It's just... it's never the same compared to going there and seeing things yourself. And for me, I just learned so much more by seeing things.

And that was — I think it was really helpful in a way that it kind of verified all of my designs I created.

RAMA CHAKAKI: The typical way of transporting vaccines can be quite flawed. Remember, vaccines need to be kept between 2 and 8 degrees Celsius while they're being transported or stored.

The way they were being deployed to rural areas was through regular, picnic-style cool boxes.

KITTY LIAO: And then around the four sides, the inside of the box, you will have to put four ice packs in order to get the vaccines down to the right temperature, so that's one ice pack on each side.

It's actually quite awkward to carry if you were to travel, to walk on mountains, or walking in a river.

RAMA CHAKAKI: Out in the field, Kitty was able to observe how packed vaccines are handled, and confirm her suspicions about why the current delivery system is wasteful.

KITTY LIAO: These trained health workers, they would open that lid, just put the lid on the floor or on the table. And then they go in to take all the vaccines and do the vaccinations.

And then that lid was just permanently there on the floor or on the table. So that's one big issue. Imagine we have to keep the vaccines but then this lid is open when it's 36 or 40 degrees outside. So that's the first problem with the human issue.

RAMA CHAKAKI: Secondly, Kitty observed that these cool boxes would usually have one or two ice packs in them instead of four. The mindset was that as long as there's at least one, it's cold and sufficient. But only one ice pack wasn't enough to keep the right temperature.

KITTY LIAO: The third problem is that most of these vaccine carriers, they don't have any separators between the ice and the vaccines.

So for those vaccines who are in direct contact with the ice pack, when the ice pack was still frozen, the vaccines get frozen as well. So that meant some of the vaccines when they were sensitive to freezing temperatures, they would just get damaged.

RAMA CHAKAKI: And finally, the vaccines would be put in small glass vials that are very fragile and would often break.

All these resulted in spoiled vaccines, millions of dollars worth of wasted injections, and most importantly, communities vulnerable to disease.

KITTY LIAO: So we brought these cool boxes back to the lab and did exactly what they did and then see how the temperature changed. And so eventually, so with the smaller box that we tested, it only lasted for one hour with this opening and closing action.

And then the bigger one, it takes about three and a half hours.

RAMA CHAKAKI: That means vaccines can last up to three hours in there before they're spoiled. But in many rural places, travel time is longer than three hours and all the vaccines would be useless by the time they get there.

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RAMA CHAKAKI: Here comes Kitty's engineering skills and user-centered design approach. She put together a new prototype that solved all these problems and called it SMILE.

The first thing you'll notice about SMILE is that it's not a box. It's shaped like a big hexagon, the size of a watermelon. In the centre is one large cylindrical ice pack and around it, the vaccines are stored.

Kind of like a sunflower: the petals forming the vials of vaccine.

KITTY LIAO: On the front side of this SMILE device, there is a dial. It's a bit like an old school telephone; you have different... one to eight like a round dial plate. So on SMILE, they are 18 and with a lock.

And then there's a door, quite a small door, not a big lid where you expose everything. So that small door itself is self-closing. So it's spring loaded.

So that's the first thing to minimize that heat transfer or minimize that human error. Imagine it's a bit like a vending machine. So when you open that vending machine, you're only exposed to that one sweet and then the rest of the sweets or biscuits, things like that, they're still kept in a cool, separate compartment.

You're only exposed to that one chamber of vaccines and then the rest of vaccines are kept cool.

RAMA CHAKAKI: That way, the heat doesn't go in and damage the vaccines even if you keep opening and closing the lid. Because it opens onto a single compartment, depending on which number you've turned the dial to.

The other advantage is having a singular ice pack that is separated from the vaccines. No vaccine vials are touching the ice pack and only one ice pack means it's easy to operate and maneuver.

KITTY LIAO: So for the existing cool boxes, if they remain shut, the cooling time is from a few hours to like 24 hours. But when you start opening it, the cooling time would go down to one hour to four hours.

With SMILE, when it remains shut, the cooling time is from three days to six days. And when it's being opened, so opened or closed, the cooling time would still remain at nearly three days to nearly six days.

RAMA CHAKAKI: Wow! This is a massive game changer, Kitty. It makes a world of a difference for rural communities.

What's been the reaction from people in these communities?

KITTY LIAO: We did a blind test on them, so we didn't tell them what this is, because imagine they were given this device and it looks really different; it's got dials and something to turn.

They said, "That's a really brilliant design because then everything is kept in the right place." So when they have the SMILE, they can go into several villages in one trip, for example. So they can go to village A and B and C.

RAMA CHAKAKI: The SMILE vaccine delivery model comes with its own backpack that includes a hip strap and a chest strap. Like a mountaineering backpack. This makes SMILE easy to take up trails, rivers, and rural areas but also keeps the box insulated.

With this prototype in hand, the next step is to start using SMILE out in the field. Kitty is planning to work with stakeholders that are already working in vaccine delivery to help with getting the production, manufacturing, tooling and moulding ready to get SMILE out there.

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RAMA CHAKAKI: Kitty, your design offers a vital solution to an issue many of us perhaps take for granted. I'm guessing it wasn't always a simple process though. What's been the biggest challenge in putting this together?

KITTY LIAO: A lot of the 3D printing technologies were still not that ideal for us because, as you know, to make sure that our thermal... the thermal properties are how we would like them to be, and also would be the same as the final product when it's mass produced.

So we have to make sure (with) these things, there's no microscopic level of holes, which is common in 3D printed products.

RAMA CHAKAKI: And what is it that you're most proud of?

KITTY LIAO: It's been incredible because I remember the sketches I made at the very, very start and then there's little prototypes. And to now looking back, there's so many versions of different prototypes, iterations, and then seeing SMILE being trialed and used in the lab, and in the field, in remote Madagascar.

That... that is a dream come true for me. So I think the progress we've made. Yeah, that's something I'm really proud of so seeing how things are in the field and then that confirmed my design. I think that's a proud moment because when I'm involved in these startup community, there's always people talking about user-centered design and designing with the users. For me, I feel that, even before seeing the users, I was able to design it just as they like it, how they would want it. And for me, that's something I'm really proud of.

RAMA CHAKAKI: "Innovate with Purpose" is the official podcast of Expo Live, an innovation programme by Expo 2020 Dubai. Innovation can come from anywhere, to everyone.

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