

Scott Hanselman: This is ACM ByteCast, a podcast series from the Association for Computing Machinery, the world's largest education in scientific computing society. We talk to researchers, practitioners, and innovators who are at the intersection of computing research and practice. They share their experiences, the lessons they've learned, and their own visions for the future of computing. I'm your host today, Scott Hanselman.

Hi, I'm Scott Hanselman. This is another episode of Hansel Minutes in association with and partnership with the ACM ByteCast. If you're listening to the ACM ByteCast, you should check out Hansel Minutes. We've got a great show with a lot of fresh faces. And if you're listening to Hansel Minutes, you should check out ACM ByteCast as part of the association for computing machinery at learning.acm.org/ByteCast. That's B-Y-T-E cast. Today, we're chatting with Charu Thomas. She is the CEO of Ox and is completely revolutionizing pick methods with augmented reality. How are you?

Charu Thomas: I'm doing very well, Scott. Thank you so much for having me this afternoon.

Scott Hanselman: So, sometimes you'll go and you'll Google for people and you'll find blogs and you'll find social media, but when we Google for you, I find news articles about how you're revolutionizing things, I find paper that you wrote in 2008, and I also find out that you are the CEO of a company that is in Northwest Arkansas, which no disrespect to our good friends in Arkansas, is not a place that I think of when I think of starting a new technical company. Are you from Arkansas?

Charu Thomas: Yeah, so I'm actually not from Arkansas. It's kind of a crazy story of how I got to Northwest Arkansas. I was actually born in Australia and I grew up in north Georgia, just north of Atlanta in a little town called Cumming, Georgia. I wish I was making that up, but I'm not. And went to Georgia Tech, graduated from their number one industrial engineering program, and then moved to Northwest Arkansas originally as a part of a startup accelerator as soon as I graduated. And what I found here, it was a really, really unique ecosystem centered around retail and supply chain. There's three fortune 500 companies, some of the best supply chain and retail executives were here and I was able to build relationships and eventually even poach some of those folks to join our team as we were growing.

Scott Hanselman: Wow, so it sounds like-

Charu Thomas: That was kind of reason.

Scott Hanselman: It sounds like there's some stuff happening in Arkansas that people should be aware of when it comes to this kind of technology.

Charu Thomas: Definitely, definitely. I think so.

Scott Hanselman: Okay. So the paper that we're referring to and that I'm going to link to in the show notes is on comparing order picking. What is order picking and why is it something that most people who are listening don't even think about in their daily lives?

Charu Thomas: Yeah, order picking is a process where frontline operators are tasked with going into a facility, whether that's a warehouse or a store or a micro fulfillment center, and they're going to go and fulfill and pick those items off the shelves so they can be delivered to a customer's door and you can have your modern day conveniences of eCommerce right at your footsteps. It's an incredibly labor intensive process and a lot of people really don't know what goes into it. In fact, there's been a ton of legacy systems that have been built to make the process more effective and efficient over time. And then you also think about in the future there's lots of automation technologies that exist in order to make the process a lot more effective and efficient over time. I mean, that's really what the process is. It's retrieving items from shelves so that they can get to your door faster.

Scott Hanselman: Now I've gone to Ikea, I think we all have at one point or another, and I usually end up with a piece of paper and a pencil and I walk around in this giant warehouse looking for numbers and sometimes I'll end up all the way out at the front and I've got the wrong thing and then it's a whole mess. This 2022, is this still the technique that some people use?

Charu Thomas: It is unfortunately the technique that a majority people use. In fact, 80% of warehouses today are still leveraging manual methods, like pick to paper, which is exactly what you just described. It's incredibly inefficient and in fact, if you think about picking itself, you can kind of break down the sub tasks or the subcategories, so travel times, seeking and fulfillment times, scanning, et cetera. Travel is one of the biggest costs, it's about 60% of the total time. And so there's a lot of opportunity to optimize and really drive down cost when it comes to some of these manual processes because not all of them are really directly related to fulfilling items.

Scott Hanselman: Yeah, in your paper you mentioned that about 55% of \$60 billion being spent on warehouse operations is just picking stuff, which I assume that cost is passed on to the customer?

Charu Thomas: Yeah, no definitely, definitely. It's incredibly labor intensive. If you think about other actions that happen in warehouse environments like replenishment, when you're replenishing, that unit of work, you do one action, and you can replenish a whole bay in one fell swoop. Versus picking and fulfillment, you're going multiple times, it's a really repetitive process, incredibly challenging, manual. So those orders just add up.

I'll give you an example. This is probably going to help clarify because I love to talk about our actual frontline operators. They're really the heroes of the story.

They're the ones who are on the floor, making it happen. And a good example is one of our users, her name's Stacy, and Stacy's an absolutely incredible lady. She's a single mom. She has three kids, three lovely children that she loves to spend time with, and she works her ass off. She works two jobs at two different stores, retail stores, and she has to come in an extra hour every single day that she's not paid for just to print out 400 pieces of paper because they have to get those 400 orders on the truck by 3:00 PM.

And so, as you can imagine, she's printing out 400 pieces of paper. She's frantically trying to organize and stack them, staple them up, and then as her other operators come in for the start of their shift, they grab a stack of paper, a flatbed truck, a handheld scanner, and a shopping cart and they're just trying to manage all this stuff, trying to loop through the store to get as many items as possible.

And with Ox, we're able to take their average order fulfill time from 14 minutes to about 10 minutes by removing a lot of those manual processes, by making it a lot more effective, and by giving the users a better operator experience fundamentally.

Scott Hanselman: In my little small town here in rural Oregon, we just got Instacart and when my family got sick recently I started having groceries delivered, which I think is amazing, what a fantastic thing. But every single order includes either something I didn't ask for or something that is missing, and I can only assume that they're walking around with their phones and trying to use them as barcode readers and they're trying, but it still feels like barcode readers is a simplistic solution. It's just an improvement, but it's not the answer.

Charu Thomas: Yeah. Yeah. You know, one of the really interesting challenges that I think Instacart and a lot of gig economies have is since they're picking from stores, the inventory doesn't necessarily... What you see on the shelf isn't what they have on the back end system. That's different than a warehouse or a traditional distribution center. Of course, there's inventory inaccuracies all the time. In fact, when I was first doing customer discovery many, many years ago and wanted to be an entrepreneur, that's one of the biggest problems that warehouses talk about is inventory. But even still, you have a little bit more predictability in inventory in traditional distribution fulfillment centers than you do in a store because you're competing with the customer for those same items, right?

So let's say you or I, Scott, we walk into a Walmart or a Kroger and we pick something up, but then we put it somewhere else. That completely changed their inventory numbers without them realizing and it's a really hard problem to solve. Now, obviously there's digital twin technologies and plenty other possible solutions for those types of problems, but I do think it's still a big gap that exists for a lot of retailers.

Scott Hanselman: So barcodes, and I'm old enough to remember when barcodes started being attached to objects, when UPCs started to exist, and I've seen situations in other countries where objects don't have UPC codes, so barcodes are a benefit. But I've also seen people adding RFIDs. We've seen the idea of like an Amazon where when something leaves the building, that it could be automatically... and I assume that could be applied to warehouses as well. But is it going to cost a lot of money to attach stuff to other stuff to track stuff?

Charu Thomas: Yes, that's a great point and that's honestly been... So RFID I think has been a concept in retail for, and this even predates my career, but I'd say like 20 or 30 years. And the big reason it failed to get widespread adoption was because of that exact reason. Even though the cost of each tag, passive tags, are cents on the dollar, attaching them to every single individual item, it adds up pretty quickly unfortunately. Now that being said, some of the more I'd say forward thinking retailers, we have seen that some of them are sort of forcing that type of behavior because they have enough leverage to be able to really shift the entire market in that direction. And so if that is the case, that could change the story fundamentally. But you're absolutely right, I think the infrastructure cost is really one of the biggest limiters to technologies like RFID.

In fact, in the paper that I wrote a couple years ago, one of the technologies we worked with was RFID and the way we kind of got around that was we tagged, instead of the individual items, we tagged the shelves with RFID and we had an RFID reader on the person so whenever they reached into a bin, they would scan the RFID tag as they would go in. Now, obviously it's not necessarily tracking each individual item and there's room for discrepancy in that, but it took out a lot of manual scanning, which is what you'd have with a traditional barcode scanner, right? The line of site problem that tends to come up with barcode, so it does solve that.

Scott Hanselman: That's really useful and if you don't mind, I want to take just a few minutes to dig into that because we're talking on a podcast and folks can't see us, but let's think about this for a second. Someone is picking something off of a shelf and they have a scanner. They have to intentionally, with intent, with one hand, adjust the object such that the barcode is pointed towards them and they have to scan it. And that's a non-natural thing when I just want to pick the thing up. So you're describing a situation where they have something on their wrist, like a watch, but it's an RFID scanner. Their intent is implicit upon entering the basket, so then the scanning is a side effect. Right?

Charu Thomas: Correct. That's exactly right. That's exactly right. And that's why it was actually so much faster in that paper than traditional methods.

Scott Hanselman: Okay. But then you bring up the idea of verification or not. How important is that double check?

Charu Thomas: So I would say that most sophisticated operations today, all of them leverage some form of accuracy, right? And that's why barcodes have become the standard and there are organizations like GS One who are enforcing those types of standards in the US and more broadly as well. I would say that it is something that's been built into the process. However, that is kind of an assumption that's been built based on the technology. Again, a lot of those assumptions have been that's what people did before, right? And that's one of the things that I think is so, so incredible about the supply chain and why it provides such a unique opportunity for disruption, because there's a lot of legacy in there that you can kind of rip apart once you have new technologies that we do have in the world today. And that's one of the things that's been so exciting for me.

I know I'm not really answering your question necessarily, but that's been one of the things that's been most exciting for me is seeing the capabilities that we're able to offer just by doing stuff that other people thought they did. So I'll give you another example, like pick walk optimization, right? People always say that they do pick, walk optimization in their warehouses-

Scott Hanselman: Can you say that word... you're saying pick what?

Charu Thomas: Oh, I'm sorry. Yeah. That's like kind of a niche term. Pick walk optimization.

Scott Hanselman: Like walking?

Charu Thomas: Yeah. Yeah. So-

Scott Hanselman: Pick walk optimization, okay.

Charu Thomas: Yeah. Yeah, so a lot of warehouse management systems, they propose or say that they have some form of optimization and they do. Basically what they do is they calculate a global best route and then they reapply that every single time to each order. And that's a heuristic, it actually works pretty decently in most environments. Because if you think about traveling salesmen, right?

Scott Hanselman: I was just going to say that, it's the traveling salesman problem applied to your order in a warehouse.

Charu Thomas: Exactly, exactly. And you know better than me, Scott, that traveling salesmen gets really, really complex, especially when you have multiple different nodes and each one of those items that you're picking is a node in the graph, right? So it gets super, super complex, really ends up being incalculable and there's basically heuristic you can use to kind of cut that down by assuming the aisles. They kind of restrict your emotion a little bit more. And so that's basically what a lot of warehouse management systems do, which is kind of like the current generation. But again, if you break that down with the technology that we have today with like true order batching, we can do a lot smarter walk optimization

with some of the new technologies that we have today and that's what we've been doing at Ox.

So it's just been really cool to kind of rip out, honestly, a lot of this old technology and rethink about the assumptions that are fundamentally creating some of that solution that existed in the past.

Scott Hanselman: Yeah. I also want to mention, because we do like to expand acronyms on the show, GS One, you can learn about a [gsone.com](#), the barcode kind of conglomerate, the global barcode, and it started in 1974 with the first barcode being a stick of gum that was actually scanned.

Charu Thomas: Wow.

Scott Hanselman: So, that's where barcodes came from. Isn't that interesting?

Charu Thomas: That's fascinating. That's really cool. I didn't know that.

Scott Hanselman: So I'm thinking about that computers should do the boring stuff and here we are making humans have the cognitive load of doing all of the boring stuff. That process and the mental processing goes into the person's brain that's tired and exhausted, and they have to think about this kind of stuff. Is this a problem that we solve with heads up displays and we just put something like an extra pair of eyes on the person's eyes?

Charu Thomas: That's what I say. And I think it's even without a heads up display, there's a lot of value to be had in just pure software infrastructure for removing some of those manual tasks, removing some of the manual load planning that happens right before the operator is even on the floor. And so you're exactly right, Scott. I mean, I completely agree with that and I think that there's just so much opportunity that we have to unlock through those types of technologies.

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So we've got computer vision available to us, kind of think about the Lego pieces, the Lego blocks that we can snap together that have come together in the last few years. I think though, is the answer a \$3,500 HoloLens that sits on my head. Because we just said a minute ago that pennies on the dollar for RFIDs was too expensive. How is big expensive headsets the answer? Is there a middle ground?

Charu Thomas: Yeah, no, you're absolutely right. So I would say that I don't think big, expensive headsets are the answer. And I think the expense is one thing. I think obviously it all comes down to kind of the business case and ROI. So, that's one element of it. The other element of it that I'd say is actually sometimes more important

than the economic value is the wearability, right? So heaviness and ruggedization. So, I guess let's think about all those three things separately. So one, the economics; two, the wearability; and three, the ruggedization. So diving deeper into the economic piece of it, I do think that it all comes down to kind of the business case. So if you're able to get that efficiency gain that you'd need to see to justify the expense, that's kind of how typical investments are made in this space.

Now, that being said, one of the things that we've been doing at Ox is we've been driving down the fundamental price of some of the hardware that we're leveraging. And what I mean by that is we've been working with manufacturers directly to decrease the price of hardware so it is throwaway and we're able to offer device as a service as a business model. Meaning you don't have to buy \$3,000 TC70 scan guns that might be industrialized, might be great, but they're very expensive, when we can offer you for a monthly subscription, a full device set that we maintain, manage, provision and ship to you. So right out of the box, you're using this better technology for the operator experience. So, that's one element of it.

Scott Hanselman: Okay.

Charu Thomas: I guess second point was related to wearability. So with a big headset like the Microsoft HoloLens, the head weight is a really, really big challenge because in these shifts, operators are wearing these devices for eight to 10 hours. We've kind of come to this rule of thumb that we offer many different mounting options, so glasses, headbands, and hats. Headbands are actually the most popular, which is something shocking... Yeah, that was shocking to me too, but I think it's because they balance the weight a little bit better and they can kind of pull up the head weight.

Another rule of thumb that we've always found that's been helpful is we try to aim for less than 40 grams on the nose. For glasses, that sometimes can be hard to maintain just because where the weight tends to be. So yeah, that's another factor. The third one is definitely ruggedization. In these types of environments, ruggedization is really, really important because you're throwing these devices around, you're dropping them. So, you're right, if you have a really expensive device, that might not be as rugged for that type of environment. So one of the things that we really keep in mind when we're kind of looking at devices and trying to support devices is their IP ratings. This is actually probably something also I'd say that our COO would be able to speak about much better than I, but when we're thinking about even the devices that we purchase, we think about lifetime in terms of depreciation, just for our core business. So it's a really important thing to keep in mind when we're thinking about devices.

Scott Hanselman: Yeah, of course an IEP rating is an ingress protection. It's like when dust or when water gets inside of something, so that's another really important thing. You

don't want to buy a \$3,500 device and then it gets wet or a little piece of dust in there and it ruins it.

Charu Thomas: Exactly.

Scott Hanselman: Interesting, interesting. Okay. So when I think about, I don't like waste and I get really concerned about how many Android phones that we all have in our kitchen in the drawer and the new phone we get every year. And I think to myself, here's a device, which is a pocket super computer with a camera and a battery and all of these kinds of things. Is the device that you're describing that we're putting on our face, or headband, or glasses, is that another phone in a different format or is that a device that is an edge compute device that may talk to a device in their pocket or somewhere else in the building?

Charu Thomas: Yeah, that's a great question. So I will say that we've actually worked with multiple variations of both. What actually ends up working in operation kind of does depend on some of the details, but I will say there's kind of pros and cons to both of those approaches. We've seen compute on the head. We do that a lot. One of the benefits of it is obviously you don't need that external device, you don't need a wire, you don't need any communication, so that's really helpful. That's a pro.

I think one of the cons is its heavier because you have the battery on your head, so head weight, and balance actually becomes a problem, right? So if you have one of the newer designs, or I wouldn't say it's super new anymore, but one of the designs that I really like is the fact that we have external battery packs on one side and a display on the other. So the wire goes around, it's a little bit more comfortable and more balanced versus if you have just a display on one side with the battery. So that's another element of it.

The external compute, I think that's a lot better for those head weight reasons because again, you could make it a lot more powerful, just candidly, but you get into kind of the wire problem of just comfort. So just getting around, that's really, really important. That can be kind of solved through just operational methods though.

Scott Hanselman: Now, I had mentioned at the beginning things like Ikea, and I think people are thinking of Costco, and you said Kroger. Those are giant, but you've also talked about smaller micro organizations. Things like Shopify have made it so someone could have a small warehouse of their own, maybe in an industrial park or in a couple of storage units. But I would think that VR/AR/XR type equipment would be completely out of my ability as a micro retailer.

Charu Thomas: Yeah. I mean, I would agree with you, honestly. I would say that for that type of operation, there's a huge amount of value to again be had in some of the just pure software, and again, throw away mobile devices of service models because

those kinds of operations can offer you again, better efficiency without necessarily investing in more capital intensive infrastructure.

Scott Hanselman: Okay. So to translate that, you're saying that while I may not need a full AR headset for a situation like that, I can still get automated logic with a platform like Ox that would enable me to solve that problem. It's like software as a service. Just like I go to Square and I get an iPad and a little device, and now I can start taking orders, I can do the same thing on the logistics and the picking side?

Charu Thomas: Yeah, that's exactly right.

Scott Hanselman: I'm starting to understand how your business is going to work here. So your business will scale from the small to the large companies?

Charu Thomas: Yeah. Yeah, definitely. I do think that we've really focused on helping serve the enterprise and mid-market companies and that's purely for the reason of we think that there's a really big value to be had for all the 5.5 billion associates and frontline operators who are today in those facilities and we want to really help those people. We think that they're kind of centralized models. If you really think about how a lot of these operations work, they have many facilities. In fact, one of our customers, we started in one facility, we're going to be in 12 this year and 50 next year, right? So that's kind of like the scaling model, but again, they're centralized, either third-party logistics, retail, or grocery companies.

Scott Hanselman: We have to mention though that you are not an older person. And I know that it is maybe indelicate to mention that, but when someone is on a Forbes 30 under 30 list and is a CEO of a company and is doing largely revenue-based type of a startup, it's worth mentioning your age. While some people your age might be just getting started, you're building an entire company. I'm curious whether it was it teachers or professors, or what made you feel that you could do that, because sometimes the doing it is just not being told you shouldn't do it?

Charu Thomas: Oh my gosh, Scott, you are 100% right. You know, I think that there's so, so many people along my life that I'm so indebted to that have just invested so much in me. You know, a couple people that come to mind just off the top of my head, my professor at Georgia Tech, his name's Dr. Thad Starner, he's the inventor Google Glass. I came to him one day and said that I wanted to be an entrepreneur and he completely laughed at me, but he gave me a book called Business Plans that Win Dollar Signs and said, "When you're a billionaire, give me 1%," or said something facetious like that. And obviously he was completely joking, but I took it as the ultimate vote of confidence and I went back, read the book, annotated the whole thing, and came back the next week and just kept coming back.

And I think that he's been so instrumental in my journey. There's way too many people I think that I could point to who have also been instrumental at just

different moments in my life. My mom is another example. When I was graduating college and I really wanted to be an entrepreneur, but I didn't know how, there was kind of two paths I was considering. One was going to go down the research path, get a PhD in computer science, which I love research by the way, no hate on that. I could definitely see myself doing that for the rest of my life and I would probably be very happy.

But she really encouraged me because I had a really new opportunity. We had won \$100,000 from a startup competition just as [inaudible 00:25:16] funding. And so she really encouraged me to take that opportunity and without her encouragement, I definitely would not be here today because we had absolutely nothing. I did not want to work on... You know, it was maybe not the brightest future that we had. And obviously the team, I think that there's so many incredible people on our team and I could spend every single moment talking about each one of them and how incredible they are. But every single person on our team is so immense. Tanner, our chief product officer, Brian, our CRO, Brent, our COO, Phillip, our CTO, just every single person, our investors. There's so many people who are involved in making this company so great and I'm so thankful to each and every one of them for believing in us and for just investing so much in our journey.

Scott Hanselman: And it's worth also just reminding our listeners, Thad Starner, inventor of Google Glass, wearable computing pioneer who was thinking about this stuff as early as the early 2000s. So that's pretty cool that you got to just hang out with Thad Starner as a mentor.

Charu Thomas: Yeah, yeah. It was actually crazy. I mean, I didn't know him at the time. I knew he was a professor on campus. I heard a lot of great things about him, but I just went to his office hours one day and again, that was the day where he kind of laughed at me a little bit and just kept showing up from there, trying to prove him wrong basically, and eventually built a really great friendship. And he actually let me lead some of his projects in order picking, which is how we started publishing research, and it all kind of snowballed from there.

Scott Hanselman: One other thing I'm curious about, not as someone who's older than you, but as your peer, as a person who's in technology with you, I don't know if I would know how to be a CEO. I look at my CEO and I look at other CEOs I work with, and I go, "Wow, I don't know if I have that thing." But I look at them and I think they must have the recipe. I'm curious how you learn to be a CEO.

Charu Thomas: You know, Scott, I think it's one of those things I'm still learning. You also said before, people are just getting started in my career. I feel like that too. There's so much that's left to do. We're very ambitious. We have a huge vision at Ox to really, really change the frontline operator experience and pioneer this new concept of human-centered automation. I think it's so, so important, especially if we're thinking about just concepts like equity in the world, things that mean a

lot to me. And so I just am so, so excited about what we have, but we're just at the beginning and I'm still learning to be a CEO, no doubt.

I think a couple of things that have helped me though on this journey and these have been tools that I've been taught from other leaders, people who inspire me or even executive coaches, so just people who are directly supposed to help me out and make me a better executive. And a couple things that come to mind. One is from one of our mentors, his name is Mark Lorie, and he's an incredibly prolific entrepreneur. For context, he started a company called diapers.com, was acquired by Amazon for half a billion dollars. Jet.com, acquired by Walmart for \$3 billion. He just raised \$200 or \$350 million for his new company called Wonder.

So he's an immense prolific entrepreneur and he told me, as a CEO, you need to spend your time on three things, V C and P. Vision, capital, and people. And I think that was a really, really great framework of really the three things that you need to be a CEO. You need to know where you're going and then you need to get the right resources, the right people, the right capital to get to that outcome. So, that was really helpful.

Another thing that's been helpful for me is I tend to be kind of all over the place, a little bit unfocused, so an executive coach taught me the rule of three. That tends to stick pretty well, so it's just helped me kind of process and communicate my ideas a little bit better.

Scott Hanselman: Very cool. Well, this has been an absolute joy chatting with you today. I could talk to you for another hour.

Charu Thomas: Me too, Scott. Thank you so much for having me.

Scott Hanselman: This has been great. Well, thank you so much. We've been chatting with Charu Thomas. She's an entrepreneur, researcher, and a hacker, the founder of Ox, formerly Oculogx, building an AR platform for order picking in warehouses and based on augmented reality. Fantastic stuff.

This has also been an episode of Hansel Minutes in association with the ACM ByteCast. If you're listening to one or both of those, do listen to the other because we've got a lot of fresh faces and a lot of fresh tech for you to see. This has been another episode and we'll see you again. Next week.

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