Catalyzing Computing Podcast Episode 23 - Game-Based Learning and Integrated Photonics with Erik Verlage (Part 1)

Intro [00:00:10]

Khari: Hello, I'm your host, Khari Douglas, and welcome to Catalyzing Computing, the official podcast of the Computing Community Consortium. The Computing Community Consortium, or CCC for short, is a programmatic committee of the Computing Research Association. The mission of the CCC is to catalyze the computing research community and enable the pursuit of innovative, high-impact research.

In this episode I interview Eric Verlage, a research scientist at the Massachusetts Institute of Technology, who creates digital learning tools for photonics education. He's developing 3-D virtual lab environments that allow users to interact with micron-scale photonics circuit components, enabling self directed learning for the emerging photonics workforce. His research areas include integrated photonics, photovoltaic materials, and photoelectrochemistry. In this episode, we discuss building educational games and using games, virtual reality, and augmented reality for job training. Enjoy

Interview [00:01:10]

Khari: Here today with Eric Verlage from MIT. How are you doing today?

Erik: Very well. Very excited.

Khari: So could you say a little bit about your background? You're currently at MIT. What do you do there?

Erik: So I'm currently a research scientist here at MIT and I'm working on creating educational software, mostly for photonics education and online learning in photonics and optics.

Khari: So what are photonics for people who don't know?

Erik: So photonics is the study and use of photons. There are many different technologies that use photonics. So it's the creation of photons and the use of photons in matter, and then the capture of photons in photo detectors. So whereas in optics you might think of it as more of the kind of sending light through a lens, photonics is when you start to use photons and the properties of photons on the micron-scale, sending signals around on an optical circuit, or through optical fibre or LCD, or any of these other devices that are using the properties of photons on the nano or micron-scale.

Khari: Okay. So these tools you're developing are to help train people that build photonic systems.

Erik: Right, so we're trying to train both engineers and technicians. Our field specifically is integrated photonics. We're trying to train engineers to create and to design integrated circuits that include optics and photonics on the circuit level. So these are photonic devices that use photons instead of electrons for optical computing.

Khari: Okay. So how did you get involved in this space? Did you do research in photonics previously?

Erik: So I actually came over from photovoltaics. My research was originally in photovoltaics applications. I was creating anti-reflective coatings for photovoltaic cells, and I was also working on solar fuels. We were working on absorbing light in semiconductors and then using that voltage that's created when you absorb light to split

water into hydrogen and oxygen. So we were using the energy from the sun in order to perform chemical reactions inside of a device.

Khari: Interesting. So how did you get involved in computer science generally?

Erik: Originally, when I was a high school student, I actually competed in the Mexican Computer Science Olympiad, the Olimpiada Mexicana de Informática.

I grew up in Guadalajara. I was a part of a network of American schools. I went to school at the American School Foundation of Guadalajara. There are a few different types of competitions that our school was involved in — there was a programming competition, there was a media competition. We were able to travel to many different areas of the country to participate in these national competitions around computer science or other types of content generation and media.

I found that to be quite enjoyable so when I went on to undergrad, while I was getting my degree in physics, I was also doing a few internships creating educational media and educational software at the MIT Media Lab. I was working on sociometric badges and creating games that use biometric feedback to help autistic children recognize social cues.

Khari: Ok. How did those kinds of games work? That sounds pretty interesting.

Erik: Right, so for sociometric badges, we were trying to gather data from employees of a business in order to analyze their behavior, who interacts with who and trying to figure out from their interactions what type of networks are created within an organization. We were working on speech recognition software that would be recording useful information without actually recording the actual voices of the participants. So we were trying to analyze that information.

Later in a second project I did at the MIT Media Lab we created educational games that we're using biometric feedback to help autistic children understand the social cues. So we would record the feedback from people who were experiencing a social situation and use digital displays in order to help autistic children recognize that a social interaction is occurring and give them more of a sense of who's happy and who's sad in a relationship as it progresses. We were trying to create games that would help autistic children make those connections.

Khari: Ok. So could you talk a little bit about the history of MIT's work in virtual reality and learning technologies?

Erik: So MIT's been involved from the very beginning. Especially at the MIT Media Lab, there have been many different groups that have been working on VR. I can't really give you a good sense of the overall contributions of MIT to the field, but I can say that they were on the leading edge in many of these new technologies that were coming on the market, both in terms of developing the technology and also working on how that technology is being used.

Recent example of a project that the MIT Media Lab is focusing on. They've been trying to solve the problem of avatars in VR [that] normally don't have much emotion, so you have these emotionless avatars walking around. One of their recent projects is trying to use biosignal sensors in head mounted displays to gather data about the emotional state of the user and then use that to create what they're calling an emotional beast — an avatar that has the emotions of the wearer and that is expressive in order to make it so that the users within a digital environments are not so blank faced and walking around with fewer social interactions. They're trying to make it much more lively and much more like real life.

Khari Ok, interesting. So they're scanning these faces in real time to then project into whatever virtual or augmented reality is occurring?

Erik: Right. It takes both hardware and software to make this happen. So you have to have hardware that can detect the emotional cues that are given off by facial features and by...sometimes you'll also use bio receptors. You'll be able to tell the conductance of someone's skin to see whether they're calm or in a state of stress. There are many different ways — you can also tell from heartbeat and other vital signals. From the sensors that you put onto the body you can tell things about the user. At that point you want to analyze all of the data coming in and be able to create a useful emotional state for the user that you then display in the avatar.

Khari: Hmm. Obviously, this is still just sort of research, but do you see any sort of applications in the field you're working in for a technology like that?

Erik: So I think in general with VR, one of the main problems — and this is not just VR, but online learning in general — one of the major challenges that we have is how do you create communities of people and how do you create social interactions that are beneficial to both parties who are meeting each other online or trying to interact online.

That's one of the areas that we've really failed to build the human element into these social networks, and so I think in terms of training tools and all of these interactive spaces, of trying to create these types of emotional avatars...that's something that's is missing and that's not being utilized in our training tools at the moment. So this has applications in many fields. Anytime you want to do online training or online learning, this is an area that would be very beneficial.

Khari: So I know you also mentioned that the MIT Media Lab is working on something called the CLEVR project.

Erik: We are collaborators with the Education Arcade, which is a group on campus that has multiple projects mostly geared around game based learning or creating interactive

environments that encourage playful learning or collaborative learning in groups. The Education Arcade is its own group on campus, and they have a project that they've been spearheading called the Collaborative Learning Environments in Virtual Reality or CLEVR project. They're trying to explore what can VR do in the classroom.

One of their most recent games that they've been working on is called Cellverse. So this is a game where they want students to explore a cell in a way that they haven't before, that they can only do in virtual reality. One of the problems that they noticed early on is, a lot of students when they're trying to describe a cell or draw a cell they draw it in the way that their textbooks draw it. So they draw a cell with the ribosome, and mitochondria, a nucleus. They put all the elements there, but it's very much a simple diagram. There's one of each type of organelle, and when they're drawing these things you can tell that they're kind of regurgitating the data that they were taught. It's very much a kind of a standard template.

So the researchers on the CLEVR project really wanted to kind of push the envelope and see how students actually interact with a real cell and start to understand how these organelles interact with each other and maybe have a project that they're trying to solve as they interact with the cell. So they created the Cellverse game. And it's a game where one student will be using the head mounted display and they'll be inside of the cell, and then a second student will be guiding them through the cell and guiding them through different objectives using an iPad.

They're definitely trying to create this as a teaching tool for use in the classroom so that students can gather around and watch other students be working in VR. One of the main things that they are discovering is if they test students before and after and have them draw cells before and after, when they're in the Cellverse environment they get to see a 360-degree view around them and see, wow, there are many, many organelles, a lot of times all of the same type. In the three dimensions they’re all around you, you can see how they're all interacting with each other in a very complex way. And this is a view

that textbooks don't really get to, even 2D screens...there's something about exploring this for yourself, and seeing in three dimensions the expanse of all of these different organelles interacting with each other, and how many of them there are, and where they're situated in 3D space. There's something about that that is very powerful.

Khari: Yeah, that makes sense. I can definitely see how that would stick in your mind more. Are there unique challenges to building...because you said that it's designed for one student to be in it and another student to sort of help guide them around and other students to watch? Are there challenges to designing something that can be used in sort of a group context as opposed to just one individual with one screen?

Erik: Definitely, yes. So this is something that is actually a major design challenge for almost all the content that we're developing. A lot of times when people are making educational games you have to go one of two routes: you either have to design it for use in the classroom, or you have to design it as sort of an entertainment game or a game that's targeted on a different platform towards students or towards parents. So the Education Arcade really does cater much of their work towards creating content that can be used in the classroom. For that reason they also keep in mind, what does the teacher need to know or what does the teacher need to see in this project in order to use it?

So they create instruction guides for teachers and give them feedback about how to use it in their classroom. There are many constraints that that puts on the designer. So you have to have the experience be something around 30 to 45 minutes. You can’t have experience that takes too long because you have to be able to accomplish something in the class period. They have to be able to meet certain learning objectives or standards. It has to align with the curriculum that is set for our K-12 schooling system. So you definitely have to make sure that teachers can tell their superiors and tell the school

boards that they are meeting their educational requirements with this learning experience.

Khari: Right.

Erik: And you also have to then make it fun. Whereas with entertainment games you normally only have to worry about is it fun to play and does it give you a rewarding experience. Here, because we're designing educational content that has to be used in the classroom, there are all these extra constraints on top of that. You really have to advocate and make sure that you're not just creating what might be called chocolate covered broccoli.

So a lot of times with these educational games what ends up happening is that you find a way to make something that is educational and that is achieving your learning objectives, and that's the broccoli part, and then you cover it in chocolate. You basically pour entertaining game elements all around it to try to entice people: “Oh, look, it is fun to play. It is interesting to explore this space or to play this game.” But in reality you’ve sort of separated out the educational activities from the game that's interesting and fun to explore. The real challenge is how to not make chocolate covered broccoli but to actually create content where the interesting aspects of the game are tied directly to the learning outcomes or lead directly to learning outcomes.

Khari: That makes sense, yeah. So in working together, it seems like you'd have a lot of different people involved in this. Obviously you have the people doing the more computer science part of designing the game, but also to some degree visual artist, teachers, and psychologists. What's sort of the process to bring all those people together into a collaboration?

Erik: Right, well, game design and game development is actually extremely multidisciplinary. It's one of the more multi disciplinary projects that you can work on. As

you said, you have to have programmers and you have to have game designers and instructional designers who are making sure that these interactive games and simulations are achieving what you want them to achieve. So, in terms of the design process, a lot of times what you start with is making a paper prototype.

So you go through and you analyze what it is we want the game to achieve and what activities do we think are going to be part of the game loop, the main game loop that we want people to do over and over. So once you start with an objective of what you want to accomplish, then you go to the paper prototyping phase and you basically just write on index cards, and write down on pieces of paper what you want the different states of the game [to be[. And then bring people in and you recreate what it would be like to play this digital game with paper and note cards.

[Laughter]

So that experience is quite fun because you can change it on the fly even. So if you're trying to figure out what works best — to have them have access to this tool or this feature early on, later on — you can make design decisions very, very quickly and test different ideas. So this whole rapid prototyping process can be done very quickly and that gives you the flexibility to be able to change things on the fly and figure out what is the core thing that's fun about playing this game and also what is going to lead to learning outcomes that you want.

So then once you have paper prototyped the game and started the design process, now you have to bring in people with a whole background of expertise. So you have to bring in game developers or people who are programmers who are experienced in using these game engines. You have to bring in graphical artists. You have to start to create the art that will be in the game.

And you have to bring in you are UI/UX experts, because a lot of times what you'll end up finding is that although your your experience worked on paper and when you were able to move things around there are always UI problems that pop up and you have to...even the color that you choose for something might affect how people see it and how people use it.

So you have to bring in people who have that expertise to be able to design the UI, but also the user experience and make sure that people are interacting with the content in the way that you want. And then after that, don't forget, you have to have sound effects. You have to add…So there's all these different artists coming into play and all of the content comes together and makes something that's greater than the separate pieces.

So the whole ends up being a much more enjoyable and interactive environment than you could ever have with everyone working separately. So, yeah, this is a very interdisciplinary activity. And that's one of the most fun things about it, is that it involves all these different fields. So you'll never be an expert in all of them at the same time. You'll always need a large team to come together to create a really good game.

Khari: Yeah. So, I mean, obviously there's a lot of moving pieces here. So I guess, maybe kind of a weird question, but what happens if you get the game close to being done and you realize critical elements aren't working?

Maybe — you know, because it's an educational game — maybe some of the key objectives you thought would be there aren't really working out the way you had hoped or maybe it's not as fun as you thought it would be, so you worry people won't play it.

Erik: Right. Yeah, that's always a risk that you run, especially when you're trying to make an entertaining product. I guess it's similar to the film industry. A good movie is hard. It's hard to just crank it out. You have to...it almost takes a little bit of artistic

inspiration, like what's good and what's not. There's no correct formula to make something that will definitely be a great movie. It's some amount of intuition that you have to follow and you have to take some leaps of faith in doing something new.

So I think in general, because you're constantly going back to playtest and beta testing, you do get a sense of people are finding this fun or people are not finding this fun, but it's not as quantitative as you might like. You do have to kind of like sit there and look them in the eye, because people will tell you, “Oh, yeah. It's great!” But you can tell they're actually not enjoying it.

Or you follow the scent of, oh, something interesting is happening here, they're actually engaged and interested in this part of the game. So there's always some amount of artistic interpretation of what's happening and what's enjoyable. The game industry definitely...there are many games that flop because they just aren't fun to play. So it's always a risk that you’re running.

[Laughter]

Khari: Yeah. In the specific context you were talking about games being used in the classroom. How easy is it to get that set up? I assume most school boards or whatever have pretty strict curriculum. So how are you able to like insert yourself in and have this game available in biology class or whatever?

Erik: That's still an open question because, as you might know if you have children, games are not currently a standard thing to have in a curriculum. So we're still figuring out how do you incorporate these types of activities in the classroom setting. We've had more success in some fields and less success in others. It is an open question of how do you get them in the classroom.

One thing in the US at least that's important is you need school buy-in. You can't just cater to teachers because a lot of times teachers are very constrained in how much time they have to add new activities for students to do it, even though they would be very engaging and very active learning...even though they would have all these benefits, you still have to have school buy-in so that they give them, as teachers, the space and time to add those activities.

So far, a lot of companies that are trying to create educational games have not been doing so well or they've been fighting, not necessarily trying to push into the classroom. But those that have been making content that has been getting into classrooms a lot of times they're doing it at its district level. They're having buy-in from someone who's in charge of many schools, who's able to push this content in and make sure that the teachers have the support that they need to use the content in their classrooms.

Khari: Ok. Yeah, that makes a lot of sense. So I did see a stat somewhere — and I don't know how true this is — that was saying that the game based learning industry will amount to over $17 billion by 2023. I couldn't find anything to really back that up but do you know...does that seem true? Is that something on the scale of what you're aware of?

Erik: Well, I think learning games, it's been around for a long time. People from really early on have been trying to use learning games and trying to sell learning games to both schools and teachers and also to individuals. So I don't know if you remember there was a DS at one point, I think it was called Brain Age.

Khari: I do remember….

Erik: Right, so there've been multiple waves of games being marketed towards adults and towards children. And we're in one of these new waves of games being marketed

heavily towards the end user. So there are many learning games coming up on the App Store and on Android and on different devices.

One example is Code Spark Academy. They're doing quite well in marketing simple games that teach very young children programming concepts using block based puzzles. Each block represents an action the character can take using only pictures and arrows, so no words. Students arrange the blocks to write a script or solve the puzzle.

A lot of times what the industry is trying to do is it's trying to market itself as a way to keep yourself, keep your brain sharp and keep your problem solving skills up to date.

Khari: Mhmm. You're not a psychologist, so this might be outside of your scope — I've heard of a lot of those games like Brain Age and stuff, but I've heard some disputed opinions on how good they actually are in terms of your ability to transfer that learning to other domains. How much of game based learning is strictly targeted towards that game or at least the concept within the game, if it's say a math game?

Erik: Right. So I think in general, people have been disappointed in the past about learning games in past decades. But what we're starting to find, and this is a lot of work coming from Valerie Shute at Florida State University, is showing that a lot of times those games that we're maybe mismarketed as learning games, we're not actually as good as true games at increasing human cognition.

So her work was comparing the entertainment game Portal 2 to the leading educational apps and looking at time that people spent solving problems in Portal 2 and comparing that to time that's spent in other educational apps. So Valerie Shute's work definitely did find that it was very effective. Solving problems with portals, not surprisingly, like those those are some games that require that you that you really do think differently and that you train your brain to solve these types of puzzles. So I think there's a difference

between games that are kind of only on the surface really educational and those that are really using the content that they're trying to teach as part of the puzzle solving mechanic or as part of the core element of the game.

We're still on the very first stages of rolling out these types of games, but I think we're definitely finding that there are things that educational games are very useful in doing that they can be used quite effectively for a few specific areas, and we're only going to be discovering how they can be used in an ever increasing way going forward. So I think that in this case educational games might be finally breaking through that barrier and having the outcomes that they claim they're having.

Khari: Yeah, they would be exciting. So backing away from games for a second we'll probably come back to a little bit later. You're part of a team that just got a new five million dollar award. Can you talk a little bit about that project?

Erik: Sure. So we recently received a grant to develop contempt for advanced manufacturing education. This is a project that is a collaboration between MIT, Clemson University, and University of Arizona. We are currently in the beginning stages — we just started in October — we're in the early stages of creating these interactive modules that are built around educational simulations and educational games. We have three separate thrusts of the types of interactive content that we're creating: we're creating optics and photonics fundamental simulations; we're creating tool training VR simulations, and that's an area where Clemson University is taking the lead; and we are also creating application focused educational games.

For the application games that's an area where the MIT Education Arcade is bringing their many years of experience creating educational games and creating instructional material for teachers who are using the educational games. They're bringing all of that background and all of that expertise to bear to this project. So we're very excited about how we can create more engaging real world application systems built around things

like hyperscale data centers, and wireless avionics communication, and LIDAR systems for self-driving cars.

So we are we're trying to create content that at the same time is both instructive in terms of the technology that we're trying to teach our students about, as well as giving them a good sense of what type of real world applications the technologies are going to be useful for, and having that be part of the game based learning environment that they're going to be exploring.

Khari: So within the U.S. I understand there's sort of a skills gap for the technicians and engineers that work in manufacturing. Do you know how significant the skills gap is?

Erik: So we are currently conducting an industry survey about what the training needs different jobs would require, as well as how difficult it is for employers to find people to fill these jobs. As we talk to more and more people it's becoming very apparent that especially in optics and photonics, these new and emerging fields, there really is no one on the technician level who's able to fill this role. So a lot of times they have equipment that they need someone who has an understanding of optics and photonics to be able to manage, but at the same time they need their engineers on their team to be working on engineering tasks. So what they're finding and what we're what we're exploring with our education roadmap that we're going to be developing over the course of the next year is, they are finding that there's this skill gap that needs to be filled by somebody who will be working as a technician within the organization, but who also needs to understand a little bit more of the fundamentals behind optics and photonics.

So we're calling this role a super technician, someone who has specialized training in this field, and through our surveying efforts we're finding that this is actually a very big problem nationally, that there are many areas of the country that are currently underserved and that are needed people to fill this skills gap. One of the main

objectives that we have in this grant is to start by focusing on optics and photonics, which is a scenario we're very familiar with and we know what kind of training is needed in those areas, and to then explore in other topics, in other advanced manufacturing areas what other skills gaps exist and try to become a design house for creating interactive educational content in those areas.

Khari: Ok, and this grant came from the Office of Naval Research, so I'm assuming the Navy probably has an interest in addressing these kinds of skill gaps as well.

Erik: Right, the grant is administered by the Office of Naval Research, and the DoD in general is funding a lot of activity around these fields and advanced manufacturing. In our case, it's around the field of integrative photonics. And one of the reasons that they're so interested in this is the application areas. There are many applications for military interests. So we have data communication, we have RF or wireless communication mostly going into 5G, we have LIDAR technologies, and also chemical sensing.

So they are actually quite interested in seeing this technology grow. During the Obama administration they set up 14 manufacturing USA institutes that would be focused on developing advanced manufacturing for many different fields, including robotics, and integrated photonics, and lightweight materials, and additive materials. So a lot of these different areas, what they recognized was that they really needed a boost from government funding and support to make sure that that advanced manufacturing was going to be coming to term, and becoming a center point for U.S. advanced manufacturing, and making sure that these jobs remain within the US.

Khari: Ok. In terms of designing content for adults — which are the people who would mostly be using these tools, I imagine — versus kids, do you notice...are

there big differences in terms of how you have to design those kinds of games or training resources?

Erik: Yeah, definitely. So one of the main challenges that come up with trying to design content for children and for K-12 — it's more difficult to test your subjects. So you have that issue of having to make sure that your research with human subjects receives a little bit more attention. A lot of times children will need something that's a little bit more entertaining and engaging than adults will. Adults are very motivated to learn the content a lot of times, so you do have that advantage.

However, you do have the fact that kids are normally digital natives, whereas adults are coming more as digital immigrants. So a lot of times when you're trying to create educational content for adults you do need to take that in mind and make sure that the content that you're designing is intuitive to use and easy to use. So it puts a little bit more extra pressure and you can't necessarily rely on people being able to figure it out in the same way. You have to make sure that things are well designed for the adult learner.

Khari: So in addition to design, are there other ways you can help adult learners sort of overcome the technological knowledge gaps they might have?

Erik: Right, so there actually is an interesting idea here that VR will make that easier. So a lot of times adults have trouble using computers because they don't know necessarily all of the the inherent defaults that a user interface has. There's a lot of promise, and it's not there yet, but there's a lot of promise that as things become more and more intuitive to use in VR, that we might be able to train an older population in a way that they don't have to figure out how to rotate around something to be able to see it from all sides, they can literally just tilt their head and figure out exactly how. They don't necessarily have to use some user interface, we’re just making it more and more intuitive and more

and more 3-D in the real world to allow them to use that technology in the way that they normally would.

There's that hope and desire, but of course VR UI is still a work in progress. There are many different questions that are coming up, as in how do you move around in VR if you don't have the capacity to have a full room that is VR compatible? Right now we have teleporting and other types of ways of getting around but it is a little clunky. So there are many questions to be answered about exactly what the final version of these types of tools will be and what types of UI will evolve to meet the needs of adult learners.

Khari: So as VR becomes more commercially available — like I think now you can go buy an Oculus Rift or whatever — do you think that will sort of help solve these problems as industry and regular people get involved? Or do you think that some of these questions are things that need to be addressed more in sort of an academic or government research level?

Erik: We definitely need more research on how these tools are going to be used, and the technology does need to advance. Right now you do have to wear something bulky as you're moving around. So at some point we'll get to a point where it's as easy as putting on a pair of glasses and you're able to use VR or AR in your everyday life. And that's actually one of the most exciting things that we can be looking forward to: what does our workforce look like and what does workforce training look like in the future?

One of the most exciting ideas is that in order to enable lifelong learning, maybe when you are being trained to use some piece of equipment you use a tool like AR or VR, and then you find it so useful that you end up using it in your everyday life, in your job. So as that person graduates from whatever program that's taught him or her how to use this technology or this equipment, maybe when future updates need to be made to that training tool, maybe they are able to use those AR glasses on the job, and you can give

them additional information about things that are occurring on the job. And whenever you need to be retrained on something maybe that's just a notification that comes up saying, “Hey, do you want to be retrained on how to use this other piece of equipment,” that you might not have been trained on before.

So in a way we can, in the future, use these training tools and have them invade the workforce itself, so that people who are...currently people who work in the field, they can’t really look up how to do their job very easily. In an office job we definitely have the ability to Google whatever it is that we're trying to figure out, but if you're going to fix some piece of equipment out in the field, a lot of times you either have to bring along the manual in paper form and look through it. At the moment. It's not really that useful to have some piece of technology help you in that context, but in the future, it might be we might be.

We might be able to create digital field manuals that allow you to use AR or VR where they can point out the literal object and have arrows showing you what to do and what things turn, what knobs to turn on n the equipments in order to to be able to do your job more effectively. So at that point we'll have gone beyond this barrier of going to the classroom to learn something, and then at some point you stop learning and then you become a person who's working on the field. We'll have bridged that gap and now Google will be available to everybody who's working out in the field, so it's not just going to be an office job advantage of being able to look things up on the fly. Hopefully, that will eventually become something that the working class will be able to use in their everyday life as well.

Khari: Yeah, that does seem exciting. I guess in my head of imagining sort of like an Iron Man style, just like look at something and it shows you all this info about it.

Erik: Yeah, that's the dream is that we'll get to the point where that's something that can be used on the fab floor for, let's say, a technician who's working on a fab line in the semiconductor industry. We'd be able to give them the tools that they can use in their job. And at that point they will be able to be a lifelong learner and learn as they go to work every day.

Khari: So I'm imagining in a system like that, it would require some pretty advanced image recognition technology. Do you all currently work with people that work sort of in that field of image recognition or machine learning/AI kind of stuff?

Erik: So there's a lot of, there are many groups on campus, including CSAIL, who are working on the actual programming of how this work will go. But there's a lot of talk about the Internet of Things and how that will eventually transform our world. And so I think this is only going to accelerate. We're going to be expanding things out into this Internet of things. The virtual and physical worlds will start to collide more and more. So I don't think this is that far away in terms of the use case for this is already there and the public will demand it very, very quickly.

So I think we're already going to be making progress in that direction. So there's no inherent barrier to getting there.

[Outro 00:38:14]

Khari: That's it for this episode of the podcast. We'll be back next week for part two of my interview with Erik Verlage. In that episode we continue to discuss building educational games. Till next week, peace.