**[MUSIC]**

**DANIELLE FEINBERG:** You know, on WALL-E it's towards the end and we're racing to beat the clock to get it done in time. And all of a sudden, the director says, "I'm so sorry, but I've realized that if I make this critical change in the story, that it's going to make it a better film. And I know it means you guys are going to have to throw some of this out and start over. And we're already down to the wire, but I think it's going to make a better movie."

**[MUSIC]**

**KEVIN SCOTT:** Hi, everyone. Welcome to Behind the Tech. I'm your host, Kevin Scott Chief Technology Officer for Microsoft. In this podcast, we're going to get behind the tech. We'll talk with some of the people who have made our modern tech world possible, and understand what motivated them to create what they did.

So, join me to maybe learn a little bit about the history of computing, and get a few behind-the- scenes insights into what's happening today. Stick around.

**[MUSIC]**

**KEVIN SCOTT:** Today, I'm here with my colleague, Christina Warren. Christina is a senior cloud developer advocate at Microsoft.

**CHRISTINA WARREN:** Hey, Kevin. I'm so excited about your conversation today.

**KEVIN SCOTT:** Yeah, today we're going to chat with Danielle Feinberg. I've been really excited to get her on the show.

**CHRISTINA WARREN:** Yeah, I think this will be really interesting to a lot of engineers because not only does she work at one of the coolest tech companies on the planet -- Pixar. But they're also one of the most creative companies on the planet. So, she gets to mix these two worlds where she's literally programming movies.

**KEVIN SCOTT:** Yeah, and she's so incredibly inspirational in addition to being a brilliant technologist and a brilliant storyteller, she also is doing this really incredible work to inspire the next generation of computer scientists to come into the field. She has a really great platform for doing that in that her work is literally so visual and captivating.

**CHRISTINA WARREN:** And she's working on some of the most iconic films and projects. Things that all of us kind of look at.

**KEVIN SCOTT:** Yeah, absolutely. She goes and puts in all of this crazy work on these film projects. And then the thing that comes out is, by and large, adored by many, many, many millions of people.

**CHRISTINA WARREN:** Well, I can't wait to hear what you two talk about.

**KEVIN SCOTT:** Yeah, so, we will chat later.

**[MUSIC]**

**KEVIN SCOTT:** Coming up next, Danielle Feinberg. Danielle is Director of Photography for Lighting at Pixar Studios. Her love of combining computers and art began when she was eight years old. This eventually led her to a BA in computer science from Harvard. Today, besides making films for Pixar, she mentors teenage girls, encouraging them to pursue code, math, and science. Welcome, Danielle.

**DANIELLE FEINBERG:** Thank you.

**KEVIN SCOTT:** I'm so, so, so excited. (laughter) In some ways, I think you have the best job in the world. Because you get to code, and it's non-trivial, very mathematical coding. And at the same time, you get to indulge your creative side. So, let's talk for a second about lighting. Do you think you could do a little two- or three-minute explanation of what the lighting problem is?

**DANIELLE FEINBERG:** Sure. Because the software is mimicking real life in many ways, if we don't put any lights in, it actually comes out black. Because it looks around the room. Where are the lights? And what color am I going to make these pixels? If we don't put lights in, it comes out black.

**KEVIN SCOTT:** And in some ways, it's really similar to cinema. If you go onto a movie set, you've got these lights.

**DANIELLE FEINBERG:** Absolutely.

**KEVIN SCOTT:** And they know where the shadows are going to fall.

**DANIELLE FEINBERG:** Yes. And it's mimicking all that, but ultimately, we want control. And so we want to kind of harness the power of what are the physics of real-world stuff? But then let me tweak that because I'm making a movie; I'm making art. Our biggest job in lighting is actually to help tell the story. We have a humongous impact on the mood.

Now, if you can imagine your favorite film, lit as if it all took place at the DMV. With that horrible overhead, boring, fluorescent light. (Kevin laughs) That's a really different movie than if you put Coco all in DMV lighting, the feel of that movie is completely different.

**KEVIN SCOTT:** Yes. And Coco is a really good example for a great many reasons that would just be impossible to do with classic lighting.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** The number of light sources. Like when you go into the --

**DANIELLE FEINBERG:** Yeah. The Land of the Dead.

**KEVIN SCOTT:** Oh, my god. It's unbelievable. I still don't know how you did it.

**DANIELLE FEINBERG:** Well, that first shot has 8.5 million lights in it. And it took so much time to figure out how to do it. We had to develop new technology. That's like eight million more than we ever had.

**KEVIN SCOTT:** Yeah, you can't hand place eight million.

**DANIELLE FEINBERG:** You can't hand place all of them, right? And so we get the sets department to build all the street lamps named a certain way. And then we write the code to find all the streetlamps. And then it points a point at every streetlamp that, then, is a light.

But then you do this super-special light that does all this, essentially, fancy math and special sampling. So, the computer considers it one expansive light, even though you have a million streetlamps. And so I can change the color of all of them at once. I change how much the throw is all at once.

But let's say you end up in one little spot where you need a couple of those streetlamps. You don't want it controlled by the whole thing. We have a way to upgrade them into their own lights. And on and on and on. And so there's this massive complexity to it.

But put all that aside. We're trying to make this magical world. We want you to walk into The Land of the Dead and feel this enormous awe because we want you to feel what Miguel feels.

**KEVIN SCOTT:** Yeah. I know if I were trying to do your job, I am such am such a technical nerd that I would be completely overwhelmed by all of the sort of sterile technical bits. (Danielle chuckles) And there must be this tension that people fight against. Here's all of this technical complexity, and there has to be a human story somewhere in there.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** That must be interesting.

**DANIELLE FEINBERG:** Yeah. And I think everyone at Pixar is so nerded-out about making great movies, that anything you need to do to get to that point, and that you get the opportunity to contribute to that, everybody gets totally into it, you know.

And so, sometimes you have to wade through a lot of sort of technical stuff to get to the thing that's your contribution to the movie. But I think, in secret, most people love that part, too. (laughter)

**KEVIN SCOTT:** So, I want to go all the way back to when you were a little kid and try to understand how this started. When did you start to either develop your creative tendencies or your coding tendencies when you were little?

**DANIELLE FEINBERG:** Yeah. My parents are both super artistic. My sister's super artistic. We just grew up in this family where the after-school stuff or the classes or whatever were always art classes that my parents put us in. And so that was sort of a part of life.

**KEVIN SCOTT:** And what sort of stuff did you do? Did you draw? Was it painting?

**DANIELLE FEINBERG:** It was all kinds of stuff. I remember taking, when I was really little, a pottery class. And then I remember when I was maybe seven or eight years old going -- I grew up in Boulder, Colorado.

Going to the University of Colorado, and we made those paper mache masks, where you take a balloon and blow it up and do paper mache on it. And so I just sort of grew up with art all around. And then I went to this really cool, creative, unusual kind of private elementary school called Bixby School in Boulder.

And one day, one of the dads said, "Hey, I want to teach a programming class after school for the kids." And I was eight or nine. This is like mid to early '80s, I guess. And so it was like we had three of the first Apple computers.

**KEVIN SCOTT:** Oh, that's awesome.

**DANIELLE FEINBERG:** And it was, like, well, I don't know what programming is, but I love these computer things. And so it turned out to be in the language Logo. And so it just happened that my very first programming experience was writing code that made this little icon of a turtle drive around on the screen and everywhere it went, it left a line.

And so, my first coding experience made pictures. And coming from this art background, but also really deeply already loving math and science, it was like this magical combo of the two that I had no idea at the time what it meant. I just was like, "This is really cool." "I like programming." (laugh)

**KEVIN SCOTT:** Yeah. I remember I had similar experiences. The thing that enticed me to want to understand programming more, part of it was just -- it's the mystery. Right?

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** And the more mysterious the thing, the more I wanted to understand how it worked. But the real hook for me were video games. When I grew up, the console video games had just started coming out. And I'm, like, "Oh, my god." "These are the most amazing things ever." And there were video games on the Apple IIe. And I'm like, "I've got to figure out how to make these games."

**DANIELLE FEINBERG:** Or the games were -- The kids would probably cringe at now, but it was all text, but you were writing things and investigating a world. And you had to figure out where the key was and the thing that the -- You know, and there were no pictures. It was all text. But it was this whole world, and it all existed inside the computer.

**KEVIN SCOTT:** And you were in charge of it.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** I just felt so empowered. It was this amazing thing. So, where did you go from there? You're eight years old, you're learning Logo.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** What's next?

**DANIELLE FEINBERG:** The school then brought in -- happened to be a woman from the University of Colorado who was studying programming. And she taught us the language BASIC. I always think it's so awesome that my second computer science teacher was a woman. And my third one was a woman. And my fourth one was a woman.

**KEVIN SCOTT:** Wow.

**DANIELLE FEINBERG:** Which had to have some impact in there somewhere. But she came in and taught us BASIC. And then, of course, I could do things with BASIC at home on my Apple computer. And so it became just this hobby to program in my spare time.

**KEVIN SCOTT:** And so, what were some of the first programs that you wrote, that were like actually real programs?

**DANIELLE FEINBERG:** Like, I made a horse- racing program. (laugh) And it had little animations of these horses running across the screen.

**KEVIN SCOTT:** That's awesome.

**DANIELLE FEINBERG:** You might have been able to bet on the horses and whether they won or not. (laughter)

**KEVIN SCOTT:** So, you literally were just destined to do what you do.

**DANIELLE FEINBERG:** I think I was, yeah. And it's like of course, not anything you realize at the time. You're just messing around and having fun.

**KEVIN SCOTT:** Yeah. And did you share any of the programs that you wrote with your friends? Was there community there? Or were you just doing it mostly for yourself?

**DANIELLE FEINBERG:** You know, it was all for myself. I mean, maybe, like I did a programming class in junior high. And there were three of us in the class I think. And so I probably shared it with the other two people in the class, but it wasn't a big thing then, I don't think.

**KEVIN SCOTT:** Yeah. Super interesting. And, eventually, I read somewhere in some of your bio materials that you learned Pascal?

**DANIELLE FEINBERG:** Uh-huh. (affirmative)

**KEVIN SCOTT:** So, was this Turbo Pascal or was it MPW Pascal?

**DANIELLE FEINBERG:** MPW Pascal.

**KEVIN SCOTT:** Gotcha.

**DANIELLE FEINBERG:** And in high school, I was dying to learn something with more depth to it than BASIC. Because, you know, that was a limited language that I loved, but I was like, "I want to be a real programmer." "I've got to learn --" And it turned out, like, okay, Pascal seemed to be the most accessible thing.

**KEVIN SCOTT:** Yeah. (laugh)

**DANIELLE FEINBERG:** And then I sign up for the Pascal class. And the first class, I look around and I'm like, "This is sort of a weird collection of people for a programming class." And the teacher comes in and she takes roll and she shows us how to turn the computers on. And she says, "I'm going to get coffee." And she never came back. (laugh)

And it turned out, it was like the classroom for derelicts. Where everybody sat there and played video games. And the teacher went left and never came back. (laugh) And so my friend and I were so bored after the first week that we broke into the cabinets to get the textbooks to teach ourselves. And so in the room full of derelicts, the little honors students were actually the people that were breaking and entering on school property. (laugh)

**KEVIN SCOTT:** That's outstanding. Outstanding. And were you able to teach yourself?

**DANIELLE FEINBERG:** We did a little bit. But I really learned freshman year in college. When Pascal was the language that they taught us first semester of freshman year.

**KEVIN SCOTT:** And so you, basically, just had this positive reinforcement the whole time. You show up at Harvard, and you know that you wanted to major in computer science?

**DANIELLE FEINBERG:** I thought I wanted to do mechanical engineering, because in my head, that was equivalent to inventing things. But it satisfied the math and science and the creation thing. But I kind of looked at the classes and I went, "These don't look that great anymore." "But I can take these computer science classes, because they count towards engineering, and that'll buy me some time, while I figure out what I actually want to do."

And then I think it was really two weeks into the first semester, I was like, "Wait, why am I not studying computer science?" "This is idiotic." So, it took me two weeks to figure it out, but then it was pretty obvious.

**KEVIN SCOTT:** And how mathematically prepared were you? Because you chose a specialty inside of computer science, where math is really important.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** It's not just the lie that we tell that's, like, "Oh, it's important for everything."

**DANIELLE FEINBERG:** Right. Right. Totally.

**KEVIN SCOTT:** It's really important for computer graphics.

**DANIELLE FEINBERG:** Yeah. You know, I loved math. And I would say -- I was always in honors math. And I was on the math team in junior high. But I went to public junior high and high school. And at my high school, at least then, you couldn't take calculus unless you were honors and a year ahead. And so I was honors, but not a year ahead. And so I never got to take calculus.

And so I got to Harvard, and like everybody had taken calculus. And so you do the testing, you know, when you first get there, to see what you test into. And I test into calculus. Seemingly, obviously, right?

**KEVIN SCOTT:** Right.

**DANIELLE FEINBERG:** But I realized pretty quickly that everyone else in there had already taken calculus. They just hadn't tested out of it. And so I was at a massive deficit going into it because I was trying to learn stuff that people had already spent a year learning.

**KEVIN SCOTT:** And that's one of the hard things. Like, I found when I was teaching computer sciences. I taught CS at the University of Virginia -- or I TA'd a section of it. And I had this huge diversity in my class.

I had some kids who had no business being there because everything was just trivially easy for them. We should have just tested them out and sent them on to something more challenging. And then we had kids who had no programming experience whatsoever and no talent for it.

And it was just sort of awful. It's just hard teaching a class like that. And it's really hard being a student. How did you figure out that it was sort of okay that you were where you were, and that the people who were doing better than you it was just because they got a chance to take the materials in high school?

**DANIELLE FEINBERG:** You know, I don't know that I did ever figure that out really until long afterwards. It was that thing of like you sit in there, and it's full-on imposter syndrome, because you're already sitting at Harvard. And I already felt like, "Wow, somebody made a giant mistake and let me in here." "And they're going to figure it out at some point." And so, while experiencing all that, I also just beared down and was like, "I'm doing this."

You know, I'm pretty dogged about that kind of thing. When it's like, this is what I want to do. I'm not giving up. And I may torture myself with all these feelings of not deserving to be there or whatever it is. But I'm not stopping. And so I put in a huge amount of effort. Every week, I'm going to the office hours to get almost an extra hour or two hours of class. And talking to the teachers.

And, unfortunately, those entry-level math classes are taught by graduate students, who that's not their gig. They're not there to teach, and so they don't actually really care that much. So, it was those first two semesters that were the hardest, because it was hard to get to someone who cared about teaching you as much.

**KEVIN SCOTT:** Yes.

**DANIELLE FEINBERG:** And then the third semester, I got the woman who was the head of the math department. And that lady was awesome. And I would go to office hours and she would totally dig into it with me.

**KEVIN SCOTT:** And what class was that you were taking?

**DANIELLE FEINBERG:** That was linear algebra, which --

**KEVIN SCOTT:** Oh! Murder!

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** And also probably the most important thing --

**DANIELLE FEINBERG:** For computer graphics, it's like critical. So, it was pretty awesome.

**KEVIN SCOTT:** Oh, that's great. So, when did you decide that computer graphics was the thing?

**DANIELLE FEINBERG:** Well, you know, it's that same thing of, like, I'm looking at these engineering classes. I don't know, looking at the computer classes and I go, (gasps) "Look at that computer graphics class." "That sounds awesome." "I want to take that." "How soon can I take that?" "Oh, well, it's got this prerequisite here." And then, "Oh, I can't take it till junior year."

And so I'm such a nerd. Sophomore year, I emailed the professor, and I was, like, "Hey, I'm so excited to take your class, is there anything I could do to get ahead? Is there anything I could just play with now?" And I got the most confused e-mail back from him. You know, I don't think most Harvard students are like emailing professors for future classes and asking how they can do work for it. (laugh)

He was, like, "I guess you could go buy the textbook." But it must have made an impression. We're still friends to this day. And he clearly knew my enthusiasm going into the class. And so I go in, and it was really a class about programming -- all the underpinnings of the programming to get to the D world. But there was a day where he turned off the lights and he started playing these films. And it was the Pixar short films from the late '80s and early '90s. And this is, I think, '94.

And I still completely clearly etched in my mind, just watched those with my mouth hanging open. Was like, "That is what I have to do with my life." Because it was all this math, science, and code I'd been learning, but it created world and stories and characters in this way, that to me, was just the most perfect combination of everything that I loved.

**KEVIN SCOTT:** Yeah. That's so amazing. Those films made an impact on me as well. And for a while, I thought I was going to be a computer graphics person, but --

**DANIELLE FEINBERG:** Really?

**KEVIN SCOTT:** Yeah. I just decided I wasn't creative enough to do it. I had no role-modeling for it. And I was super happy with my specialization. I was a compiler guy.

**DANIELLE FEINBERG:** Nice!

**KEVIN SCOTT:** I've always had this great degree of empathy for software developers and wanting to do things for them that help them practice their craft. And it's underlied my entire career. But I've always sort of wondered about the computer graphic stuff because it's a little bit more performative than maybe any other kind of software engineering.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** Because, I can't show, my "Ooh! Look, I did static single assignment form." And show it to my mom and like, "Yay!" (laugh) No, none of that. Whereas you worked on Coco. And I literally wept three times in the course of this movie because it was so compelling. So, that must be amazing.

**DANIELLE FEINBERG:** It's incredible. Yeah. It's really incredible.

**KEVIN SCOTT:** So, you see these films in this class, and then how soon were you able to connect programming to you being able... That must have been a really interesting journey.

**DANIELLE FEINBERG:** Yeah. Thinking back to then, it was like, okay, I saw these Pixar short films. But what's Pixar? Nobody knows what Pixar is. It's nothing right now. It's some animation studio you've never heard of.

And even if I wanted to watch those films again, I couldn't, because it's not like we had iTunes or YouTube or something. You had to go to a Spike and Mike's Animation festival in a theater or someone had to have an actual copy of them -- a VHS tape, perhaps. (laugh)

And so the next year, my senior year, Toy Story came out. And it was like suddenly that's that same company that made those short films. And they've made this feature film. It was the first feature-length, computer-animated film that was ever made. And I was, like, "Those are the guys." But how do I work there? Like, what do I have to do to qualify to work there? Because who knows? Because it's this brand-new thing that's coming up.

So I thought, "Well, I'd better get some art on my resume." So, I took a couple classes through the art department. And my senior year, I took a year-long animation class. That was more traditional animation. But for my senior film, I managed to use some computer animation for my senior film.

**KEVIN SCOTT:** Oh, that's awesome. Do you still have that laying around?

**DANIELLE FEINBERG:** I do. The lighting is atrocious. I didn't know what lighting was at all. It's really funny, embarrassing. The whole thing's embarrassing. But it sure was fun. And so I started to get a little bit of a sense, but there were no role models. There was no information anywhere. And so it was kind of scrapping to try and figure out what to do to get qualified.

It turned out, I probably didn't even have to think that hard about it. Because having gotten a computer science degree and specialized in computer graphics, no one had any experience. So, when I ended up applying to Pixar, they were like, "You're great, come work on this next film, A Bug's Life, because we need people that know computer science. And if you know computer graphics, fantastic."

**KEVIN SCOTT:** I remember going to see A Bug's Life when I was taking a graduate computer graphics seminar.

**DANIELLE FEINBERG:** Oh, really?

**KEVIN SCOTT:** And so we -- yeah, this was a great part of this class, these full-length, animated movies. So, there was Bug's Life. And there was Antz from DreamWorks, I guess.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** And the pipeline was just starting to go. And so part of our duty as scholars, we would go see these movies.

**DANIELLE FEINBERG:** Shoot, that's so hard.

**KEVIN SCOTT:** Yes, so difficult. And it just struck me that the progress was so fast. How was experiencing that as a Pixar employee? Because it must have been like just exponential curve after exponential --

**DANIELLE FEINBERG:** Oh, it was insane. So, coming in after Toy Story, I'm coming in early '97. Toy Story came out in November of '95. And Bug's Life comes out towards the end of '98. So, I worked on A Bug's Life for over a year and a half. And sort of seeing a little bit of how Toy Story was made and the giant leaps they had made just in the software we were using to make A Bug's Life.

And the problems that were faced were, like, on Toy Story, you're making plastic toys that have very defined ways in which they move. The best thing the computer can do is make plastic. For whatever dumb reason, that's the easiest thing to simulate. So, now you're making these bugs, down on the forest floor, with all this organic plants and nature.

And it was like such a massive leap harder that on A Bug's Life, the last department that happens is lighting. The last creative step. And they got half of my department, the rendering department, to come help on lighting so we could make the deadline because everybody's missing their deadlines because it's so, so, so, so hard. And we're trying to hit the deadline. And that was actually how I got my first taste of lighting was on A Bug's Life because that movie was so much harder than Toy Story, then.

And Toy Story was so hard because they're making it all up as they go, too. You know, I get asked, "What was the hardest film you've ever worked on?" I'm, like, "They all are." When you're working on those films, every single one feels like it's the hardest one you've ever done. We aren't biting off quite as gigantic leaps of change and breaking barriers in terms of, like, What? Hair? We can't do hair. Now we can do hair. What? Curly hair? We can't do curly hair. Okay, now it's not quite as huge of barriers, but each one still feels like it's the hardest thing you've ever worked on.

**KEVIN SCOTT:** Yeah. And I remember seeing A Bug's Life. One of the incredible things was just how many more polygons were in that movie than Toy Story.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** Do you remember, count-wise, what the increase in complexity was?

**DANIELLE FEINBERG:** I don't know. A while ago, someone said, "Oh, if we tried to render the original Toy Story now on our machines, it would take like five minutes." Or something insane, you know? But, I mean, it was. And especially if you look at those couple early films, if you went from Toy Story to Finding Nemo, the sort of visual jumps that each one was taking was pretty phenomenal.

**KEVIN SCOTT:** Yeah, staggering.

**DANIELLE FEINBERG:** And part of that is the software. And part of that is -- Sharon Calahan, who I learned lighting from, who's probably one of the best computer lighters in the entire world. And she's saying, "Hey, can you do this to the software now?" "Can you add this to the software now?" "Can you add this?" And so part of it is people with experience and technology and the two of those things coming together, so your art tool set is getting better and better.

**KEVIN SCOTT:** I can sort of understand how you went from eight years old through your senior year at Harvard, and you just sort of learned all of the mechanical bits about how you write computer programs and even the mathematical bits about how you do like D modeling and the cool lighting stuff. How did you learn how to tell stories?

**DANIELLE FEINBERG:** That's really from being at Pixar and just being around some of the best storytellers in the world. And understanding that a massive part of it is iteration, and people understanding what makes great stories. And also the amount of feedback people get at Pixar, there are directors that have made these blockbusters, but they still are talking to the creative brain trust. They're showing them their movie, taking their comments.

You know, art is such a hard thing. Where, when you get into it, you can't always see what's happening. You get really kind of myopic about it. And to have these people that you trust be able to give you this feedback on it so that you can pull back out again and you can solve those problems and understand so that the movie plays for all kinds of people, maybe not just you.

And you watch all of that happen over and over again and like, you know, on WALL-E, it's towards the end. And we're racing to beat the clock, to get it done in time. And all of a sudden, the director says, "I'm so sorry, but I've realized that if I make this critical change in the story, that it's going to make it a better film." "And I know it means you guys are going to have to throw some of this out and start over, and we're already down to the wire, but I think it's going to make a better movie." And everyone sort of goes, "Okay." You know?

And there's no complaining after that. I mean, our spouses and stuff might complain a little bit because we're gone on Saturdays. But people are so dedicated to it that that you just go after it in that way.

**KEVIN SCOTT:** Yeah. And is that something that Pixar had from the beginning? I know I've read the famous story about the restart on Toy Story 2. Where John Lasseter wasn't as involved, and then came in and realized that there was no way to bridge the gap from where the movie was to like where it needed to be.

**KEVIN SCOTT/DANIELLE FEINBERG:** Yeah. Yeah. And then just basically a big restart. Was that one of those pivotal moments in the company? Or did you guys always have that?

**KEVIN SCOTT/DANIELLE FEINBERG:** It's so easy to look back and be, like, "Oh, we've always done this." But the truth is, it felt like there's these guys who are really brilliant. Some of the very core Pixar folks, and some of them went to CalArts together and stuff. But they were like buddies and they trusted each other artistically. And so they're banding together at this tiny little company that no one knows who it is it has no money.

You know, you're making a movie. You don't know what you're doing because no one else has done it before. You're making everything up. And so you're just figuring it out as you go With some people that you trust. And it works. And so then you go, "Whoa, okay, what part of that worked?" And you go make the next one and it works. And so then you go, "Whoa, okay, what part of that worked?" And you go make the next one. And as you go, you find the things that work. And that becomes your process. But it's not like anyone from the beginning was like "Well, this is the process." "And this is how we should do it." "And it's always going to work."

And with the Toy Story one, I think, in a way, that sealed our dedication to creating the very best stories that we could, no matter what. Because what was happening is that movie was originally supposed to go direct to video which was a thing Disney was doing a lot. And we all felt sort of like, well, that in itself made it seem like it was this second-rate story that we don't have to put as much effort into or something. And that, already, even at that point, felt really weird. We already knew that wasn't what the root of that company.

And so I think everybody was actually quite relieved when it was we're not doing this direct-to-video thing. This is going to be a theatrical release, and we're going to drop everything to make it the best thing possible. Actually, I think we made that movie in nine months is my recollection. That's one of my happiest golden moments of memories from then, because the whole company was sitting there all day, all night making that movie together. And bonding that way.

**KEVIN SCOTT:** Yeah, so, in a way, the mistake there was doing an unnatural thing.

**DANIELLE FEINBERG:** Yeah, yeah, exactly.

**KEVIN SCOTT:** Yeah, no, that's interesting. And I've always appreciated the consistent quality of the art and the storytelling. I've got an eight-year-old and a ten-year-old. And when they were much younger, Disney was pushing out the computer-animated films like Tinkerbell. So, I've seen all of these dozens of times each.

And they were so good. And you could just see the John Lasseter touch on all of them. It's like even though they were direct to video, they were just great. My kids would watch them over and over again. Like, they were so good, that my wife and I would watch them over and over again with them.

**DANIELLE FEINBERG:** That's awesome.

**KEVIN SCOTT:** And we would eagerly await the next one coming out. That's amazing discipline for your product so that you're putting that into this thing that, you probably could have gotten by with less if you wanted.

**DANIELLE FEINBERG:** Yeah. Well, you have to trust on some level that that's going to pay off in the end. Because I think that's a huge leap of faith most of the time in the world, right? No, if you actually spend this money to make this better, you will not only recoup that money, but get more of it. It takes a very specific kind of faith in things to follow through on that.

**KEVIN SCOTT:** So, how do you get people to be vulnerable enough to put themselves out there creatively in this process where you need lots of feedback and lots of criticism in order to get to the best thing?

**DANIELLE FEINBERG:** I think it's really hard. I mean, I think you know coming in that that's what's going to happen. I don't know that it's easy for anyone. I mean, that's particularly difficult. We've had people where it didn't work out for them to be directors at Pixar.

Being a director there, it is no joke. People are like, "Oh, you want to direct a film, right?" And I'm like, "Oh, geez, I don't know." (laugh) We're a director-driven studio. You're in charge of the story, but you're in charge of everything else.

Nothing goes into those movies without someone presenting it to you and saying, "Do you like this? Is this what you imagined?" And so you have to be a story expert. And you also have to have an opinion on everything or understand how to trust your lieutenants and stuff. It's pretty challenging.

**KEVIN SCOTT:** And it must impact everybody, though, because you want everybody whether they're a lighting engineer or a storyboard artist or a director to take creative risk.

**DANIELLE FEINBERG:** Yeah, definitely.

**KEVIN SCOTT:** And sort of the same thing that you want in any high-performing company, actually. You want employees to come in and give their best idea to sort of push the boundaries on things. And when you do that, sometimes you fail.

**DANIELLE FEINBERG:** Yeah. One thing is that because it's coming from an art background, where people are particularly used to -- like, if you go to art school, you get an art critique every time. In my brain, it's almost like hitting in baseball. If you're amazing, you only succeed one out of three times anyways.

**KEVIN SCOTT:** Right.

**DANIELLE FEINBERG:** And so I think some part of it is people come in with that understanding that this is art, and you can't always control what's going on and so you need help from people. And you definitely have to be vulnerable, but you also understand the stakes involved. And also, that is another part of the culture at Pixar is people want to take risks. So, a movie like WALL-E with a robot who doesn't talk or Ratatouille, with rats that cook, you know, those are not normal or low-risk ideas for movies, generally. But people are at Pixar because that's the kind of stuff they want to make. They don't want to make boring, schlocky films. They're into, like, the excitement of it and doing cutting-edge things.

**KEVIN SCOTT:** Yeah. How do you onboard new people into your team? Like, what are the big challenges?

**DANIELLE FEINBERG:** A lot of the challenge is really the technology because we have this sort of Frankenstein pipeline where we've built this beast of a pipeline that is a beast so that you can plug in different pieces of software. And so part of it is our own proprietary software, and part of it --

**KEVIN SCOTT:** And it evolves pretty quickly, right? Probably from film to film, they're like --

**DANIELLE FEINBERG:** Oh, yeah, day to day sometimes. Which is awesome, because then when you need something, you can get something. You know, you're not trying to talk to some other company and convince them they need to do this thing for you. But we can also plug in third-party software as well. And so part of the onboarding is really people getting up to speed on that process.

At least in lighting, we've made that a lot easier, where our tools have gotten sort of streamlined and easier, and a little clearer. Plus, now, we're using a software package that's used in other -- it's a public package called Katana. And so more people come in with at least a little bit of experience with it. Where, before, it was our own software. It was our own lights. It was everything was ours. And so you had to come in and try and untangle the mess of what was going on there.

**KEVIN SCOTT:** Yeah. And sort of culture-wise, how do you get people acculturated? Because everywhere I've worked, there's been this sort of "Frankenpipeline" (laughter) of stuff, right? Like, I don't know why I always choose to work for companies who have a lot of, you know, "not invented here." But the culture stuff is interesting as well.

**DANIELLE FEINBERG:** Yeah. The hardest thing is that because the computer graphics and visual effects industry has been changing a lot over the last, I don't know, ten years, where things are getting shipped to, say, India and different parts of Asia. And some of the visual effects houses went under. And the whole industry, everybody was pretty freaked out about how long it was going to stick around.

And then a lot of people, instead of being at a company for years and years, they end up doing freelance and then kind of moving place to place. And so people come to Pixar, and we can't always do this, but generally, when you work at Pixar, you work at Pixar. We don't do contract hires. We don't hire per project because we feel like the culture takes a hit then. And, you know, you build up all this expertise, we want you to stay and all these things. And so, people come in and they're so used to having to sell themselves quickly so that they can keep getting jobs at this place because they're freelance.

That's actually the hardest thing is to get people to calm down about that because it's so opposite of what our culture is, that you're like, "Okay, you don't have to sell yourself anymore." "Like, just come. Just be a part of things." "Try not to get too competitive about it." When the competitive part gets introduced amongst people within a department is when things get really funky. Because making these movies is hard and it's like a very team thing. You're very dependent on your teammates and stuff.

**KEVIN SCOTT:** Yeah. Well, and it sounds too like again, your process is about competing against mediocrity not against each other.

**DANIELLE FEINBERG:** Exactly. Yes. Totally. (laughter)

**KEVIN SCOTT:** So, speaking of this big change in the industry, what are the big changes that you've seen in either computer-animated films or at Pixar over your tenure there?

**DANIELLE FEINBERG:** Well, I think at Pixar, a lot of it's about the technology and continuing to push it and see what you can do. And it's really about the story. People can think up any story they want. And so, then, how does the technology evolve to tell that story? And so there's been a lot of that. In general, in the sort of bigger scope of things, with VR coming out, how does that impact us?

And I don't think anyone really gets how to use that in the way -- We tell these stories, and we're super -- I don't know, really picky and precise about how we're framing a shot. We spend a lot of time thinking about where we place the camera and how we light it so you're looking in the right place. And if the audience suddenly could look wherever they wanted, I don't know if we know how to tell stories anymore. And so someone will crack the code.

I mean, there's already been a bunch of VR stuff. But someone will get that. I don't know that it's going to be us. But, obviously, there's stuff changing all around. You look at video games, they're doing some of that sort of storytelling in that way. The visuals of storytelling are getting much closer to the visuals of computer animation. There's all these things that are starting to cross over. And live-action movies are using way more computer graphics.

**KEVIN SCOTT:** But that's an interesting thing. I mean, I remember being a little kid, I never enjoyed the choose- your-own-adventure books as much as I enjoyed something where the author had a perspective.

**DANIELLE FEINBERG:** Carefully orchestrated and set up so that the things were revealed at this pace, and when they wanted them to be. Yeah.

**KEVIN SCOTT:** Yeah, it's a thing, storytelling.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** Some people are good at it. And also, I'm guessing, practice makes perfect. So, after you've done it for years, you're going to inherently be better than someone who's just trying to extemporaneously create an example for themselves.

**DANIELLE FEINBERG:** Right. Right. Totally.

**KEVIN SCOTT:** Yeah. I think that's one of the big challenges in general with VR. The technology is actually really at an incredible point right now. There are a bunch of really compelling industrial applications, but the consumer applications right now are -- we've got some thoughts about what it could look like. But that's the hard problem I think.

**DANIELLE FEINBERG:** Yeah. The thing that's most exciting about VR, to me, is what you could do in education. And, like, how excited you could get kids immediately and engaged and feed them all the things they need to be learning, but in a way where they were totally engaged. That, to me, is the thing. I can't wait to see more of that stuff coming out.

**KEVIN SCOTT:** So, Danielle, I know one of the things that you are really passionate about is mentoring and helping the younger generation of computer scientists get into the field and to prosper. So, tell us a little bit more about that.

**DANIELLE FEINBERG:** years ago, I spoke at this girls' math and science camp. And I talked to them about how we made the films at Pixar and all the math, science, and code behind it. And it was amazing to see their eyes light up when I told them about it. It was kind of like when I was sitting in that college class. And so it's turned into my passion thing. I spend almost all of my free time running around giving talks, talking about the STEM behind our movies and trying to get kids excited about that stuff.

**KEVIN SCOTT:** Yeah. And I think that's how I first became aware of you. I was watching one of these documentary films. And I'm, like, "Oh, who is this enthusiastic person?" (laughter) And then we met at Grace Hopper, where you sat for a portrait session for Behind the Tech.

Yeah, I've been an enormous fan ever since. You are quite a role model to many young computer scientists. And do you have particular things that you're actively pushing on in education, other than VR, that you think would be super beneficial? Because, you know, in a sense, you almost got an ideal path through our educational system.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** And, like, my god, what if we could give that to every child who had interest and potential?

**DANIELLE FEINBERG:** That would be amazing.

**KEVIN SCOTT:** Yeah.

**DANIELLE FEINBERG:** Well, I do have an agenda. I want them to see how exciting computer science is. And how exciting math and science are. So that, you know, when I was in my classes in college, I was one of a couple girls studying in these huge lecture halls. And sort of knowing how lonely that is, and how much of a detriment that is to just learning something that you're interested in learning.

You have to get over this hump of every time you walk in the room, there aren't people that look like you, so everything around you is telling you you don't belong there. And when you have any kind of struggles, you start going, "Maybe I don't belong here." You know? And so finding a way to get girls and underrepresented minorities and stuff excited about math, science, code, so that when they hit those, they go, "I don't care, this is too cool. I'm going to keep on going."

That's really my agenda, is so that we get more and more diversity in the classroom so that just because you want to study computer science, you don't have to go through this whole other extra thing just to learn the thing you want to learn.

**KEVIN SCOTT:** Well, I also think the thing that you were talking about earlier around this sort of notion of imposter syndrome, and holy crap, some of this stuff is really hard. Hearing somebody like you saying that, "This was hard for me," can give people inspiration to push through. It's like this weird thing with math and computer science.

There are all these apocryphal stories about these great geniuses, people who have gone on to accomplish these incredibly difficult intellectual feats. And, you know, many of them, when they write their biographies, will sort of describe these moments where, oh my god, like, I almost gave up here because it was too hard or nobody gave me permission to struggle.

**DANIELLE FEINBERG:** Yeah.

**KEVIN SCOTT:** I thought that the struggle was a sign that I was --

**DANIELLE FEINBERG:** Not good at it.

**KEVIN SCOTT:** Not good at it, and I didn't belong because all these other folks looked like it's so easy. I really love to hear accomplished folks sort of say that, "Man, this really was hard." Because you're just not doing anybody any good pretending that it was trivial.

**DANIELLE FEINBERG:** No, in fact, you're getting them out of it because they go, "Well, this isn't easy for me, so, I clearly don't belong here, right?" The woman who is my mentor at Pixar, Sharon, one day, long, long ago, she emailed me a quote. And it was something along the lines of "Confidence is a gift for the creatively less talented" or something like that. (laugh)

And I was, like, "Oh, this is amazing." "This is like validating all the days where I feel like I don't know what I'm doing. (laughter)

**KEVIN SCOTT:** So, what are you most excited about on the horizon? Either technologically or inside of computer science?

**DANIELLE FEINBERG:** Yeah. If I'm going to answer that completely honestly, it really is the VR stuff for education. Just because, did you see the Mars bus thing? Where the students get on the bus and all of a sudden, they're transported to Mars.

**KEVIN SCOTT:** So cool.

**DANIELLE FEINBERG:** And they're sitting next to each other and pointing out things and yelling and screaming. And I was like, "Oh, that is --" And they're just driving around. It was like D.C. or something. And it's just -- it's a bus. It's outfitted, and they're suddenly transported to Mars. And I was, like, when you can do that kind of stuff, man, that's life-transforming.

**KEVIN SCOTT:** Yeah, that's awesome. So, any advice that you would give to folks who are trying to enter the field either to become programmers or maybe they want to do something like you did that's more creative?

**DANIELLE FEINBERG:** Yeah. You know, it's funny. I talk to students now, and they come up and they said, "Well, I thought I had to choose between art and STEM. And now I see that maybe I don't have to do that." And so that is always really exciting to me because my happiest place is the combination of those two things.

And now it isn't just making animated films is the only place you can do that. There's just billions of ways you can combine those things. And that's one of the exciting things, I think, about computer science period is that you asking kids now to specialize more and more. And you have to decide what you want to do.

I was talking to these girls, and this 13-year-old girl says, "I'm gonna be a lawyer." And I was, like, "Why are you deciding that at 13?" That's insane. And the thing that I'm always saying from my love of computer science is this actually opens up the entire world to you.

This is the base for any job in the world now. There is an element of computer science. And so instead of shutting things down, you're actually opening things up in this really marvelous way. So, I don't even remember what the original question was. But -- (laughs)

**KEVIN SCOTT:** But that's a good answer. And I will put an exclamation point behind that. So, like, parents and kids who may be listening to this should really understand that we are rapidly becoming a world where every business needs technology. It's not just that the technology industry is the place where technology is being created.

So, we did a thing with LinkedIn data a few months back where we showed that the rate of hiring of software engineers is growing more quickly outside of the technology industry than it is within.

**DANIELLE FEINBERG:** Really?

**KEVIN SCOTT:** You have all sorts of things like major automotive companies hiring more software engineers than mechanical engineers. And so the opportunity that's going to be there for these kids in the future is absolutely incredible.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** I don't know about you, but the thing that is remarkable to me when I sit down at the keyboard and try to write anything these days is how rapidly our tools are becoming more powerful. So, like, what you can accomplish with a given amount of effort is becoming more and more every day.

**DANIELLE FEINBERG:** Absolutely.

**KEVIN SCOTT:** It's just this thing that you can do. Whether you have a creative bent or you're very analytic or whatever. If you master these skills, you don't necessarily have to be a computer scientist. But it's going to be this tool that you can use to --

**DANIELLE FEINBERG:** You can use all over the place. Like, when people are saying, "Well, you have to know how to write. You have to know how to do math." And this is on par with how important those things are if not more.

**KEVIN SCOTT:** Yes. And, again, exclamation point. You know, given the work that I do, it almost seems nonsensical to have to emphasize that. But you still sort of have to. It hasn't sunk in yet.

**DANIELLE FEINBERG:** Talking about advice for kids that want to get out there and do this stuff is that as schools struggle to keep up with developing their computer science curriculum, finding teachers who know computer science who aren't like, "See you, I'm going to go industry." You know, different things like that. Sort of remembering that if you're one of those kids, that there's now all kinds of stuff online where you can teach yourself.

And, also, you might have a teacher, but it doesn't make every teacher a good teacher. And so you might go take a class, and it doesn't make any sense to you. And that isn't necessarily because you aren't any good at it, it might be there's a teacher struggling to figure out how to teach it to you. You know?

And so if the class doesn't go well, go find an online thing and work at it a little bit. Because we've all had the bad math teacher or the bad English teacher or whatever that made you feel really crummy at it. And it turned out, it was just like you needed a different person.

**KEVIN SCOTT:** Yeah. And if you can invest in a foundation early of sort of practicing learning. Of course, you want to learn something that's valuable, but just sort of the practice of quickly getting information in your head, and figuring out how to retain it is, like, such a valuable tool -- especially when you have all of these online assets. I'm just pathologically curious. (laugh) And so I'm just going around teaching myself all sorts of crap on Coursera or open courseware or YouTube.

**DANIELLE FEINBERG:** Awesome, yeah.

**KEVIN SCOTT:** It's like the Matrix, you can just download this crap into your head.

**DANIELLE FEINBERG:** So much stuff, yeah.

**KEVIN SCOTT:** I mean, it's just sort of shocking what you can teach yourself.

**DANIELLE FEINBERG:** Yeah, totally.

**KEVIN SCOTT:** Yeah, you want to go become a blacksmith?

**DANIELLE FEINBERG:** You can do it, yeah.

**KEVIN SCOTT:** Reproduction swords. (laughter)

**DANIELLE FEINBERG:** Yeah, totally, you can find anything out there.

**KEVIN SCOTT:** Anything. (laughter) Which is really amazingly different from when you and I were kids.

**DANIELLE FEINBERG:** Right. You had to break into the cabinet to get the textbook in the class you were sitting in.

**KEVIN SCOTT:** Yeah. Yeah. The information is free now.

**DANIELLE FEINBERG:** Yeah. Yeah.

**KEVIN SCOTT:** Thank you so much for coming. This was amazing. And I really appreciate the opportunity to chat to you about all the amazing stuff that's happened in your career.

**DANIELLE FEINBERG:** Thank you, Kevin. This is such a joy. I always love our conversations because it feels like we're two peas in a pod. So, it's super fun. (laughter)

**KEVIN SCOTT:** Awesome. Thank you so much.

**[MUSIC]**

**KEVIN SCOTT:** Well, thanks for joining us for Behind the Tech. So, Danielle Feinberg, oh my god, what an amazing computer scientist. And what a truly interesting career she's had.

**CHRISTINA WARREN:** Yeah. I really loved her advice to the next generation of telling girls or boys or anybody else out there that they don't have to choose between art and computer science.

**KEVIN SCOTT:** Yes.

**CHRISTINA WARREN:** That the answer can just be "Yes." You know, you can do both. But to something that you said earlier is that everything that we do is going to be shaped by technology.

**KEVIN SCOTT:** And it will be yet another really interesting tool in everyone's arsenal. And great that we have folks like Danielle helping to inspire that next generation.

I cannot stress enough the importance of role models in helping kids be able to just imagine themselves whether they actually are going to choose that particular career path or not. But just giving them the material where they can sort of imagine the possibility of them doing something is so valuable. Especially for younger kids.

**CHRISTINA WARREN:** You were talking about how your kind of initial interest in computers came from gaming. And you thought that you were going to be studying graphics. You said you weren't creative enough to want to do that. But you're still artistic. You still do photography and things like that. Have you found that what you do as an engineer shapes the art that you do and vice versa?

**KEVIN SCOTT:** I think, not accidentally, lots of computer programmers tend to get involved in photography. And on the one hand, a very technical thing. You have to sort of understand how your camera works and apertures and exposure times and ISOs and all of this stuff. But it's also a fairly artistic thing in that you have to be thinking about what it is that you're trying to convey to someone who's going to see a photograph that you take. And I just sort of love things that blend those two sides of your brain -- the creative, human side and the technical, nerdy side. Not that nerds aren't humans. (laughter)

**CHRISTINA WARREN:** Because there is kind of this notion that a lot of people have where you don't need the right brain, you don't need creativity when it comes to code. I, personally, completely disagree. But I'd love to know your perspective and where you feel like creativity, programming, and engineering intersect.

**KEVIN SCOTT:** Yeah, I think there's a huge amount of overlap. The good thing about programming is I think it offers a safe haven for lots of different types of folks to be able to make really great contributions.

I've always thought of code as a craft -- borderline art. There's, certainly, deeply technical parts about coding. And in many cases in coding, solving a problem is more clear cut than putting out a piece of art. It either gets the bits to the user in less than a second or not. It either solves a particular algorithmic problem inside of the constraints of a problem or it doesn't. But in writing the code itself, there's a lot that can be fairly artistic. So, for folks who have never looked at code before, it can be almost literary.

The difference between elegantly written code and sort of poorly written code is almost the difference between Finnegans Wake and the scribblings of a five-year-old trying to learn language for the first time at all. There's just an incredible difference in like how programmers choose to express the solution to a particular problem. That's a great thing that can be, in some cases, the interesting part of the job is the care to craft and detail that you take with the thing that you're doing.

For me, I attribute a lot of that -- not that I will claim to write the world's most elegant code -- but my grandfather and my father were both in construction. And, you know, my grandfather was a great craftsman. He cared about every little detail of the things that he was building. And even though, on the surface, coding is very different from building a house, actually, when you look at it, many, many, many more similarities than there are differences.

**CHRISTINA WARREN:** Definitely, because things need to be done a certain way to work together, but you can also have a lot of freedom to build that house however you want.

**KEVIN SCOTT:** Yes.

**CHRISTINA WARREN:** And you were talking about some of the constraints that are in code before that something's going to work or it's not. I think that kind of opens up artistic possibilities, too. When you're forced into sometimes even certain constraints that can force people to become more creative and more artistic --

**KEVIN SCOTT:** Yeah.

**CHRISTINA WARREN:** in what they decide to build.

**KEVIN SCOTT:** And, also, sometimes when you're coding, you're building a system, you can put little flourishes in there that are incredibly satisfying. And you may be the only person who knows that they're there. You know, the same way that a stonesmith might carve an extra little thing into something. And she may be the only person in the world who knows that that thing is there, but incredibly satisfying.

**CHRISTINA WARREN:** I love it.

**KEVIN SCOTT:** So, once again, it's been great chatting. See you next time.

**CHRISTINA WARREN:** See ya!

**[MUSIC]**

**KEVIN SCOTT:** Be sure to join us next time on Behind the Tech. We'll be chatting with Reid Hoffman -- investor, author, and entrepreneur. Reid was co-founder and executive chairman of LinkedIn. And is now partner at the venture firm Greylock, host of the podcast Masters of Scale, and author of the upcoming book, Blitzscaling. Be sure to tell your friends about our new podcast -- Behind the Tech -- and to subscribe. See you next time.

**[MUSIC]**