[SLICE OF MIT THEME MUSIC]

ANNOUNCER: You're listening to the *Slice of MIT* podcast, a production of the MIT Alumni Association.

JOE MCGONEGAL: This is the MIT Alumni Books Podcast. I'm Joe McGonegal, Director of Alumni Education. Dr. AnneMarie Thomas, MIT class of 2001, is an associate professor at the University of St. Thomas school of Engineering. Her new book, *Making Makers-- Kids, Tools, and the Future* of *Innovation,* was published last fall by Maker media. It's a book for parents and for kids, but also one for adults who for one reason or another, stopped tinkering and working with their hands to make things at some young age. Here is an excerpt.

ANNEMARIE THOMAS: Personally, I built my academic career on the importance of play. A few years into a tenure track faculty position teaching engineering, I realized as much as I cared about my research topic at the time, projects related to design for aging, it was through pre-K through 12 education, and in particular, technological literacy that I believe that I personally could make the biggest impact in the world. So I traded in my lab full of Walker parts and scheduled nursing home visits for quite literally, paint, clay, and preschooler's.

In the process for teaching college level engineering classes, I was doing a lot of basic misunderstanding about how electricity and circuits work. At the time, my daughter was nearing her first birthday and I tried to imagine how I might teach her about circuitry.

Well, maybe it was like Leah Buechley. We're doing amazing things with sewn and painted circuits. I wanted something even easier to work with.

That's why I challenged a first-year engineering student, Samuel Johnson, to work with me for a summer to develop sculptable circuits. After diving into established scientific literature, such as *1,001 Things to do with Your Toddler on a Rainy Day,* we managed to fill our lab space with brightly-hued variety of Play-Dohs, covering a wide range in texture, smells, and varying levels of electrical resistance.

By the end of the summer, Samuel had developed recipes for conducted and non-conductive nontoxic Play-Doh, and squishy circuits were born. These days, we're delighted to note that the squishy circuits are used in schools and museums around the world. Our goal, which seems to have been met, was to invite children of all ages to play with circuits.

MCGONEGAL: AnneMarie Thomas, thanks for joining me. A book about the childhoods of makers. Why write this book now?

THOMAS: You know, I'm an engineering professor, and an entrepreneurship professor. And I realized over the years that many of my students were coming in, and really hadn't spent a lot of time taking things apart and building things, and really playing with technology and tools as kids.

And as a parent myself, I became really curious about what the childhoods of the people that I grew up admiring were like. People who went on to put things on the moon, or create innovations that we spend a lot of time talking about. I wanted to make sure that my kids, and my students, got some of those experiences. But first, I had to figure out what those experiences were.

MCGONEGAL: You interviewed dozens of makers in various industries and in academia around the world. The book takes us through their stories. But also, you asked them all to submit pictures, it looks like, from their childhoods. One of the most endearing parts of the book. That must have been an obstacle, waiting for all of those to come in. What else got in the way of writing the book?

THOMAS: Mostly, it was time. Pictures are easy. The nice thing is, if a maker doesn't have pictures of themselves or want to share them as a kid, all of their parents have saved them. So I met moms and dads of quite a few of the people that we see on the news for their technological innovation.

I think for me, the thing starting out was figuring out whether there was a cohesive thread among the stories. I did about 70 interviews, and before I started them, I was curious. Will there be any similarities? And I was actually kind of shocked to find out that over and over, regardless of where people grew up or what area they grew up, a lot of the same things were important to these adults when they looked back at their own childhood.

MCGONEGAL: So you narrowed down on seven or eight characteristics that all of these makers had in common.

THOMAS: Exactly. Yup.

MCGONEGAL: My favorite chapter was risk. Hearing about some of the things that went wrong in childhoods of makers, and how some of them might be billed as terrorists, given the amount of

gunpowder they played with. And how surprising to learn there was an atomic set for children, and a chemistry set for children with actual chemicals in it. But are we missing those kind of risky products these days on the shelves?

THOMAS: It's a hard thing as a parent to look at, right? Because we're pretty lucky that some of those makers made it through their childhoods. Ironically, I learned that the MIT professor who taught me how to be safe in a shop, Woodie Flowers, in mechanical engineering, was quite an avid rocket builder as a child, and had a couple of near misses. That really kind of shaped his future, and how he taught other people to use things safely in a shop.

I do think that we prevent a lot of kids from taking risks. And if you don't take small risks, you don't really learn which risks are acceptable, and which you can handle. Christy Canada, who is a biology alum from MIT, she's been teaching her kids, she says, to do dangerous thing safely. Which I think is a very powerful concept. How do you do dangerous things safely?

Because that's everything from crossing the street to cutting your food, to cooking your food can carry some risk, but I do think we've tried as a culture to prevent kids from taking risk, and thinking that that's safer. But really, by not letting them learn their own limits from a young age, I would argue that we're actually making things more dangerous.

MCGONEGAL: Talk about some of the MIT alumni featured in the book. There was one even from your class who you had not known. Was it Holly Gates?

THOMAS: Holly Gates. Yeah, I think Holly is a year or two ahead of me. Holly had probably the most interesting childhood. There's some great pictures he sent.

Holly actually grew up on a boat. And his parents were working on building a boat, and the boat was in drydock. So Holly really grew up watching his parents make things.

And Holly very early on was-- as he put it-- zapping things, and testing things out. And he was the kind of kid who made his own homemade Tesla coil. And he interestingly has gone on-- probably my favorite blog of all blogs right now is Holly's blog, Tooling Up.

Holly is electrical engineer, but he and his kids live a pretty-- some would say low-tech life where they use very little power. They are doing their own gardening, they're making their own clothing. And by using those sort of tools, he's really being forced to stop and think about what his family consumes, and how his family interacts with the things they use.

It's a very fascinating story. So someone who's very high-tech by day, and probably many people would categorize as low-tech the rest of the time. But really allowing him to pause and think about his interaction with technology and tools.

MCGONEGAL: Then there's a fair share of non-MIT alumni in the book. What did you learn about other higher ed institutions, and how they engender being a maker?

THOMAS: Well, I think that the interesting thing was many of the makers in the book, some went to MIT, some didn't go to college. Some dropped out, some went to liberal arts schools. What I found more than anything, that it was this kind of self-sufficiency and willingness to be persistent and ask lots of questions that really drove these makers.

They weren't all straight-A students. Similarly, they weren't all dropping out of school and hating school. Some like it, some didn't.

Some were avid readers. I heard lots and lots of stories of books from people who went on to do great things. But then I also heard from people who had a really hard time reading. For example, Dean Kamen from DEKA Research and creator of FIRST Robotics and the iBOT wheelchair. Dean struggled reading as a kid. And so was never the top student in the class.

So I think that's an interesting lesson, is that there really aren't any-- there isn't a test that can tell us who these makers are going to be. There's not a standard grade or a metric. It's more looking at the sense of passion that they all had, and curiosity. I think curiosity, more than anything.

And letting them really pursue their own path. None of these makers really wanted to do exactly what they were told. Usually, when I give talks and I ask people if they remember something they made as a kid, everybody does.

And then I say, well, how many of you was the thing that you made exactly like what everyone else in your class made, where you're following exact directions? And very rarely, do I get more than one or two hands for that.

People are really proud of being able to take their own path. And I think that's something that particularly pre-K through 12 education is grappling with right now. And figuring out how to let students really bring some of this creativity and self-guided learning back into their studies.

MCGONEGAL: Industry is doing its part. You talk about some young makers who went on to developing kits

for children.

THOMAS: There is actually a really touching story about Meccano. There's Luc Mayrand, who was a Disney imagineer. He worked-- I won't give away the story, but how he got his Meccano as a kid is probably one of the greatest stories of persistence that I came across in the book.

And to this day, when I interviewed him many, many years later, I interviewed him via Skype for the book. And partway through it, he said, oh, wait, actually, and turned his camera. And on his wall is a model for a future ride that was built using the same Meccano he had gotten as a kid. So that was a touching moment. Many makers were showing me their Legos.

I do think sometimes the simplest tools are the best ones. A lot of people talked about found materials less so than formal kits. There are some great kits out there. I talked with Lenore Edman, who is one of the founders at Evil Mad Science Lab, that creates lots of fantastic little electronic kits, that I do some of them with my own kids.

But I think more and more, so many kids are being given kits with instructions. Or parents are looking to buy the perfect tools to teach their kids something. And giving them less of the freedom that would come from handing them some random parts, and a lot of duct tape, and maybe a hammer.

MCGONEGAL: Talk about some of the current projects in your Playful Learning Lab at University of St. Thomas.

THOMAS: So I'm pretty fortunate. My students in the Playful Learning Lab at St. Thomas come from a variety of disciplines. Mostly engineering, electrical and mechanical, but quite a few from education in our engineering education program. And they're all undergraduates, with the exception of a few master's students who are art history students.

And we really look at the interface between learning and play, and engineering and technology. So examples of this. This summer, we're doing a series of summer camps for youngsters to create rising sixth graders with the St. Paul public libraries.

And through that, we're doing art bots. So building little robots that can create art. And then using laser cutters to create wooden frames for them. In the same vein as some of our squishy circuits work. How can we embed technology in class to really let kids learn by doing, but also use it as a form of self-expression.

We also look at things like the engineering circuits. So we have some students who are putting [INAUDIBLE] on the flying [INAUDIBLE], and the people on the plane took years to look at ways [INAUDIBLE]. Because it's surprising how many circuits there actually are in the US. There's quite a few by MIT, and about four within an hour of my house in Minnesota.

And finally, we've been working a lot with chefs, and looking at ways we can use design and food to both help kids who are looking at the nutrition and biology of it. But also the design aspects, and any artistic and cultural aspects of it as well.

And then a lot of the output is done in conjunction with K-12 schools. So we work very closely with a school in Minnesota for deaf children. I'm fortunate to have a bunch of engineering students that can sign. So one day a week, we teach engineering at the Metro Deaf School in St. Paul.

MCGONEGAL: How do you call upon your ocean engineering degree from MIT at all in this work?

THOMAS: So sadly, my ocean engineering days, they aren't as obvious. I was out first thing this morning. I'm on a trip to New Jersey, so I guess that kind of counts. But it doesn't count as much from my research.

And I would say, I think what I gained most from ocean engineering at MIT is it was a really hands-on program. I always tell people it's a little bit mechanical engineering, a little bit electrical, a little bit computer science. And then we get really good at waterproofing it all.

And I think that actually-- that translates to a lot of the things that I learned in the book as well. One of my favorite stories-- well, they're all my favorite stories. That Paul McGill, who's a researcher at the Monterey Bay Aquarium Research Institute, he's done pretty amazing things. When you're out at sea and something breaks, there isn't a Radio Shack, there isn't a [INAUDIBLE] car right down the street if you're out at sea in the Arctic or Antarctic.

And seeing some of these engineers and makers be able to create functional robots from literally scraps on boats. So I'd like to think I still have a little bit of the scrappy figure it out, get it done, regardless of what parts you have around you sense that I think many of us in ocean engineering had. But I do think my formal sending robots out to sea days are probably over.

MCGONEGAL: You mentioned the blog Tooling Up. Can you talk about some other things that you're reading right now?

THOMAS: I have to admit my daughters, particularly my first grader is an avid reader. So we do lots of *Harry Potter* reading in our house. And to me, in some ways, actually, the *Harry Potter* books tie in really nicely with the things in the research I ended up making. This sense of kids empowerment in solving their own problems.

I just read a great book, actually, yesterday on-- called *Do No Harm* on neurosurgery. In the summer, I love to read anything. Because I think if there's anything I've learned, it's that you never know where the next great project's coming from. And you never know what kind of collaboration is going to be most rewarding for the students and for research.

If anyone had told me when I was an ocean engineer at MIT that I was going to get tenure based probably mostly on Play-Doh, I probably would've laughed. But you never know where those things end up. Spending your day with circus performers, and preschool teachers, and lots and lots of Play-Doh-- our lab has lots of Play-Doh-- it's fun. And also, it's sort of the nature of innovation and engineering in general, is that to do something new, you have to be willing to try to combine things that haven't been combined before.

MCGONEGAL: Your quote early in the book sums that up nicely, is it the creative adult is a child who has survived.

THOMAS: Yeah, I think that's right, and I think it's true. That really, maybe, I misnamed the book. One of my interview subjects, Amon Millner, who was an MIT alum, Lifelong Kindergarten Lab, and now professor at Olin College. He said, well, you know, maybe it's not *Making Makers.* Because every child is a maker.

What you're really talking about, AnneMarie, is trying to maintain makers. Trying to keep them makers. Not let them lose that spark as they get older. And I think that's very true.

MCGONEGAL: AnneMarie Thomas's new book, *Making Makers-- Kids, Tools, and the Future of Innovation* is available online or at your favorite local bookstore. AnneMarie, thanks for joining me.

THOMAS: Thank you so much.

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