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Aaron Tucker -AT
Kristen Reynolds -KR

KR: 00:01:22 …Tell us a little bit about your early life and culture, and how you became interested in medicine, technology, engineering, and innovation.

AT: 00:01:48 I grew up in Albuquerque. I come from a family of engineers, so I've always been around it. My dad is a civil engineer by training, but he does more chemical engineering now. His twin brother is an electrical engineer. My grandfather is an aerospace engineer. His father was not an engineer, but he was a mechanic that worked on aircraft in the Second World War. It's really been around our family for many, many, many years. From the beginning, it was always a part of what we did. My dad worked for thirty-five years at a national laboratory doing research for the government. I always really, really enjoyed doing the "take your son to work days" because they had all kinds of cool tech there that they would show off to us. That's how I got into it—something around me from the beginning. I really understood what engineering was, because a lot of kids don't totally understand what engineering entails-especially the difference between engineering and science-which is something that a lot of people don't even ever learn. It's always been a part of our family, a part of my upbringing. I've been interested in it from the beginning.

KR: 00:02:59 Nice! Do you have a particular memory about going to work with your dad?

AT: 00:03:06 I probably did it six or seven times and he would do a demonstration of the stuff that he had worked on, which

was cool. He was very successful. He worked on research for counteracting potential chemical and biological weapons attacks. He had this neat product, that he ended up meeting President Bush for back in the day. President George W. Bush. He got to show that off, and it was cool seeing him succeed. He was on the news a couple of times because he was involved in the anthrax attacks in 2001. I remember I was about four or five, and I remember he was gone for two months because he was helping clean up those terrorist attacks back in 2001.

I think that was one of my favorite memories, just seeing hands-on exactly what he did and the reasons—because as a kid you don't totally understand why he's busy all the time. That kind of thing. I would say that was one of my favorite memories. But as part of that, we got to do all kinds of cool stuff. They had tours of the unique facilities. I remember there was this room where they tried to eliminate all potential sound. You walk in and you speak to somebody, and you can't hear them if they're more than ten yards away. Things like that—unique tech, got me very, very interested from the start.

KR: 00:04:29 That's so cool. What was the age range that you were going to work with your dad?

AT: 00:04:34 They would let you come, I think, starting when you were six or seven. I remember the first year I did it was probably first or second grade. Then I did it most of elementary school, and a little bit in middle school.

KR: 00:04:46 When did you decide that you wanted to become an engineer?

AT: 00:04:52 I decided my junior year of high school, I would say that was when I was starting to look at schools. I was pretty sure I wanted to do engineering, so I decided on mechanical. But regardless, I figured that I would just do the four years even if I didn't like it that much, and then go to grad school for something else after. So that's what I ended up doing-I mean, I'm still an engineer-but I went for the four years of the mechanical engineering degree and then went to grad school to specialize further in mechanical engineering.

KR: 00:05:20 Why did you choose mechanical initially?

AT: 00:05:23 [Mechanical engineering], to me, was to me the most interesting to me because I was considering aerospace like my grandpa, and that's a good pathway into that. Civil engineering, I wasn't always as interested in structures as I was in mechanisms and that kind of thing. I remember I used to mess around with doors as a kid—little cabinet doors, opening and closing them. That drove my parents crazy. [Mechanical engineering] was just sort of the thing that was the most interesting to me out of the big four different types of engineering—electrical, mechanical, civil, and chemical.

KR: 00:06:06 You mentioned that you went to Calvin College. And roundabout when was that?

AT: 00:06:12 I started in 2013. Finished in 2017.

KR: 00:06:16 Oh my God. You started college eight years after I graduated high school [Both laugh]. Tell me about your time in college. What was that like for you? How did it shape you?

AT: 00:06:26 It was awesome! [Calvin College] is a smaller liberal arts school, which I really, really wanted. Because I wasn't totally sure if I wanted to do engineering, and I also wanted to play soccer. I got to [play soccer] for a couple years before I decided I didn't want to do it anymore. It was great. It's in an unusual location in the [United States]. [Grand Rapids, Michigan] has a heavy Dutch immigrant population, so I wasn't expecting that. I didn't really know anybody before I went there. I just sort of showed up. But it's an awesome place to live. They were really, really amazing people to go to school with. I made many great friends, but I think, most importantly, I got a well-rounded education. More than almost anybody I've met in grad school. Because it really was a true liberal arts experience, I really liked it.

KR: 00:07:13 Say more about the liberal arts experience.

AT: 00:07:16 They just did a really good job of creating a strong core set of classes, and the professors in the core classes were excellent—they really enjoyed what they were doing. I took a British literature class that I thought I was going to hate, but I ended up really liking. One of my favorite classes was a history class I took, which was a world

history class from 1500 to 1800, or so. I took a philosophy class, which was excellent as well. I got a sense for many different aspects of academia, and I think it encouraged me to continue pursuing engineering because I really liked engineering and the other classes. I decided I liked these [subjects] as classes once or twice, but probably not as a career [Both laugh].

KR: 00:08:06 That's fair, that's fair. What was your first job like?

AT: 00:08:14 My first job was working at a summer day camp. It was through my high school. They had this program where parents could drop their kids off daily. It was almost like a daycare, but we did more activities with them. We had them for eight hours or something like that. So that was my first job. I did that for three summers and then the first summer in college. That was when I finished up that job. And then after that, I became an intern at the National Laboratory in Albuquerque.

KR: 00:08:46 National lab? What was that like?

AT: 00:08:48 It was Sandia National Laboratory. It was initially intended to be the national laboratory that researches non-nuclear components for nuclear weapons-for the government. That was the initial purview back in the forties and fifties. But it has since expanded to do engineering research for the government. I worked for a group that did climate research in Alaska, not at all what the initial purview of the national lab was, but I really, really liked it. It was awesome because I got to go to Alaska and help them collect data in a variety of different ways. It was a really, really awesome experience.

KR: 00:09:33 That was your second summer in college?

AT: 00:09:35 Starting my second summer, and then I did that for a second, third [year]. Then after I graduated, I did it for that summer as well before I came to grad school.

KR: 00:09:46 Tell me about Alaska then. It sounds like that was super exciting.

AT: 00:09:49 It was. They no longer have a station there, now they have moved somewhere else—I'm not sure exactly where. When I was there, they had a weather station in Barrow, Alaska,

which is the northernmost point in the United States. I got to go there to help set up some of their equipment and help maintain some of their facilities, which was awesome because, you know, when else are you going to get to go to the northern most point in United States? There's not much up there really. I mean, there are people that live there—the Native American population. There's a small little city, but it's not like there's any industry other than oil and research. It was awesome because we went in the summer and that's when the sun never sets—it just sits in the sky and goes in a circle. It's odd and really unique. I got to go out and see some of the whale carcasses. It's one of the only communities in the world that's legally allowed to whale still. We got the opportunity to learn about some of their culture. Aside from working on climate research, it was a cool experience.

KR: 00:11:04 What was that like for you with the sun never setting? How did you orient yourself?

AT: 00:11:11 It was odd because it would hit 9:00 PM or 10:00 PM and you thought it was still 5:00 PM. You'd be tired, but you'd be confused because the sun was up. They all have heavy blackout curtains, so you can sleep. It was neat.

KR: 00:11:26 That's so cool. In terms of these internships and your formative liberal arts education at Calvin College, did you have any mentors that impacted you and the decisions you made for your academic career and personal life?

AT: 00:11:47 When I was deciding to go to grad school, it was my junior year of college. One of the best things about Calvin was that it was an undergraduate-focused institution. All the classes were taught by professors. We never had a teaching assistant teach a class. But most importantly, we were able to speak to the professors one-on-one, basically whenever we wanted. I mean, you could schedule time with them, and you would usually be able to get time with a professor that week to spend thirty minutes to an hour, whether it was for class or for something personal.

00:12:42 There were quite a few different professors that I spoke to over the years who helped me decide and taught me what the differences between graduate school and undergraduate school are. I considered becoming a physician for a while. I'm glad I didn't because I liked this more. Part of what

taught me—and part of why I decided not to become a physician—is because of the conversations I had with professors. They explained to me what the differences would be between med school and doing a PhD, which I eventually did.

There was one professor, Dr. Matthew Heun. He was an excellent teacher, and he was the one who walked me through the process for grad school, and he wrote me a great recommendation.

KR: Tell me a little bit more about him.

AT: I took three classes with him. He was a thermodynamics specialist. Thermodynamics is energy study, basically. At the time I thought it was crazy-I thought I'd never have to do anything as hard, but he had us do what ended up being a ninety-page report on an energy system. We had to write up and do hundreds of equations to solve and simulate this energy system.

00:13:37 That was the last assignment that I did in undergraduate, and it was one of those things where he takes pleasure in telling you that he doesn't know the answer when you come in and ask him a question. You'll say, "I don't understand what's going on." And he's like, "Well, I don't either. It's time for you to figure it out." [Both laugh]. Often people are frustrated with it, but an essential part of learning is understanding that you may be the only person who can figure out what the answer is. He taught us that and did an excellent job. He was always available for us to ask questions. Like I said, he really explained to me the differences between undergraduate and graduate school.

KR: What did he tell you the differences were?

AT: The point of undergraduate is to do your classes, get good grades, and get a degree. The point of graduate school is simply to acquire and present new knowledge to your field, which I didn't totally understand until I sat down with Professor Heun and some of the other professors that I worked with.

00:14:41 Keeping that framework in mind when you go to graduate school is important because many people get caught up in the classes or the side projects. They won't, I guess, for

lack of a better term, design their thesis work with that in mind and they'll get stuck, or they'll have to reframe later. But if you keep in mind that the whole point is to acquire new knowledge and present it to your field, then that helps you stay grounded, and it helps you think about and design your experiments and your thesis in a way that's much more efficient.

KR: 00:15:18 Oh, that's great. That's a wonderful mentor to have as you make that transition from one to the other, for them to explain that to you. That's so cool. As you're making your transition from Calvin to the University of Minnesota, is this 2018? 2019?

AT: 00:15:42 I went right after [graduating from Calvin College]. It was 2017 when I started at the U [University of Minnesota].

KR: 00:15:46 Okay, wow. You took a summer off and then were right back in school?

AT: 00:15:50 Yeah, I figured I wouldn't go back and do graduate school if I earned a real salary, and I think I was right [Both laugh].

KR: 00:15:56 That makes sense, that makes sense. So about how old were you at the time that you started your graduate program?

AT: 00:16:02 Twenty-two.

KR: You were twenty-two years old. Did you start in the Medical Devices Center?

AT: 00:16:08 I did right away. I drew a separate experience in undergraduate. I decided I wanted to focus on medical devices [in graduate school]. The first thing I did when I was thinking about grad school is I Googled, "medical device engineering graduate school." The Medical Devices Center popped up in the first hit. I figured it looked cool, and that's how I ended up there.

KR: 00:16:33 What happened that made you decide to go into medical devices?

AT: 00:16:36 At Calvin, one of the best things they do is they have a gap in between your fall and your spring semesters—that's a January term. It's relatively common among smaller liberal

arts schools. I hadn't ever heard of it until I went there. A lot of people will take just one class during that period. It's a hyper-focused, fast-paced class, which I did a couple of times. But one of the Januarys, I went to Thailand and Cambodia as part of a trip. And the purpose of the trip was to visit a bunch of organizations, both government and non-government funded, to see how they were working in the communities and what techniques they were using. It was engineering focused, so we were specifically visiting organizations that were working on genetically modified crops, for instance. Or teaching farmers how to be more efficient with water so they can get better yields because it's difficult to farm in that portion of the world.

AT: 00:17:41 One of the organizations we visited provided expensive surgeries to people in the country for no cost to the actual individual. One way they do that is to get surgeons and physicians to donate their time, which is very expensive. They'll go down and they'll perform these difficult surgeries and expensive surgeries for them. One of the things that I experienced when I was talking to them is the various device needs that they had, and how sometimes it was a little bit difficult to get the tools that they wanted. I became, just in general, interested in medical devices because I wasn't sure what I wanted to focus on at that point once I graduated. Within the area of where I graduated, it was a lot of basic manufacturing, which is interesting to me, but not something I totally wanted to make a whole career out of. That was how I got interested in medical devices in the first place.

KR: 00:18:45 Thailand and Cambodia are beautiful. You got to spend a whole month there, approximately?

AT: 00:18:52 It was a little over three weeks.

KR: 00:18:54 I know if I'm going to Thailand, I feel like I'm going to go to the beach in between the things [Both laugh]. What else did you do while you were there?

AT: 00:19:02 It was a fast-paced trip. We went all over both Thailand and Cambodia, but mostly what we did was go to all these different organizations that they knew and learned. Like I said, we covered a very wide range of organizations. We also met with some trafficking organizations to help human trafficking survivors, that kind of thing too. Between all the

traveling-because the roads are awful, and it took forever to travel places-we only had a little bit of time for the traditional relaxation. We went to the beach one day. We did a couple of cool hikes, but mostly it was just going to these various organizations. It was awesome because we got to see basically the whole country of Cambodia… We did get to see the touristy area, which is the Banteay Chhmar ruins. It's the regime from about 1500 or so in Cambodia that ruled the entire region. We got to see all the ruins and experience that as well. That was probably the biggest touristy thing we did. But we went all over the place.

KR: 00:20:11 Wow, that's beautiful.

AT: 00:20:13 Yeah, it was great.

KR: 00:20:15 I have another follow-up question. While you are having this experience in Thailand, Cambodia and you're deciding about going into medical devices, what kind of conversations are you having with potentially your grandfather, your father, your uncle—all the engineers in your family? How is that? How are you having conversations with them about those things?

AT: 00:20:37 It's similar to what I was talking about with my professors, asking them what their experiences in graduate school were, how they picked their thesis topics, and why they ended up choosing the schools that they chose. My dad went to three different schools for his degrees. He didn't just go to two like I did. Things like that. I also asked what they look for in a program, what they liked about their experiences, what they didn't like, and that kind of thing.

KR: 00:21:04 Which schools did your dad go to?

AT: 00:21:07 My dad did his undergraduate at Purdue. Then he did a master's at UT [University of Texas] Austin, and then he did his PhD at the University of New Mexico.

KR: 00:21:14 Okay, okay. Were any of your family members trying to get you to go into their area of engineering or go to one of their schools? [Both laugh].

AT: 00:21:22 No, not too much. That was great. Because one of the things is that the [graduate] programs at these institutions

		are typically relatively specialized in one or two things, which you don't really understand, especially if you didn't go to a big research institution for undergraduate. The U [University of Minnesota] in particular, for mechanical engineering, has a very strong aerosol program and lots of great aerosol research. They also do quite a bit of more physics-heavy research, so plasmas and that type of thing. Whereas a place like University of Wisconsin - Madison, which I was also considering, is more known for engine research and improving the efficiency of combustion engines. They all understood and explained to me that when you look at these different programs, there's going to be a lot of schools that have a good program. But they may not actually have any of the research that you're interested in yourself. It was one of the big things I learned from them.
KR:	00:22:19	Can I ask about your mom? Did you talk to your mom about it, or do you have any siblings?
AT:	00:22:25	My mom has been married to my dad—for one year older than I am—twenty-nine years now. I have a little sister who is five years younger.
KR:	00:22:35	What kinds of conversations are you having with mom at this point?
AT:	00:22:38	She was the one who was like, "You should come back to New Mexico!" [Both laugh]. She was a stay-at-home mom for us, which was great because she was around all the time when we were growing up. My dad was the engineer, and she's more of the extroverted, outgoing type.
KR:	00:22:57	How does that help you in your work? Your mom's extroversion. Or does it?
AT:	00:23:01	It helps, I think. She is from El Salvador, which means she has a much different personality than a lot of people, especially my dad. He's midwestern, so it's low-key. Which is great, I am pretty introverted myself and I get along with that well. It has always been good seeing two sides because they are completely opposite, I would say, in terms of introversion and extroversion. I've always gotten a bit of an understanding of both sides. Whenever I've moved to a new place, I will have to think, "Okay, now I remember that not everybody knows who I am. They don't

always understand that I'm more introverted, so I have to work and think more about how to come across, and how to meet people. That kind of thing."

KR: 00:23:56 My husband is very introverted and I'm not, so I get that. In those moments where you're having to put yourself out there a little bit more, how do you take care of yourself? I know my husband has to go into a bubble for a week to refuel his tank [Both laughs]. What is that like for you?

AT: 00:24:19 One of the things I have done since I moved here is that I have lived alone. Which is great, because I can just go back to my space and enjoy my time. That's probably the biggest thing. I had roommates all throughout college, obviously, almost everybody does. It was great. I really liked living with them. But then, when I started living alone, I was like, "Okay, this is very relaxing." That's probably the biggest thing.

KR: 00:24:42 Do you find that you have more ideas about your work in those moments where you're refilling your tank and spending more time alone? Is that generative for you in terms of your work?

AT: 00:24:56 I would say not always. Not necessarily. A lot of times I'll focus on critically thinking about anything that I'm working on. In my head, I go through step-by-step all the different aspects of it and try to think about what you call failure modes in engineering. You think of different ways that your ideas may not work, and you try to think as much outside of the box as possible with that. Doing it on your own is extremely important, but you won't always cover everything. So honestly, a lot of times I've gotten random spouts of information from just speaking to other people and talking to them about it because people look at things differently. Getting to hear a different perspective on things has always been important. I would say a lot of the unexpected things come from that, but most of the generative ideas comes from critically thinking about things and thinking about failure modes.

KR: 00:25:58 Cool. Since you brought up failure modes, let's talk about that. Can you talk about any failures you've had and what you learned about them? You can think about this very broadly, or you can think about specific products.

AT: 00:26:09 One of the things in the Medical Devices Center really teaches anybody who works there. They have multiple programs for teaching. I never went through them because I was a grad student, but I learned all the content by working in the lab. The biggest thing that they teach is iterative design. The purpose of that is you that want to arrive at new designs and new conclusions by testing out different ideas and concepts, as many as you can manage, and recognizing that almost all of them are not going to work properly until eventually you arrive at something that does work. It's been researched a lot and shown that it's an effective way of designing new product development. You got really used to different failures when you're working in the lab. Especially because one of my roles in the lab was to work on new product development for people both inside and outside the university.

AT: 00:27:16 I served as, for lack of a better term, a consultant. A lot of what I was that I would make a design for some mechanism, for example, and then I would build a rudimentary version of it and see how well it worked. Almost always, it doesn't work the first time. You got to get really used to that. It's because a lot of people do get discouraged when they first start, I would say I probably did too. We use 3D printers a lot. You'll make a design or a part on a computer, then you'll send it to the 3D printer, you get it off the 3D printer, and you're excited! It's cool. It looks great and then it doesn't work. The immediate reaction, I think, is to be disappointed. But we really teach that that's part of the process. It's an extremely important part of the process. I would say that was probably the biggest thing I learned from working in the Medical Devices Center.

KR: 00:28:11 Did you spend a lot of time working with Art [Arthur Erdman]?

AT: Yes.

KR: In Art's specific lab? Tell me more about your relationship with Art and how you learned from him.

AT: 00:28:25 Like I said, when I wanted to come to grad school, I Googled "medical devices engineering graduate school" and the Medical Devices Center popped up first. He's the Director and founder of the Medical Devices Center. When

you do your research as a graduate student, you have typically one advisor, and that's who you do all your work under. So as the Director, I knew I wanted to have [Art] as my advisor. I sought him out as soon as I got here. I said, "Hey, I would love to research with you." That was how everything started.

He was my advisor through all four and a half years of graduate school, so I worked closely with him. Then I worked with him on all the other side projects I did in the lab. I did the Coventor, for instance, which was totally separate from my research. It wasn't related at all. It was a great experience because he really allowed me to work on things from my own perspective. He allowed me space and room to grow, understand, and learn on my own. A lot of professors in graduate school tend to be more hands-on, which is totally fine for some people. It works well, but it's not my style. The fact that he was more hands-off was amazing.

KR: 00:29:44 That's great, that's great. Did you have a conversation about that sort of being your style of work, or did it just kind of happen more organically?

AT: 00:29:51 It happened more organically, I think. More so, I had conversations with other students that have worked with him before and they said, "Yeah, he tends to be more hands-off." Which was, like I said, awesome.

KR: 00:30:01 Tell me about your first-year transitioning from Calvin to the U.

AT: 00:30:06 When you first start a PhD in engineering, you do a couple years of classes mostly. That's what you spend most of your time on, so that was most of my first year. That and buying a new winter coat because thought my Michigan coat would be fine and it wasn't [Both laugh]. Like I said, I mostly did classes for the first semester. That was the big focus.

One of the classes I did was one that Art also came up with, along with a couple of other professors. It's a large group project for a company, but everybody in your group is a grad student. What they did is they mixed up engineering grad students, business grad students, and then the occasional other type of grad student as well. Anybody can

take the class, but it's primarily engineers and business students. He was also the advisor on that project, and I got to work with him. For lack of a better term, I got to show off my skills a little bit. I did some designs and drawings that he really liked, and he told me as much. That's how I ended up coming into the Medical Devices Center and the role that I was in.

KR: 00:31:25 Nice. That first winter, what kind of coat do you have?

AT: 00:31:32 It was just a shell really. I would wear it because it snowed a bunch in Michigan, way more than it snows here in Minnesota. It was great to keep the snow off and keep you from getting wet, but most of the time it was between fifteen and twenty-five degrees in West Michigan. It was just a shell, so I'd wear a sweater or something underneath if I needed more warmth. But then I went outside for the first time, it was probably the first time I've ever been in zero-degree weather. I was like, "Oh, this is not going to keep me warm." Then I got something down.

KR: 00:32:07 Did you spend a lot of time outside that first winter and trying to do winter sports? I know they tell you to do that kind of thing when you come here.

AT: 00:32:14 I grew up downhill skiing a lot, but I didn't really do much of it here when I came. That first winter I was like, "Oh, yeah, I'll just run outside when I want to exercise." But then it got a little bit too cold. It's not quite as fun when it's below fifteen degrees. That's my cutoff. But nowadays, I still run outside a lot in the winter. I picked up cross-country skiing in my third year here, I think. So yeah, I adjusted.

KR: 00:32:45 I have not, but I still have two more years to get it together [Both laugh]. It sounds like you're active, you run, you ski… Do you run marathons?

AT: 00:32:59 I do, yeah and so does Art. Well, he stopped running full marathons a couple of years ago. He still runs ten miles to half marathons. That was one of the things that we bonded over, that we both ran. I ran the Twin Cities Marathon for the first time in 2019, and he ran it that year also. That was one of the things we connected on.

KR: 00:33:19 What were your times?

AT:	00:33:21	I don't remember what his was, but mine was like 4:10, maybe, something like that.
KR:	00:33:26	I have no head for…I don't run. I'm sorry.
AT:	00:33:28	Four hours and ten minutes.
KR:	00:33:32	Wow!
AT:	00:33:32	That's average for a person of my age.
KR:	00:33:37	How do you stay motivated to run for four hours?
AT:	00:33:41	I don't know! [Both laugh]. It's weird. I've done four marathons and I'll probably do it again this year. Every time I finish, I'm like, "Wow, that was hard. I don't know if I want to do that again." Then about six months go by and I'm like, "It sounds fun." I don't really know why I am like that, but it's one of those things. I don't think most people who run marathons understand why they do it regularly.
KR:	00:34:03	You get the itch to do another run every six months. How do you train for a marathon?
AT:	00:34:10	Mostly just by running a lot. There are a couple of subtle things that you must learn, which I didn't really learn until my third one or so. You have to manage your nutrition intake while you're running because most people—unless you're really, really elite—can't store enough food physically to go that long. Even if they are extremely fit and an elite marathon runner, they will have to eat food at some point during the race. Subtle things like that. Understanding how many electrolytes you get rid of as you exercise is important too. You can replace those, otherwise you'll get cramps. I mean, it's scientific and every person is different. I tend to lose a lot more electrolytes when I sweat, as compared to everybody else, I think. I learned that, finally, from the last one I did. It's fun, I think [Laughs].
KR:	00:35:09	It sounds like it! I mean, for people who can maintain that kind of focus, it sounds like it's a lot of fun.
AT:	00:35:15	The Twin Cities one is great because there's people all throughout the course, which is a little bit unusual for

marathons. A lot of them, especially the ones that aren't in a city, you'll have ten miles where nobody's there. But here, there's people watching the entire way, so it's a lot of fun.

KR: 00:35:32 That's lovely. There was something you just said that sparked a thought. In terms of keeping food, are there food stations along the way? Do you keep food on you?

AT: 00:35:47 You keep food on you. They have these energy gels. It's sort of like jelly, but way worse and way more gross [Both laugh]. I don't like those ones, but there's all kinds of different high-energy, dense calorie foods that you can buy. I finally figured out which one by my third one. They do have a little one food station usually where they give you one, but it's not typically enough for most people. For me at least.

KR: 00:36:20 I'm learning a lot about marathons. I had no idea you had to do all of that, so that's cool.

AT: 00:36:27 It's interesting because even when you train, you're not supposed to go longer than nineteen miles or so—nineteen or twenty miles. Most people don't hit the "wall," when most people run out of nutrients, around nineteen to twenty-two miles. You don't typically experience that until you're fully in the race.

KR: 00:36:47 How many miles is a full marathon?

AT: 00:36:50 26.2.

KR: 00:36:53 Oof, okay. Do you see any relationship between your focus and energy for your marathons and the work you do, especially navigating failure and things like that? Let me go back. You started running marathons when you were here?

AT: Yes, when I was here.

KR: You have all these formative experiences with Art in the Medical Device Center, especially around failure. Do you see any relationship between that and how you approach your marathon running?

AT: 00:37:23 I have a relatively high tolerance for-I don't even know what the word would be. I am willing to have a long horizon for a payout, basically, is what I would say. Personality wise, I wouldn't recommend grad school to a lot of people. Not because they can't do it, but because they wouldn't enjoy it at all. I tell people that. I'm like, "Look, it is kind of difficult to go three years or four years and people ask you, 'Oh, when are you going to be done?'" You don't know until three months away, the exact date you're going to be done. It's very frustrating because you have to do your research, get your results, write your thesis, and your thesis has to get reviewed. A lot of times your professors will recommend—you have four professors that review your thesis ultimately—they recommend that you do something else, so that adds another month.

00:38:17 It was frustrating when people would say, "Oh, when are you done?" You're like, "Well, I don't really know. It will be probably in this range…" [Both laugh]. I've always been relatively willing to deal with that long horizon, which is the same sort of thing as a marathon that you start training months in advance. I usually end up training by myself. Almost everybody will train by themselves for long stretches of it too. It is relatively difficult to think, "Okay, the payout is going to be when I get to mile twenty-two. There's still four more miles to go and I'm tired." I would say that it does take a sort of odd personality to want to do both those things, I think [Both laugh].

KR: 00:39:06 I get that sense of delayed gratification and just trying to hang in there for the long haul. My grandmother was asking me when I was going to finish my dissertation, and I was like, "Granny, I haven't even started writing yet. I just went ABD [all but dissertation]." She was like, "Oh, so you're going to do that, and then you're going to write your book." I was like, "Let me get through the dissertation first. Let me celebrate the diss, and then we'll worry about what's on the other side." Let's talk a little bit more about what you think it takes to be an innovator in medicine and technology today.

AT: 00:39:47 People will say, "Wow, they invented something, or they came up with some brand-new technology!" But what a lot of people don't understand is that almost all new technology is just combinations of currently existing tech. I think the biggest thing it takes to be an innovator is to just

pay attention to the world around you. Think about why somebody designed something the way that they did. Think about, in your own designs, whether you can incorporate something that somebody already made. Maybe you'll see a piece of a machine that works a certain way, and you're trying to design your own machine that does a completely different function. But you really like the way that this one piece achieved that. That's the fundamentals of engineering. It's perfectly fine to use a solution that somebody else has already done, or at least a portion of it, and incorporate that into your own work. That's what almost everything is really… better and better combinations of previously existing technology.

00:40:53 Almost everything I've ever built over the years has been, "Oh, I really like the way that that thing worked that I saw," or I'll make a little note or take a picture of something that I think is unique. When they went about something cleverly. I think that's the biggest thing, is paying attention to the world around you. Thinking about and trying to understand the intention of designers when they make devices. And like I said, it can be something totally unrelated. I've taken principles of 3D printers before and applied them to a device that has nothing to do with 3D printing.

KR: 00:41:40 Can you give me an example of a particular technology that you took and then built around? Or a particular device?

AT: 00:41:47 Sure. The Coventor, if you want to talk about that, is the exact same mechanism that you find in a car engine.

KR: 00:41:56 Wow. Say more about that. That's so cool.

AT: 00:41:59 Art's big focus of research, before he founded the Medical Devices Center… One of the things that's fascinating about Art is that he basically had multiple careers in academia. All in the space of his one lifetime, which is extremely unusual. He wrote an entire book on mechanisms in the eighties, I believe, which is used across the world in many different universities.[1] For a lot of professors, when you write a textbook, that is your crowning achievement of your career. But after he finished that, he started the Medical

[1] A. G. Erdman and G. N. Sandor, *Advanced Mechanism Design: Analysis and Synthesis* (Prentice Hall, 1984)

Devices Center. He's covered a lot of ground in his career, which is amazing.

I did mechanisms work with him. One of the fundamental mechanisms is a slider crank mechanism, and that's the same thing that you'll find in the car engine. Some of these probably have some slider cranks on them too. But in terms of the Coventor, there's probably eighteen different ways to do exactly what we did. Other people try to do different mechanisms to achieve the same goal. I was comfortable with the slider crank mechanism. I'd studied it, I'd done analysis on it, and everything. For me, it was a pretty easy transition. But it's the of thing that you see all over the place.

KR: 00:43:20 When you say you did analysis on it, what do you mean?

AT: 00:43:22 Homework problems. I did a project as an undergraduate with a slider crank mechanism. I built a couple of them to test out the error design for a totally different project. I built a couple rudimentary slider crank mechanisms before too, so I understood how to make it work and some of the things not to do. That type of thing.

KR: 00:43:48 Dr. Richardson calls Art with this idea for what becomes the Conventor. Then Art contacts you and asks you to prototype it?

AT: 00:44:01 That's exactly what happened. Another awesome thing that Art did was when he started the Medical Devices Center, he said, "I want it to be physically located next to where physicians are." Steve [Dr. Stephen Richardson] had walked by the Center multiple times on the way to the OR [operating room], or to clinic. He's an anesthesiologist. The anesthesiology office is in the same building as the Medical Devices Center, and sometimes you'll walk by it to get to the anesthesiology office. He had seen it before and he thought, "I wonder if they could help me with prototyping." That's exactly what happened. He came in. I happened not to be there that day, but he talked to Art. Art emailed me and asked me to make them a small piece of the prototype that they were currently working on. I went and helped them test the device, and I made a couple of on-the-spot modifications to help us get through that test that we had done. From then on, that's when we took off with it.

KR: 00:45:05 When you enter the project, you're already thinking that you want to go with the slider crank mechanism. Is that where you start or is that where you wind up?

AT: 00:45:13 They had already done a slider crank, but they had some issues with it. It was at a point where we could have stuck with it, or we could have quickly pivoted to something else. I thought it would be easy to make it work as a slider crank, especially with the tools and materials we had on hand.

KR: 00:45:33 Is that basically the driving mechanism of the machine? The thing that mimics what a person would be doing, inflating and deflating the bag?

AT: 00:45:44 The driving mechanism, correct. The whole point is that you have a motor. The motor rotates and you want to turn that rotation into linear motion. That is what the slider crank does, turns rotation into linear motion.

KR: 00:45:54 Awesome, thank you. I like to know how things work because I'm a nerd [Both laugh]. You're doing all this amazing work at the U in 2020. You're what? Twenty-four? Twenty-five?

AT: 00:46:09 Twenty-four, turning twenty-five.

KR: 00:46:12 You're in the middle of your program and COVID-19 hits. Can we talk a little bit about how COVID-19 impacted your education and your life in general?

AT: 00:46:24 I mean, this was most of my life for six months of COVID-19. It was funny because we were working nonstop on this for about, I would say it was twelve to fourteen-hour days for a solid six weeks on end. Everyone else is going home and they're panicking. Everything's changing, and I really didn't pay attention to any of it. I was just head down working on this, making sure that we had a viable concept, making sure we could push it forward, and making sure that we could get it out the door into the hands of people that needed it. It was odd because I never really went home to work. I worked in person for months. Even after we finished, or we had done the bulk of the project, I continued to help maintain the labs. It was a little different for me than for a lot of people. It was odd because I dropped everything and focused on a single concept, which I'll probably never do again. I have read a lot about

engineering in World War II, especially because there were huge technological jumps in that war, even compared to the First World War. It felt like that. Like okay, it doesn't matter what else is going on—just focus on developing weaponry or defensive technology, that kind of thing.

KR: 00:47:50 Are your parents encouraging you to come home at this point, or what's happening personally?

AT: 00:47:57 From the beginning I was like, "I'm working on this. We're getting somewhere with it." They're in Albuquerque, so even then, I don't think I would've gone home. I would've just stayed here because I had a lease. My dad was really interested in it, and he loves technology. I kept him updated about that kind of thing. [My family] were all working at home. My sister moved home. She was an undergraduate at the time. They were all together, but I was still here working on the Coventor.

KR: 00:48:33 That's so interesting that your father had this experience with anthrax. I remember when my dad got the vaccine because he was in the Air Force. And this is one of the really big things in your career, at least up until this point, because you're only twenty-six?

AT: 00:48:49 I'm twenty-eight now. I was twenty-four during COVID-19.

KR: 00:48:52 You're only twenty-eight, and you've already done this. Your dad has this anthrax thing. Your grandfather, you said, worked in World War II, he was an engineer.

AT: 00:49:05 My great-grandfather.

KR: 00:49:06 Your great-grandfather. Now you've got this Coventor thing that I've seen all these articles about. So how does that feel for you to be in this lineage of innovators and doing this kind of work?

AT: 00:49:24 It's funny because the Coventor is such a simple concept, which was the point. But it is so simple that it almost feels like, "Well, I mean, anybody could have done it really." I just happened to be at the right time, in the right place. They had enough experience, and I had a great team to work with. I was able to get it to the point that it was along with everybody else that worked on it. It was great to talk

to my grandpa about it after because we hadn't seen him for a couple of years. Obviously, because he was quite old, we were all staying away from them for the sake of safety. He was excited to hear about it. I sent him all the news articles and everything, and he really enjoyed it. It was great because, like I said, I grew up hearing about everything that he had done.

00:50:12 He did designs on two of the fighter jets that the US has used for many years. He worked on the F15 and the F18 when he worked for McDonnell Douglas. I would say it was relatively satisfying because for his work, the F15 has a couple of noticeable notches on the elevator wings in the back. We call those the "Paul Tucker Notches" because he was the one who suggested them. It's cool to have to have my own thing, but like I said, really nobody could have done it. I just happened to be in the right place at the right time.

KR: 00:50:48 Well, it's very similar to what they say about Art, right? Anybody could do that, but that person did it. It's simple, but you did it. I think that that's important to note. I think that there's this beautiful lineage being traced in terms of engineering in your family. It is delightful. I'm sure you're making your family proud, and it's nice to hear you talk about it.

AT: 00:51:19 They were very happy when I went to go get my PhD. They love education [Both laugh].

KR: 00:51:24 You are basically coming, not fresh out of school, but you've been in school for a while. Now you said you're self-employed and you've started your own business, and so what are some things that you are hoping to explore for yourself now that so much of your time isn't being taken up by school?

AT: 00:51:48 I got a great offer to work on a startup with some people that I had met through the Medical Devices Center. But I wanted to be able to continue working on multiple concepts. I also want to be able to start my own company focused on my own technology at some point. It would be nice not being tied down full-time to a particular job because there are certain obligations that come with that. The ability to continue exploring things I'm interested in on

my own is exciting to me. I'm hoping that, like I said, I can keep it going for a while.

KR: 00:52:28 Is there anything you are looking forward to traveling to do any marathons?

AT: 00:52:35 You don't get paid very well as a grad student, so I sadly wasn't able to keep up in-person with a lot of my friends in grad school. It's been about a year since I graduated, so I've been doing a lot of traveling and visiting friends I hadn't seen in a while. That kind of thing. It's nice to be able to go and travel on my own time and if I get my stuff done, it's not like somebody's going to tell me no, I can't take PTO [paid time off]. It's great being able to make my own schedule. Hopefully when it gets to the point of having kids, I'll be able to keep it going and be around them a lot, which would be awesome. Hopefully I can maintain it.

KR: 00:53:17 What are you envisioning for your future children in terms of, are you hoping that they continue the engineering heritage?

AT: 00:53:27 I think that would be awesome. It's not something that I would push them towards if they're not interested in it. I mean, it's not for everyone, that's for sure. You got to really like math, and I can focus on long problems. Not everyone can do that, which can be a benefit in many ways. People that can move on to the next thing quickly can do many interesting things. In marketing it's always about the next cool thing, right? It depends on who they are, what their personalities are. But yeah, I mean I love engineering. If they take that up, I'd be happy.

KR: 00:54:05 You come out the gate really enjoying math?

AT: 00:54:09 Oh yeah. I loved reading too as a kid. I didn't go outside very much when I was younger, so I started playing more sports. I used to win all the reading contests in elementary school.

KR: 00:54:28 Oh, that's cool. Do you have a favorite book?

AT: 00:54:30 *Count of Monte Cristo*.

KR: 00:54:32 Really? I love *Count of Monte Cristo*. I read that book back-to-back. [Indecipherable] is one of my favorite movies and books. I love the book a lot more.

AT: 00:54:40 I just restarted it again on the plane the other day [Laughs]. The last time I read it was 2016, I think. So, it was time for a reread.

KR: 00:54:53 Yeah, it might be time for me to reread it too. I haven't read it in a while. How would you say that your identity or culture has impacted your experience in medical technology?

AT: 00:55:10 I think so much of it, like I said, goes back to my family being willing and interested in exploring technology. My grandpa, like I said, was an aerospace engineer, so I just loved talking to him about planes. He's all into the plane news and what Boeing is doing, what Airbus is doing, and all that good stuff. Then a couple of my aunts and uncles worked at Boeing. Because Boeing bought McDonald Douglas. He worked at McDonald Douglas for the rest of his career and then ended up at Boeing after they got purchased. It's just always been a part of who I am. For me, I think more so than anything else, it was just the family encouragement to pursue engineering and to always think about the wider world, how things work, why they work that way, and why somebody intended them to work that way. That's probably the biggest thing.

KR: 00:56:08 In terms of your experience, again thinking about culture, how do you think that the culture of the field has changed since you've entered it until now?

AT: 00:56:24 Well, I haven't been in it that long, so it's a little hard to say…

KR: 00:56:31 It's okay if you don't have an answer too.

AT: 00:56:34 I have worked with quite a few different companies in this space, but I wouldn't say there's anybody that I've worked with for a long time. I think it's always interesting seeing when people decide to go pursue new startups and new companies. Seeing what interests people to move on from their current role. Because there's the big players like Boston Scientific, Medtronic, and you'll get people that worked there for many years and then suddenly, they

decide there's this new company I want to be a part of. I think what's interesting is that people in this field are very, very interested in the product itself, which you don't always get in a lot of other fields when you're manufacturing basic products. For example, cart wheels. It's fun to make your machines work and to increase your productivity, but a lot of people aren't particularly interested in cart wheels in and of themselves. It's a lot of fun because you get to buy a product. You get to buy into what a company is doing, and you get to see how your changes impact and improve lives. That's one of the things I've really liked about this field. People are very passionate about exactly what it is that they work on.

KR: 00:58:00 I like that you mentioned that. There's small things and infrastructures that make our lives work, which people don't always pay attention to. I hear that keep coming up in some of your responses to our questions, being attuned to those things is beneficial.

AT: 00:58:19 Of course, even for people that work on some of those less flashy technologies, like you said, they're extremely important for our everyday lives. Take away any basic mechanism, and things are a lot worse. The door mechanism is not a slider crank, but it is a four-bar mechanism up there and makes sure that it doesn't slam in your face when you are not quite paying attention to closing it [Both laugh]. Even take away some of those very basic things, and our lives are a lot different. In medical devices, it's great because you get to see firsthand, close-up exactly what the impact is of your work.

KR: 00:59:00 That's great. Tell me a little bit more about having a hands-on, detailed exposure and interest in different products. How do you then make the decision between going the startup route versus going to one of the bigger, more established companies?

AT: 00:59:23 One of the drawbacks of medical devices is also one of the necessities. The FDA, [Federal Drug Administration], of course, is a huge part of the way that medical technology advances. You have to get all your devices approved by the organization before they're able to be sold, which is obviously extremely important. You want strong regulation and oversight on these [medical devices], so that you're not doing things that are harmful instead of helpful. But by

nature, it means that products tend to move quite a bit slower than in some other industries. When it comes to my personal preferences, I like to do things that are new, exciting, and fast-paced. You don't always get that in a big company. You do oftentimes, but you don't always. A lot of times they're really focused on incremental improvements and making current devices better in certain ways. That takes its own cycle of time to get up and running through the FDA. It's something I would enjoy if I did it. But personally, I like to do newer and more exciting things. That's why I decided not to go for one of the bigger companies when I first started. I may end up there at one of them one of these days. I'm sure I'd enjoy it. I figured if I had the opportunity to do something like this now, then I might as well take it.

KR: 01:00:41 What is the name of the startup, if you can share?

AT: 01:00:46 It's in stealth mode, we'll call it. I have my own consultancy company. That's where most of the work comes through. I'm paid as a contractor right now.

KR: 01:01:02 Okay, that makes sense. I won't ask any more questions since it's in stealth mode. Do you anticipate staying in Minnesota? It seems like it's such a unique place for this kind of work. It produces a lot of technologists who do this kind of work. Do you anticipate staying here for the long-term to keep capitalizing on this Medical Alley situation? Or do you envision yourself going elsewhere?

AT: 01:01:32 I think I'll stay here, at least for the time being. Like you said, there is a huge ecosystem for it here, of which Earl Bakken is a huge reason. Yeah, probably for the immediate term.

KR: 01:01:45 We've been talking for about an hour at this point. Is there anything that you want to share that I haven't asked you about, or anything that you're hoping that I would ask you that I didn't get to?

AT: 01:02:09 That's a good question [Pauses]. One thing that we haven't touched on, which has been important and one of the things that the Medical Devices Center does better than almost anywhere else I've seen, is that it is important to work with multiple people in the technology spaces that you're

focused in. Like I said, the reason that we even worked on the Coventor is simply because we happen to be physically located next to where physicians work. There were lots of other people that had worked on the exact same concept basically as the Coventor. But because we happened to be situated in an ecosystem where we had direct access to physicians, direct access to regulatory experts, and direct access to the medical device industry—we were able to get ours out the door. Where lots of other people ran into roadblocks in not even knowing who to talk to or who to contact. I would say in addition to keeping in mind the wider world and the way that things are designed, I think it's important to expand your horizons and to speak to not only users, but other people inside the space of your products and your designs. Whether that's medical devices, or some other industry, that's a huge lesson that I learned. There's no substitute for speaking to players in that space.

KR: 01:03:56 It's interesting that you close this out with that because we were talking about that balance of extroversion and introversion. You've got to be in the space where the people are and talk with them. That's lovely. You're our third interview, and in each interview, it comes up how important it is to be in proximity or at least in conversation with people in terms of developing those relationships and developing ideas a little bit more. I love how that keeps coming up. It seems like it's a critical part of how folks think about innovation.

AT: 01:04:31 Oh, absolutely. And it's not actually totally obvious. I mean, people say it and it sounds obvious, but then like I said, there wasn't a physical lab space next to physicians at these other companies or schools that were working on similar concepts to the Coventor, and it was just more difficult for them.

KR: 01:04:52 You and your team were all able to come together and troubleshoot things to get through the first six months of the pandemic with a cool project, for sure. Well, the rest of us were kind of scrambling trying to find eggs [Both laugh]. Thank you so, so much, Aaron. This was really delightful and really informative. I really love getting to hear about your family and the role they've kind of played in who you are and the work you do. Thank you for sharing that with us.