Aimee Kennedy: 00:00 And if we don't all agree that education is a very tough problem that is absolutely worth solving, that absolutely does great things for humanity, then we're deluding ourselves.

Sam Bodary: 00:18 Check, check, check, check, check, check, check. Hello, everybody, and welcome for the very first time to Greater Than STEM. A podcast about real students solving real problems. But, just this once we're not gonna actually talk to students. No, no, no, I know, it's okay. We're gonna consider this episode zero. Is that all right?

Speaker 3: 00:36 I guess so.

Speaker 4: 00:36 Okay.

Speaker 5: 00:37 I get it.

Speaker 6: 00:38 Fine.

Sam Bodary: 00:38 I want this episode to be just a little introduction to set the stage for the stuff to come. First things first, my name is Sam Bodary. I work at the largest nonprofit research and development organization in the world, Battelle Memorial Institute. It's a place that solves big problems with science and engineering. We're gonna learn more about that later. But, I'm not a scientist or an engineer. I've got a BA in English and a background in afterschool programming. I'm an office assistant on this education and philanthropy team at Battelle. We do work to make STEM education accessible to all students regardless of their zip code.

 Now, today, Battelle employs around 20,000 people and manages national labs across the country solving huge problems for people around the whole world. But, this place wasn't always an R&D superpower and it didn't always have an education team. And I only started working here two years ago. So, before we jump into the regular podcasts, I wanted to figure out how Battelle got here, partly just for my own benefit because I'm curious about it. But I wanna trace the history from before the Great Depression through almost a century all the way to today when they hired me as an office assistant.

 But to do that, we have to go back in time to the late 1800s.

Russ Austin: 01:59 I never do this without notes.

Sam Bodary: 02:01 Russ Austin is Battelle's general counsel. He's the big lawyer at the top.

Russ Austin: 02:05 My mom insisted that both my brother and I become musicians.

Sam Bodary: 02:10 So he's still got a piano and he's got a trombone in the basement. But he's been at Battelle for over a decade. And if anybody has any big legal questions, he's the guy to talk to. He's also a big Battelle history buff. Let's start with Gordon's dad, John Gordon. He owned the Columbus Iron and Steel Works and was a big industrialist of the time.

Russ Austin: 02:33 And so the family business interests as well were also in metal processing, the steel industry and things like that, so very well aligned with metallurgy in that sense.

Sam Bodary: 02:44 Stop. Metallurgy. Metallurgy is a flavor of science and engineering that studies the physical and chemical behavior of metallic elements, their compounds, and their mixtures. In general, metallurgists are problem solvers. They try to change the properties of metals to make them better at whatever somebody's gonna use them for. Like you know how aluminum can be used everywhere, from soda cans to foil candy wrappers to cars and airplanes? That's metallurgy at work. So, John Gordon worked in iron and steel, so that's where most of the Battelle fortune initially came from. But that's just one half of the power couple. John Gordon married Annie Norton in 1881. In her own right, she's pretty rad.

Russ Austin: 03:27 I would look at two things. She was the first female member of the Republican National Committee, and then she picketed for women's suffrage at the Republican Party Convention. This is back in the 20s, so this is being way ahead of your time for a woman in this country at that time.

Sam Bodary: 03:42 Obviously no slouch.

Russ Austin: 03:44 A great business leader, a great political leader at her time, and a strong supporter of her son's vision for the Battelle Memorial Institute.

Sam Bodary: 03:53 Okay, we're making progress now. So she delivered her son, Gordon, on August 10, 1883. Obviously the kid didn't want for much. But apparently Gordon was pretty level headed.

Russ Austin: 04:04 Not a typical rich man's son, very serious minded, not flashy either in the way he dressed or the way he spent his money, very modest in taste and habits. Had a lot of friends, very well liked and very well respected in the community.

Sam Bodary: 04:19 So he learned about the family business and then about metallurgy proper of course.

Russ Austin: 04:24 He attended the Sheffield School at Yale.

Sam Bodary: 04:28 That was a pretty hands-on program, a lot different than most of the classical liberal education that most universities were providing at the time.

Russ Austin: 04:35 This was a strong technology focus, and he believed in that. And he went there for a couple of years and learned a lot about metallurgy.

Sam Bodary: 04:42 Oh, metallurgy, we love you, metallurgy. Despite the education, he remained an enthusiastic hobbyist in science. He could be conversational, but he wasn't working directly with the materials, even though John Gordon had him start out that way.

Russ Austin: 04:56 And one of the things he did was he started off understanding the family's business by working in the blast furnaces to learn what it was all about before he became in charge of anything. And that kind of thing was very influential on Gordon. So he learned a lot from that and then became a very effective leader of the family business interest after his father passed away.

Sam Bodary: 05:22 Before he died, John Gordon sold the Columbus Iron and Steel Works to the American Rolling Mill Company, leaving $1.5 million to his son, Gordon. Business responsibilities fell to Gordon and then Annie. Now, as I said before, Gordon wasn't a scientist proper, but neighbors said that he could talk for hours about the promise of research. This was a new idea at the time. GE had only started it's first lab around 1900. However, despite his talk, Gordon was never able to see his talk become reality.

 So, what led to his death and what led to his early death?

Russ Austin: 06:01 Well, Gordon was 37 years old when he wrote his will in 1920. And he needed an appendectomy three years later, in 1923, which is pretty routine now, but at the time was less than routine. And after the appendectomy, which was done here in Columbus, Ohio, he developed an infection, he became bedridden. Because of that wasn't able to move around enough and they didn't know as much about those things then as they do now and developed a pulmonary embolism and that's what's listed on his death certificate as the cause of death.

Sam Bodary: 06:39 So, he died early. But, his ideas and his hopes made it into his will and Annie's. So then when they died, how much money did Gordon leave for the institute and then how much money did Annie leave for the institute?

Russ Austin: 06:57 Sure, so Gordon, when he passed away, through his will left $1.5 million for the purposes of the Battelle Memorial Institute. And then a couple years later when his mother passed away she left $2.1 million. So that's about $3.7 million total. And in today's dollars if you're to bring that forward would be about $51 million. So a really significant amount of money to get a business started.

Sam Bodary: 07:24 So, at this point, we've got two important pieces. We've got a mission spelled out in the will. And then we've got some serious cash. So I guess we've gotta look at the will so we can learn about the mission to see what he wanted that cash to accomplish in the world. So I pulled a couple things from there that I wanna go over with you because you're the lawyer here. But I wanna stop at a couple different spots and I wanna get maybe your translation in layman's terms.

 "All the residue in my estate of every kind and character ..."

Russ Austin: 08:06 I mean, that would result in the $1.5 million that was left for the Battelle Memorial Institute.

Sam Bodary: 08:12 "I give, devise, and bequeath ..."

Russ Austin: 08:15 This is just language that's deemed legally important and acceptable when you're making this type of a bequest, creating a charitable trust like he was through his will.

Sam Bodary: 08:27 "To the trustees hereinafter named ..."

Russ Austin: 08:30 A collection of friends of the family, business associates, but it also included his mother and it included President-elect Warren G. Harding.

Sam Bodary: 08:38 "For the foundation of a Battelle Memorial Institute." Hey, that's where I work. "To be established in such a manner as said trustees may designate in accord with the laws of the State of Ohio."

Russ Austin: 08:50 Whatever you do with this amount of money or other assets that we're leaving for this purpose has to be done consistent with the laws of the State of Ohio.

Sam Bodary: 09:00 "And located in or near the city of Columbus, Ohio." Does this mean that Battelle will always be in Columbus, Ohio?

Russ Austin: 09:07 Yeah, that's pretty much the case. That is one of the requirements of the will is that the corporate headquarters and certain of the executive officers of the corporation work here in Columbus, Ohio.

Sam Bodary: 09:20 "For the purpose of education, in connection with and the encouragement of, creative and research work and the making of discoveries and inventions in connection with the metallurgy of coal, iron, steel, zinc, and their allied industries." Dang. Okay, so that's the original will. Is that still relevant to today?

Russ Austin: 09:42 So, the original purpose here that Gordon set forth was very well aligned with the family's business interests, which would have been in metallurgy, coal, iron, steel, things such as that. That has evolved over time to make them more contemporary and allowing us to do more things that are in the areas of science and engineering and technology and things like that.

Sam Bodary: 10:08 All right, so that's how Battelle gets started back in 1927. And pretty soon they got the best of the best in metallurgy working together under one roof. They're doing good work, but they haven't become capital B Battelle yet. To do that, they have to go beyond just metallurgy. We're gonna get back in the time machine and jump forward about a decade to the mid-30s. And go. Here's the story. There's a young patent attorney named Chester Carlson. And he's working on an invention that will change every office in the world. But, right now, nobody really sees that but him. When he died, his company would be close to making a billion dollars. That's $10 billion in today's money. He wasn't even a stellar student. He didn't even have a fancy laboratory. All he had was a problem and the persistence to work through failure to change the world, and change Battelle.

 This music opened an interview that he did in the 60s. So yeah, he's a big deal.

Chester Carlson: 11:06 Since childhood I had been interested in the graphic arts. And in my high school years I worked in a print shop. And also I acquired an old printing press and some type. And I set out to publish a little paper for amateur chemists.

Sam Bodary: 11:27 So keep in mind that Chester was born in 1906. He's in his teens self-publishing a newspaper in the early 1920s, around the same time that Battelle was just getting started. But, duplicating a paper takes time. And not just for kids making newspapers after school.

Chester Carlson: 11:47 Well, in the course of my patent work, I frequently have need for copies of patent specifications and drawings. And there was no really convenient way of getting them at that time. Often long detailed specifications had to be retyped a second time with consequent typographical errors creeping in.

Sam Bodary: 12:12 And that's not even getting into the drawings and schematics, which then had to be sent physically out of the office to a photocopy firm. It took a whole bunch of time and a whole bunch of money, and there had to be a better way.

Chester Carlson: 12:22 So I went to the New York Public Library, the technical division, and spent many hours there going through the literature on the ways that light could affect matter.

Sam Bodary: 12:36 All right, so I'm being cagey about what exactly he invented, but we're getting closer. We're dealing with duplication, we're dealing with light, we're dealing with offices. Carlson called the process dry printing. But a classical language professor at Ohio State suggested combining two Greek words, xeros for dry, and graphien for writing. And so we get xerography. That company that was making almost a billion dollars when he died? That was Xerox. That still is Xerox.

Daddy: 13:06 Debbie, will you please go make a copy of this?

Debbie: 13:06 Okay, Daddy.

Sam Bodary: 13:14 Also again, this music is amazing.

Daddy: 13:18 Thank you, Debbie. That was fast. Which is the original?

Debbie: 13:21 I forget.

Narrator: 13:22 You've just seen the Xerox 914 copier. It makes your first copy in less than a minute. Seven copies a minute after that. The 914 makes copies on ordinary paper automatically. For the name and number of your nearest Xerox office, look in your telephone book.

Sam Bodary: 13:42 Okay, but it wasn't that easy. He spent 15 years failing again and again and again before anything ever got even remotely close to being copied. That's part of it. That's probably the most important part of solving any new problem. So now that we showed you the end, let's learn about the beginning.

Chester Carlson: 13:59 Well, in the beginning, I worked in the kitchen of our apartment in Jackson Heights, Long Island.

Sam Bodary: 14:05 Right on, Chet. Can you take us back to your kitchen during one of the early experiments?

Chester Carlson: 14:13 So, I began experimenting in the kitchen of our apartment to make a sulfur plate. I went to an art store and bought a polished zinc plate, and to a chemical supply house and bought some chemically pure sulfur. And I took them home, and to make the coating on the plate I placed some of the sulfur onto the plate. And in the kitchen I held it over the gas burner to melt the sulfur and spread it over the plate. Of course in such an uncontrolled experiment, the very first thing that happened was that the sulfur caught fire and the apartment was filled with sulfur fumes. My experiments were not very popular after that.

Sam Bodary: 15:08 Right now we're hearing the very beginning of the design cycle. Step one, identify the problem. Things take too long to duplicate. Step two, do some background research. He went to the library. Step three, start failing. A lot. In this case, in the kitchen. Remember that old Edison quote about failure? He never failed, he just discover 10,000 ways that didn't work. This is that part.

Chester Carlson: 15:34 After a year's work, I still hadn't made an image yet. And so I didn't really know whether the process would work.

Sam Bodary: 15:45 But, with a little help from an out of work physicist ...

Chester Carlson: 15:47 We succeeded in making the first image on October 22, 1938.

Sam Bodary: 15:52 Success. So I'll just queue up the victory music over here, and I'll get it going.

Chester Carlson: 16:00 Not quite.

Sam Bodary: 16:01 Really?

Chester Carlson: 16:02 There followed six more years of working alone trying to perfect the process.

Sam Bodary: 16:10 Six years. He copied something, he proved the concept, he knew that his invention was gonna change the world. But people still couldn't see the future that he knew was coming.

Chester Carlson: 16:21 I must have talked to representatives of more than 20 companies in those years.

Sam Bodary: 16:27 So at least one of them probably believed in him, right?

Chester Carlson: 16:30 Without success.

Sam Bodary: 16:31 Ouch. Well, he had to have found somebody who had faith in him, right? Some organization that believed in the power of research, some folks that believed in inventions that could change society, some people who were looking to expand beyond metallurgy?

Chester Carlson: 16:48 Well, finally in 1944, I met a young engineer from Battelle Memorial Institute.

Sam Bodary: 16:57 Hey.

Chester Carlson: 16:58 Which is a nonprofit research organization in Columbus, Ohio.

Sam Bodary: 17:01 We know that, Chet. But thanks anyway.

Chester Carlson: 17:03 And I showed him my patent and told him about my idea. He went back to Battelle and showed it to some of his associates there. And the next time I saw him he told me that they would like to see me. So shortly after that I visited Battelle, and they told me they were interested in an arrangement me in which we would agree to share the royalties in the process in exchange for which they would do some development work at their own expense. And they started work in 1944.

Sam Bodary: 17:49 Yeah? Success. He did it. All right, no, uh. Success music, celebration, here we go. Can we do it? Yeah.

 So, Battelle helped develop the prototype, and then they sold the license to the Haloid Company in 1947. Then they sold xerography devices through the 50s. And finally in 1959 they unveiled the Xerox 914 office copier, setting the cubicle world on fire. I’ve never been this excited about copiers. This success was a huge part of Battelle's general success in the 60s and beyond. Now they work on all kinds of stuff, but they still stay true to the will from the 20s. They're still a nonprofit with a strong philanthropy arm. That finally brings us to my office's work in STEM education.

Aimee Kennedy: 18:40 Oh my gosh, if you walked around our offices, you would see in every single office a plate with the will on the plate.

Sam Bodary: 18:49 Meet my boss.

Aimee Kennedy: 18:51 My name's Aimee Kennedy.

Sam Bodary: 18:52 Now Dr. Aimee Kennedy.

Aimee Kennedy: 18:53 I have the fabulous job of directing our community engagement portfolio, which happens to be focused on STEM education.

Sam Bodary: 19:02 Aimee's a great boss for a bunch of reasons. But my favorite one is how she thinks about education as a former teacher.

Aimee Kennedy: 19:10 The whole reason that we exist, our entire mission, is to do the greatest good for humanity, to solve the world's toughest problems. And if we don't all agree that education is a very tough problem that is absolutely worth solving, that absolutely does great things for humanity, then we're deluding ourselves. So at Battelle, that's how and why we work. So in plain English, I make grants to organizations who are interested in implementing STEM education activities in their work.

Sam Bodary: 19:42 And our office has a pretty particular view on STEM education.

Aimee Kennedy: 19:46 STEM for us at Battelle, for me as an educator, for me as a parent of a STEM kid, needs to be so much more than four subject areas.

Sam Bodary: 19:56 That's science, technology, engineering, and math.

Aimee Kennedy: 19:59 Because if all it took to be STEM was to teach a lot of science and use computers and offer AP calculus, any school could be STEM.

Sam Bodary: 20:07 Now, that's not to say that any school can't be STEM, it's just greater than doing the S-T-E-M. Because problems in the real world don't have to do with any one subject. Chester Carlson wasn't just book smart. He was curious, he was persistent, he was a learner, going off into a library to teach himself whatever he needed to solve his problem. Same thing with Gordon. He wasn't a hard scientist at the top of the field, but he knew that research could change the world. So he collaborated with people and put together a thoughtful will. Without that, the Institute would never have existed in the first place.

 But, how do we teach all those skills in schools? Can we? Well, at Battelle, we use design challenges. Let's go step by step.

Aimee Kennedy: 20:54 Steps of the design challenge, when you mentioned Chester I was like, "I have to talk about the opportunity to redo your work or all the STEM teachers are gonna be like, 'Aimee Kennedy missed the opportunity to say this.'"

Sam Bodary: 21:05 Design challenges might be a foreign concept to a lot of people. Can you describe briefly what a design challenge is?

Aimee Kennedy: 21:12 So, design challenge is a complicated, complex problem that is real. It's not something that we made up. It draws on multiple disciplines to solve it. So it's not a really hard math problem. And it requires that you develop a solution that does not exist.

 So, a design challenge follows the design cycle, and I think this is another really unique part of STEM education that would be really easy for anyone to implement, STEM or not STEM, and would make a huge difference in the appetite for education of kids in your school and in your class. In the design cycle you start with identifying a problem. In the case of a design challenge, some that I've shared, sometimes Battelle has identified a problem, sometimes you look to an international agency to identify a problem, sometimes there is a problem that's happening. And then you hypothesize, it's not that different, very scientific method-y. You hypothesize some potential solutions. You might take some time to socialize those with other experts or other colleagues. You might do some prototyping. You kind of do some little testing. And then you give it a shot and you develop your solution and then you try.

 Now, it is rare that the solution's gonna work right the first time around. After you try, you have to go back and revise. That step where you fail, you fail fast, you fail forward, failure's part of the process. Failure happens, it should happen. If it doesn't happen you're not being innovative enough. So you try and you go back and you fix. And then that could be a little loop that you stick in for a while. You try, go back and fix, try, go back and fix, try, go back and fix. And then, once you have your solution, you present. You share. You add to the field. You get feedback from other experts. You think about what's next. And then the whole solution starts over again.

 Actually, I have a perfect story for that. We did a design challenge at Metro. It was after the earthquake in Haiti several years ago. The challenge was to develop a system to clean the water, improve water quality in Haiti. And I thought to myself, "This is kind of a silly design challenge. Obviously you're just gonna filter the water. Hello. How many solutions can there be?" I was blown away. So kids came up with all kinds of examples. For example, using solar power to filter water. Planting trees that roots have property to filter water. Making a straw with the filter in it, so people had individual filters. And it clicked in brain so loudly and so immediately. I was like, "Oh yeah, that's why you have to give kids open-ended problems. You have to help the structure their time and all that stuff, but they will come up with amazing solutions."

Sam Bodary: 24:34 Aimee doesn't just talk a good game. She was a teacher. And this is how she ran her class for years.

Aimee Kennedy: 24:40 Yeah, I was an English teacher for about eight years in one of Ohio's big urban eight districts. So Canton, Ohio is where I taught English. I became an English teacher because I loved reading. And it did not take me long to figure out that students don't necessarily always share my love of reading. So I had to do a better job in my class of understanding how I could get students engaged, how I could make reading and writing relevant to them, and how I could quickly diagnose where they were on the achievement spectrum and push them as far as I could.

Sam Bodary: 25:22 So Aimee left Canton schools to teach at the Metro School. This is Ohio's first STEM school. Battelle started it on the campus of the Ohio State University in 2006. Aimee took those classroom strategies into STEM education. And she then became Metro's principal. And then from there, Battelle hired her. And even though she's not in the classroom anymore, she still talks and thinks like a teacher.

Aimee Kennedy: 25:47 STEM is a great way to showcase excellence in every kid. Because for the kids who are very good at math and science and English already, they're great at school, they know exactly how to do that, they have a lot of opportunity, in a STEM school, in a regular school, to be recognized for that, to do that, to do it well. In a STEM school, they get to go as far as they can. So that might mean for a kids who's really gifted in math, you're doing some incredibly advanced personalized study with a professor, a 600 level course, that might be where you end up. And STEM can provide that for you because we're about personalization and real world experience. But for a kid who struggles a little bit in school, a design challenge where you have to present and talk about your work, and you have to work with other people, can be your shining moment. Because you might not have a skill set that gets assessed on your report card every term, but you might have a skill set that you can work with very difficult people, or you can talk to strange adults about your work, or you can defend your thinking. And so those are ways when kids who shine in that way, they get to do great at a STEM school too.

Sam Bodary: 27:08 Today, Metro isn't the only STEM school around. Battelle established the Ohio STEM Learning Network to connect schools who believe in STEM education. And now over 50 schools are designated as STEM in Ohio. They focus on real world critical thinking skills that help students solve the biggest problems. And Battelle is still working on solving those problems almost a century after it opened its doors.

Aimee Kennedy: 27:32 We have a new CEO here, well, he's not that new anymore, he's been here almost a year. But the first thing that he said to us was, "Okay, great, we've been doing great work for the last 90 years, but what's the next 90 years gonna look like? Because we have a responsibility to carry on the mission of the Battelle family." And our whole senior leadership team was like, "Oh my gosh, yes, we have to be thinking the next 90 years, not the next 18 months."

Sam Bodary: 28:02 What's your design challenge now at Battelle?

Aimee Kennedy: 28:06 Oh, my design challenge at Battelle is definitely ... the biggest one is scaling Metro. Our new CEO is like, "What you're doing is great. I'm really proud of the work that's happened so far. I'm amazed that we have schools all across the state who are interested in doing this. But we need to do more. Our mission is to encourage research, creativity, and discovery. We need to be doing that more." So he's literally given me a challenge to say, "How many kids could we serve over the next decade? What do we need to do? Where do we need to house them? How do we get the teachers ready?" All that. So that's our design challenge right now.

Sam Bodary: 28:46 So, what's my design challenge with this podcast? Well, I get to see students and teachers in action every week. And I can write up blog posts until my fingers bleed. But it's really hard to tell a story without hearing the students' voices for yourself. So, here's my solution. I'm driving to STEM schools all across Ohio interviewing students about a problem in their life, community, or world. Then I'm gonna take all that to professionals who work to solve the problem every day. If a student's concerned about space junk then we're gonna talk to NASA. If a student's passionate about pollution, then we're gonna go to a Battelle environmental scientist. You and I get to learn along the way. So that's how it's gonna work every month. We're gonna look forward to another student, another problem, another solution, and another perspective, all adding up to something greater than STEM. Thanks much to Russ Austin, Aimee Kennedy, and Chester Carlson. Big thanks to Glenn Davis for mixing. Check him out at glenndavisaudio.com. That's Glenn with two Ns. Next episode and every episode after that we start with the students. Happy episode zero. See you at episode one.