AdvanceRIT Podcast Series

Faculty Spotlight: Trailblazing Faculty at RIT

Season 03: Episode 01: Dr. Callie Babbitt

Dr. Malar Hirudayaraj: Welcome to AdvanceRIT's trailblazing faculty at RIT, the podcast series that celebrates faculty whose work and accomplishments are shaping research, innovation, and education across disciplines. I am delighted to welcome Dr. Callie Babbitt, a leading researcher in sustainability and the circular economy in RIT's Golisano Institute for Sustainability. Callie's research addresses some of the most pressing environmental challenges of her times, from electronic waste and resource recovery to food waste and the growing challenge of lithium-ion batteries from electric vehicles. Her work has earned significant recognition, including an NSF CAREER Award and a Fulbright US Scholar Award, and has taken her beyond academia into international policy discussions, including serving as a US delegate to the G7 environment ministers' meeting. Today, we will explore Callie's research journey, the accomplishments and experiences that have shaped her career, and what she sees as the next big challenges in sustainability. Professor Babbitt, welcome to the podcast. It is wonderful to have you with us.

Dr. Callie Babbitt: Thank you so much for having me. I'm delighted to be able to share with this audience.

Dr. Malar Hirudayaraj: Thank you. So I would like to begin with your personal journey. How did you find your way into sustainability and environmental research? Was this an area you always imagined building your career around?

Dr. Callie Babbitt: Well, to think about how I got into sustainability actually requires me to go back even further into how I got into engineering in the first place. So I grew up in a very small town in North Florida, and the leading industry there is a pulp and paper mill. And when I was in seventh grade chemistry class, an engineer from the pulp and paper mill came to our career day and told us about what it meant to be a chemical engineer. And I thought she was the coolest thing I had ever seen. She had this crisp white shirt, penny loafers with real shiny pennies in the, in the pocket. And she had mason jars of wood pulp at different stages of the bleaching process. And she said, a chemical engineer's job is to use math and science to solve problems. Like at the paper mill, how many, how much chemicals do we use? What temperature do we digest the pulp? How long do you bleach it? The desired state that someone wants in a product that's made from pulp, like diapers or wood or other fibers.

Dr. Malar Hirudayaraj: Okay.

Dr. Callie Babbitt: And I thought that was the neatest sounding job ever. So I decided right then and there when I was 12 years old that I would be a chemical engineer.

Dr. Malar Hirudayaraj: Interesting.

Dr. Callie Babbitt: I quickly found out that all the people at the mill got their degrees from engineering schools like Georgia Tech or University of Florida or other places. And so I said, I'm going to Georgia Tech. And I applied. I went to Georgia Tech to study chemical engineering. And when it came time to find co-op, I actually got a job back at my hometown pulp and paper mill and at Georgia Tech. At the

time, you did not go to different co-ops, you went to the same employer multiple times so that you got to gain experience and grow and develop in the job.

Dr. Malar Hirudayaraj: Okay.

Dr. Callie Babbitt: And as I was working there, you know, first of all, I would say pulp and paper mills don't smell especially good. They smell kind of like rotten eggs. And that's because when you pulp wood fibers, one of the chemicals that comes out is hydrogen sulfide and it has a rotten egg smell.

Dr. Malar Hirudayaraj: I know.

Dr. Callie Babbitt: One of the things that I learned is that people in my hometown say it smells like bacon and eggs. Not literally, but they mean it is a worthwhile sacrifice to have this noxious smell and odor pollution because they can put food on their family's table. Biggest and only big employers in the town. So very quickly I learned how important industry was for the economic growth of a town. Other formative thing that happened while I was doing my co-op at this mill was that I kept getting assigned to work on projects that had to do with environmental compliance. Some new law or environmental regulation had come out. Mill had to comply for it. And so the lowly co-op got sent out to take a bunch of samples and run analyses to help support this. And I was naive at the time, and I asked my boss, you know, every time I come back, you're trying to solve some new environmental problem or comply with some new policy, why not look five or ten years into the future and forecast where this is going and try to get ahead of the curve? Like, why are we just waiting for laws to come along? Why aren't we trying to do better and be greener now? And he was very nice, but he said, we're barely making profit this quarter. We don't have the money to invest in expensive green technology. And that was the moment that for me, the light bulb went on. Because I went to a great engineering school, I got a great engineering education, but I realized I had never learned anything about the environment, okay, Aside from complying with laws. And I started thinking, surely there must be technologies and solutions out there in the world that aren't expensive that could actually help this business become profitable and competitive and also sustainable. And so for me, that was the light bulb moment. And so instead of taking a job after graduation to go work in a factory, I decided to go back to grad school. And I then went on to do my master's and PhD in environmental engineering. And ironically enough, I was funded by a Department of Energy grant to develop environmentally friendly technologies for air pollution control at pulp and paper mills.

Dr. Malar Hirudayaraj: Oh God.

Dr. Callie Babbitt: Including the one in my hometown. So I really got to see that whole process come full circle. And during that process of my dissertation research, I learned about methods like one called life cycle assessment, which is knowledge. Life cycle assessment, which is a method we use in sustainability a lot to look at a technology very systemically. Like where do we get the raw materials, what is the energy consumption and manufacturing, what are the emissions during the use, and what do you do at the end of life? And we use this methodology to assess these new technologies for the wood products industry. So that really sparked my interest in continuing in the sustainability world because I could see a pathway to developing technology that would solve real-world problems, that would help economies grow and small towns prosper, but that would reduce damage to the environment. And that really is the crux of sustainability: how to balance these social, economic, and environmental goals in a win-win way. And that's really what set me on the path to then continuing into sustainability and then

now continuing into my own research into not only technology for industry but also lots of technologies for consumers, businesses, and companies to try to develop and use for their own benefit.

Dr. Malar Hirudayaraj: Interesting. Really interesting journey into, you know, it's, it's almost kind of come a full circle for you, right?

Dr. Callie Babbitt: Exactly, exactly. It's very circular. No pun intended.

Dr. Malar Hirudayaraj: Yeah, yeah. Your work has spanned, you know, electronic waste, food waste, and the circular economy, and more recently, rapidly, the rapidly growing challenges of lithium-ion batteries and electric vehicles. How has your research agenda evolved over the course of your career?

Dr. Callie Babbitt: Well, after I finished my PhD, I had the wonderful opportunity to go work at Arizona State University, where I did a postdoc working with a faculty member there whose interest was in electronic waste. And very quickly I learned that electronic waste is a really pressing and complex sustainability challenge. Electronics are critical to modern society all around the world. We use them for commerce, education, communication, and all kinds of different applications. And they're really good for society for the most part. There are, of course, challenges. Some of those challenges are environmental. Electronics require lots of scarce metals to manufacture. The manufacturing process itself is very high energy and demanding of high-purity chemicals that take a lot of environmental impact to make use of the products. We're consuming electricity to charge them and power them during their use. And when we're done using them, which is happening faster and faster as new technology comes out, it's very challenging to manage them in the waste stream. There are recycling technologies available, but a lot of consumers don't know about them. Sometimes you have to pay to recycle them. Just very inconvenient. And as a result, many of these electronics either end up in a landfill, all of those resources that went into their production are just thrown away, or in some cases, they get exported to developing countries where they may not be managed in a proper way. And so this was a very, you know, interesting topic for me. And I just found that it was a wonderful opportunity to kind of apply different concepts from sustainability. But then what I saw is that, you know, we're not doing better at learning from the experience. So electronics became a challenge because, you know, we're introducing new technology very quickly. Think about its environmental impact. We didn't have the necessary policy or infrastructure in place, and as a result, we're left with this big waste stream. Why aren't we learning a lesson from this? Because it turns out there's lots of waste out there in the world that we're doing the same thing for. Lithium ion batteries that are in electric vehicles. They are very high energy and resource intensive to produce, developing and using them very quickly, and we don't have policy or infrastructure in place for their end-of-life management. So I'm really interested in this idea about could we use the lessons that we learned the hard way for electronic waste and other environmental waste challenges and instead be more proactive? So I got very interested in the idea of trying to forecast or develop predictive or proactive models about these emerging waste challenges, streams that aren't yet a problem but will be if we're not careful about them. So that would include everything from solar panels and batteries, and now we're looking at plastics, textiles, and organic waste. All of these waste streams have many, many environmental challenges, but at the same time, they're also resources. I like to think that a waste is just a resource in the wrong place at the wrong time. It still has value; it still has valuable materials, energy, nutrients, et cetera, that if we put the right systems in place, we can harness that for the benefit of society. So kind of a lot of my career has been about trying to take what we've learned from past mistakes, past challenges, and past experiences, and then being more proactive about developing solutions for the future.

Dr. Malar Hirudayaraj: Very, very topical and very current. Right. These are the issues that we are, you know, we continue to face even with so much development and, you know, the progress we have made in sustainability and recycling and everything; we still face a lot of these issues. And your point about being, trying to predict, and you know, developing models that can predict and forecast is a kind of neat segue into my next question about your work and how you see research. Right. One of the things that particularly interested me about your work is that you've often been ahead of emerging societal problems, asking questions and building research around issues that subsequently become enormously important. How do you identify the problems that you believe are worth pursuing, particularly when their significance may not yet be widely recognized?

Dr. Callie Babbitt: That's a great question. I mean, in part it's a little bit self-motivated in that, you know, as an academic I want to get research funding, and I want to help students, students complete a dissertation. I want to write cutting-edge and well-cited papers. And doing that often means navigating what can be very crowded research spaces. So it seems like, you know, after a research space gets very crowded, it's hard to make a mark. So professionally, part of my goal is like thinking about what the areas are that we aren't yet trying to study and whether we can make a meaningful contribution in that way that we'll have enough of a signal; it'll rise above the noise of all the work that's being done. And very good work. There's lots of really great work and sustainability out there. But I think the other part of this answer is that I really like to think about myself as a lifelong learner. I'm very genuinely curious about the world around me. And I also think that as an academic there's so much we can learn from individuals and organizations outside of academia. And so I think, like, I really value and enjoy spending a lot of time talking to people that are working in the field, working in the factory, working on the farm, or working in the recycling facility. People whose lived experience isn't always captured in a scientific paper, but they really know what's up, like they really know what the challenges are. So a lot of times I do try to invest time and energy into developing relationships with industry and community organizations, individuals who are out there doing the actual work of sustainability. Sustainability is not glamorous. A lot of times it's messy and smelly, or you know, complex and challenging and hard. But the people that are actually doing the work of handling our waste and collecting it and recycling it know what some of the real challenges are. And so I think that's also what has helped me try to stay abreast of current issues and current trends, which is to really try to think about what other people are experiencing and then think about if there's a way that my research could actually do something beneficial to help those challenges.

Dr. Malar Hirudayaraj: Very, very, very, very interesting to listen to. You know…your ideas about research and how to position yourself. And I see that your research on electronic waste and the circular economy has received considerable attention and has extended, well, very, very much beyond academia. Could you tell us about one or two projects or findings that you believe have had the greatest impact and why so?

Dr. Callie Babbitt: Well, one of my maybe favorite or least favorite things that people say about electronic waste is that it's the fastest-growing waste stream in the world. And I've heard that a lot. And I really started thinking, is that actually true? You know, it used to be very believable, especially were buying lots of desktop computers and big bulky cathode ray tube boxes and big media players. I started thinking about, like, how the technology was changing, and I said people are on a trajectory to buy smaller, lighter devices. And the recycling industry is very backwards-looking. Like they're really thinking about the products that they're receiving, which are the ones that are coming out of households and being discarded. But on the other hand, the products that are now being sold are totally different.

We're looking at small, light mobile device ideas, like whether they are actually growing inside or getting lighter but growing in complexity because of all the technologies and materials and products. So a few years ago I had the wonderful privilege to work on a project. It was launched by funding from the National Science Foundation. And then eventually we also received funding from the Staples Innovation Lab at RIT and the Consumer Technology Association, which is a trade group that involves a lot of manufacturers of electronics. It gave me the opportunity to really talk to a lot of these manufacturers and also get data from the industry about what people are actually buying, how long they keep them in their house, and then what electronic products are getting discarded. And so we did this really huge multi-year study. It was a lot of credit to my PhD advisee Shahana Altoff, who was the lead researcher on that. She did an amazing job. The work that I talk about as being our group's work is really the work of amazing masters and PhD students and undergraduates and even high school students that I have worked with. But she did a really amazing job building a model that looked at the last 30 years of electronic waste. And we found that it was starting to go down, at least in terms of total tonnage, getting much more complicated. Product designs are harder to recycle. And so then we built a model that said, Well, what will this look like in the future if these purchasing trends continue?. That got a lot of interest from industries that were thinking about how to comply with environmental regulations. And it also got interest from some states in the United States who have electronic waste recycling laws because they want to be able to say, you know, in the next year, two or five years, how much material should we be anticipating that we'll need to collect and how do we economic case for that. So one of the things I'm very proud about that research is that the findings and the models we built, we were able to take and build customized models for states and manufacturers, help them in their decision-making and planning process. And I think that's something that I'm very proud of because in sustainability, not just trying to do research to sit in a journal, research that really makes a difference in the world. And this is a tiny, tiny, tiny contribution. It still made me feel very proud that there was some practical application.

Dr. Malar Hirudayaraj: That is very true. Right. Your research is very practical and has absolutely an immediate application opportunities. Right. And it makes a lot of difference to communities.

Dr. Callie Babbitt: I hope so.

Dr. Malar Hirudayaraj: It is, yeah. And your work has also taken you into some unusual places for an academic researcher. Right. Including serving as a US delegate to the G7 environment ministers meeting. What was that experience like, and what have you learned about taking academic expertise beyond the university and into policy or practice?

Dr. Callie Babbitt: Well, I felt very privileged to have had the opportunity to travel to events like this, to take part in things like the Fulbright program, and to speak with policymakers. At one point I had the opportunity to testify at a congressional hearing on E-waste. And you never know how things like that will turn out or if they'll make any difference. But I really feel that there's value in at least trying to get out there and share science-based evidence and research. One of the biggest things that I've learned from these experiences is that doing good research is only the first part of the challenge. Then you also have to communicate it. And I really appreciate the importance of good science communication. It's something I was never taught. It was; it's not; it was not ever discussed in undergraduate or graduate education. But I realized that I can't talk about research using a bunch of scientific jargon. You know, I have to really explain research in such a way that these decision-makers understand and can find immediate application to it. And that sometimes when we're talking about sustainability, we're not just talking about

environmental benefits because some people don't care about the environmental side. People might want to know, how does this affect me? Or what's the business case? One of the things that I've learned from these experiences is the importance of being able to explain sustainability research such a way that it really resonates with whatever audience you're speaking to. If you're talking to a business and you're talking to them about, say, waste management, it's less about, hey, let's save the trees and keep waste out of the landfill. Say, look, if you can reduce your waste and we can also reduce the tipping fee that you have this waste hauled, maybe you can by reducing, you know, if we see where the waste is coming from, it might reduce some of your upstream purchasing cost because you're purchasing something that's eventually thrown away. So we're always interested in trying to make the business case for sustainability and the social case, because, you know, and I think this is especially true for the work we do on food waste. I think one estimate says that the average American household spends fifteen hundred dollars a year on food. Never eaten. It's thrown away. So that would be everything from food left on the farm fields, leftovers at the restaurant. You don't take home, bag of spinach that you bought with good New Year's resolution and never actually ate. So this has, like, a direct and immediate consequence to households. That's money you could save by changing behavior. So I think, you know, this is something that I've really tried to learn a lot about myself, and I'm still on a journey to learn. It's something that I've tried to incorporate in my courses at RIT and my student advising is to think about, how do you tell the story of sustainability? It goes beyond the research findings. It really helps people understand why something matters to them.

Dr. Malar Hirudayaraj: And also to speak their own language. Right. When you're talking to business people, you have to speak their language. When you speak to policymakers, that's a completely different language that you have to put to them or share with them.

Dr. Callie Babbitt: Exactly, exactly.

Dr. Malar Hirudayaraj: Yeah. So I'm glad that you are kind of pivoting towards communicating meaningful, purposeful communication of your research and the impact for different groups of people, particularly those who have the capacity to have an impact on how these things are organized.

Dr. Callie Babbitt: And I think I would also add to this that I am a huge proponent of and beneficiary of interdisciplinary research and the. The new ideas and the insights from coming from having lots of different people working in lots of different topics, including outside academia, working together on a problem. And so even though I'm trained as an engineer, I've worked in primarily like a STEM focused sustainability institute. A lot of my research now has, has really shifted to thinking about like, why do humans make certain decisions? Why do organizations make decisions? What would it actually take to change people's behavior? You have to really focus a lot on technology. Like if you could make a better technology that was more economic and environmentally friendly, people would use it. But now I've learned from these interdisciplinary collaborations that it takes more than a good technology. It takes actual behavior change, education and communication. I think that's the other part of my research that I've that I've really learned from some of these, these different experiences is that in order for us to solve these big hairy problems like sustainability, which are so complex and globally interlinked, that it is not just going to take an individual laboring alone in a lab, it's going to take huge teams of people. And so learning how to work across disciplines is very important. And the communication piece, also very important there because we, you know, myself and a colleague. Colleague might be talking about the same thing but using totally different words.

Dr. Malar Hirudayaraj: Absolutely.

Dr. Callie Babbitt: Understand how to get on the same page with other researchers and other stakeholders to be effective in our research and practice.

Dr. Malar Hirudayaraj: Very true, very true. And you have received significant recognition for your work, including an NSF CAREER Award, a Fulbright US Scholar Award, and recognition here at RIT. Are there particular awards, honors, or maybe career milestones within RIT or beyond that have been especially meaningful to you, and why?

Dr. Callie Babbitt: Well, I think that all of those recognitions have so fundamentally shaped who I am as a scientist and researcher. And I am incredibly grateful for those opportunities. And I really have to give a lot of the credit to that, to the fundamentally interdisciplinary nature of the Sustainability Institute. You know, when I was hired in, I had, you know, a wonderful dean, Dr. Nabil Nasser, who really did not put any constraints on faculty in terms of what we would work on. It was really like, if you see a problem in sustainability, if you can get funding and if you can get publish on it, go for it. And so a lot of my successes, I really do credit to that freedom as a scholar to explore what I thought was intellectually challenging, not just what fit into disciplinary norms or that check certain boxes and funding or journals. And so I think that a lot of the awards that you've mentioned kind of came as a natural outgrowth of that as well as, you know, many, many failures, you know, and so I think, like, if you, I sometimes will look at the database that RIT keeps of sponsored research awards, and the thing you'll always notice is that the people that have the most funded awards also have the most rejected awards. Yeah, it's just a matter of trying and trying and trying again. And so I think I also am. It's hard to be told that an idea is not good or you don't make, or a paper gets rejected. But I think being able to turn that into a learning experience has been really valuable. But in terms of the awards and recognitions that mean the most to me, I honestly would say that it's probably those that are linked to the students that I have the privilege of advising in sustainability. And we have and have always had such an amazing cadre of students. I have had the privilege of advising many, many wonderful female students who are not just great scholars, but they're also juggling motherhood and life and many different challenges. And they, they're very inspirational to me. And seeing them win, you know, best paper awards and journal or the three minute thesis award at RIT, like, seeing accomplishments is what really fulfills me as an advisor and a scholar, because I don't think, you know, I'm proud of the research that I do, but I don't think that that's where my biggest impact will come from. I think my biggest impact in sustainability will be the education, training, and development of other students and scholars who then will go out into the world and keep influencing people around them. And so I always like to say, like, my absolute favorite moment as a professor is each year in May, when they have the PhD hooding ceremony across the stage with one of my PhD advisees who I have worked with for the last four or five or sometimes more, and getting to put that hood over their head and giving them a hug and just seeing them take off on the next journey of their life, I think that that's probably the accomplishment that I am most proud and satisfied for as a scholar. It means a lot to me.

Dr. Malar Hirudayaraj: That's wonderful. That's really, really wonderful. And when you look back at your career, the career that you have built over these years, where there are particular decisions, opportunities, collaborators, or even risks that proved especially important in getting you where you are today.

Dr. Callie Babbitt: You know, it's hard to point to just a single decision or event. I think that I give a lot of credit to the things that, you know, I've received recognition for is often a team effort. And so being able to collaborate with some really amazing faculty at RIT and amazing students, having industry partners that bought into our vision and funded it, you know, I think those are really the things that enabled my success, because maybe it's my name on the grant or my name as the corresponding author on the paper, but it's always a team effort. You know, we're always, you know, it's always a student or a collaborator. That's also the engine behind a lot of what we're doing. And so I think those would be probably the things that were most important to me. And so I think, you know, what I have intentionally tried to do is just develop groups of people around me that I enjoy working with. And so even, you know, faculty that maybe historically weren't connected to sustainability. But I thought you're a really fun person to work with, and you have creative ideas, and we get along, and we can work well together. Like, let's do a project together. And so I think that would. The thing that I would credit to some extent is just openness to collaborations and new ideas, but also, in reality, just trying and trying and trying and trying again. Because there are a lot of failures in academia. You know, you. For every grant that's funded, there's nine that are rejected. So I think just being able to pick up, back up, and get this team together and keep going is probably the biggest thing.

Dr. Malar Hirudayaraj: Interesting. Really interesting. We spoke about what makes you really feel proud about your proud, you know, moments of pride. And I want to end by looking forward. Right. What sustainability challenge or challenges are you watching today that you think we are not paying enough attention to yet, or what is next for you? Are there questions, problems you're particularly excited to pursue in the next phase of your work?

Dr. Callie Babbitt: Well, I think there's always something to work on in sustainability. We sometimes joke that you could just throw a rock in any direction and hit a sustainability problem that needs research. It's never ending. There's lots to work on. I think that most of my work in the future will continue to revolve around this idea of transforming what we think of as waste into valuable resources, using principles of the circular economy. In the future, I'm starting and hoping to build some new research looking at textiles. And because I think this is a waste stream that we have not explored enough, we don't have good data on what textiles people are throwing away, whether that's clothing or fibers or carpet or other things. We know that a lot of our textiles are made with synthetic materials like plastics, and that's a pathway for microplastics to get into the environment, and we have the opportunity to work with some great researchers at RIT that study plastics in the environment. That's one of the things I'm most excited to work on next: really trying to understand, like, are there ways to reduce the amount of textiles we purchase and discard, and are there cool new recycling and reuse technologies that we can put to use to recover the value from those? In general, you know, we're facing an increasingly volatile world in terms of material supply chains. And I think that one issue that, in general, I don't think we're paying enough attention to is, you know, where we get all of our resources and how we will be able to sustain access to those resources. Even global political disruption, we're seeing that now with fossil fuels and oil. We saw this immediately post-COVID-19 with mineral supply chains. And the reality is that as globalization continues to progress, it is going to face lots of disruptions to minerals. And so I think one of the other priorities for future research is really trying to find ways of bringing economically and socially beneficial material recovery processes into the United States. We can develop domestic supply chains for the materials we need. And I think that's something. You know, certainly people talk about this a lot, but I think it's an area we need a lot more research.

Dr. Malar Hirudayaraj: That's really, really fantastic. Thank you, Callie, for sharing your journey, your insights, and the remarkable work you have been doing. It's been fascinating to hear how you build a research career around emerging environmental challenges. Your work is a wonderful example of really how research can make a meaningful difference beyond academia. So making it really purposeful. We are delighted to have you as part of the RIT community, and I look forward to seeing where your research takes you next.

Dr. Callie Babbitt: Thank you so much. It's been a real delight to join you on the podcast, and I'm always happy to talk trash, and so I hope that maybe someone listening to this will get an idea and want to collaborate and send me an email, and it'll be lots more fun opportunities in the future.

Dr. Malar Hirudayaraj: Thank you. And to our listeners, thank you for joining us for another episode of Trailblazing Faculty at RIT. Stay tuned for more conversations with remarkable faculty whose work and contributions are making an impact at RIT and beyond. Thank you.