



# FINDING REASON

## CIVIC SCIENCE STORIES



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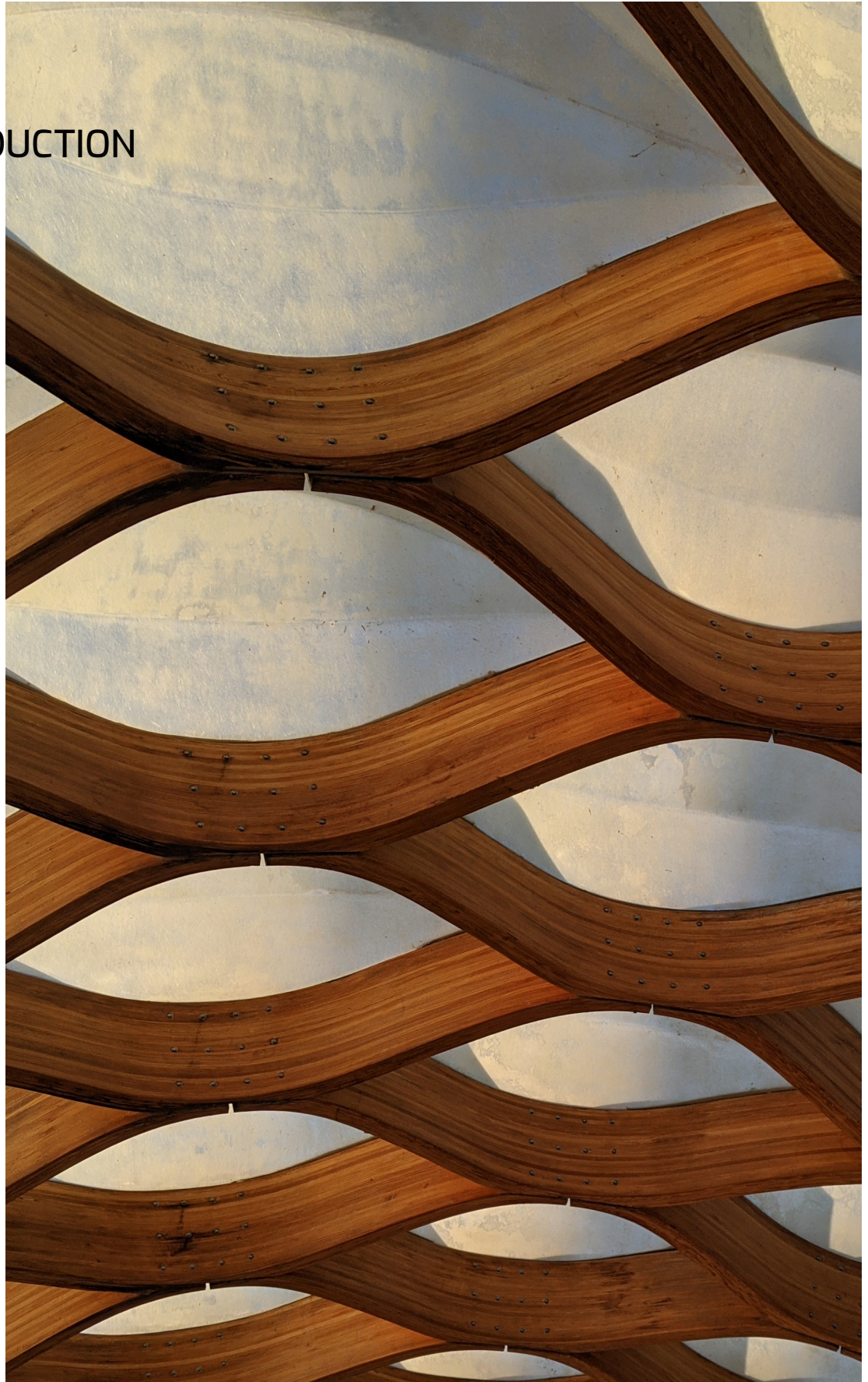


# **FINDING REASON**

## **CIVIC SCIENCE STORIES**



## INTRODUCTION





2020 hit the world like a brick wall: the COVID19 pandemic rolled on, the U.S. was forced (yet again) to come face-to-face with deeply entrenched racial injustice, west coast fires burned, and the Gulf and east coasts were inundated with strong storms, all pointing to the inevitable and rapid need for us to rethink our relationship to place. In the midst of it all, it has become more and more evident that insisting on a separation between science and society perpetuates many of society's most pressing challenges. Science, as an institution, as a method, as a profession, as a channel of our curiosity and wonder, contains multitudes.

Ensuring the rigidity that allows science to be scientific, it can also forget or minimize the stories of why people come to science, see and find the value of science in their lives, and seek to use science as a way to make sense of a wide variety of societal issues. The idea of civic science emerged in practices and research as far back as the 1920s. In 2005, Kim and Mike Fortun [wrote about civic science](#) as a science "that questions the state of things, not a science that simply serves the state". Civic Science is still being defined and framed, and so this project gives a multivocal approach through the stories of many, showing the emotive connection, the personal histories, and the future hopes that people bring to science, all with the purpose of imagining — how can science and its institutions do and be better?

The Civic Science Stories Project is a collaboration among several previous Civic Science Fellows, implementation partners at Aspiration, and story contributors who share new visions for the role and potential of science in society. The project is supported by the Science in Society Funder Collaborative. We, the co-editors of this publication, came to the above question — how can science do better — with different frames of reference and histories, and a shared intent to point science in new directions that center its relationship and benefit to society.

We started out in conversation with each other, sifting through the deeper nuances, emotions, and problems that we experienced both in our personal

and professional lives as we tried to navigate scientific institutions as they are, and to imagine what they could be. Justice, agency, power, equity, politics were all words that we surfaced, again and again, words that are many times objected to or intentionally left out in the places where "S"cience appears. As we had these conversations with each other and with others in the emerging civic science network, we knew that there were stories to surface, emotions to air, and a chance to begin talking more freely about the barriers that science, its associations, and its institutions have put up.

For if we are to make a change in the world, we have to question those who have historically held the power to build the world. We have to challenge where the rules and boundaries come from and who they are in service to. We must break the boxes that diversity, equity and inclusion efforts have told us this work should be contained in. Remaining in those boxes means not digging deep enough, leaving intact problematic paradigms and structures that stand in the way of change. As a new generation of the civic science community assembles and works to create a compass towards longer-term plans, if it is to live up to its civic intent it must center diverse articulations of what it will look like to reach this goal, and also what it looks like when that doesn't happen. The stories shared in this publication are far-reaching — they're personal, they ask hard questions, they share intimate responses, and above all, they collectively ask for science to be done differently. They point to the urgent need to build science that centers the person, that acknowledges its power and position and reshapes its structures with a lens of justice.

We hope you'll take the time to read deeply, open your heart, learn, and then reflect on these two questions: When you've finished your work in this world, what do you hope to have done to shift the way people received science's power, benefits, and wonder? Looking out seven generations to come, what do you hope your ancestors will experience as commonplace that you're not yet experiencing today?



## Acknowledgements

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Over 2020-2021 the co-editors convened a series of individual and group calls and spoke with close to 50 people working in the civic science space. Our first calls were with the Civic Science Fellows and members of the network, colleagues, and friends. From witnessing, supporting and influencing the crafting and molding of this project to contributing stories, our Civic Science Fellowship family stood by our side. Whether you contributed a story or not, your co-creative spirit in that early phase was essential to the continuation of the project, thank you. Later on, we held group calls with people from our networks, that we knew would answer our call to have these conversations. Many contributed stories, some did not, but nevertheless influenced

our vision and fueled our drive. Finally, we had individual calls with others, most of who contributed stories, some who did not, but nevertheless shared deep moments of connection and reflection. Thank you all for what you shared. After the calls some contributors worked individually on their stories, joining us at office hours to get feedback. Some contributors agreed to interviews after which we worked with a writer to iteratively craft a story. We also want to thank the members of the civic science network for their helpful comments and advice on the open draft of this framework. This has been a collaborative effort that has been buoyed by a shared brilliance, humanity, and fire for a better world. We deeply thank you all for contributing to it.



Karen Andrade



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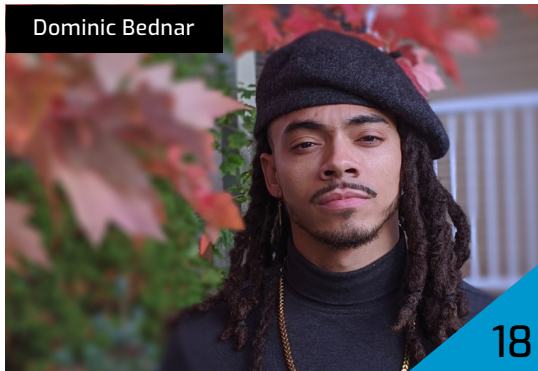
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Shannon Dosemagen



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Sam Dyson



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How can more people experience the privilege of wonder—to delight in the magic and mystery of the natural world?

Story by **Sam Dyson**, Physics PhD Student at University of Chicago





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Story by **Ivel Gontan**, Director of Empathy Initiatives at Woodland Park Zoo



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Interview with **Andrés Henríquez**, Director of STEM Education Strategy at Education Development Center





Rebecca Jim



## Ologies

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Manny Juarez



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The sciences—like architecture and design—give us the power to connect with the people and the spaces where we live.

Interview with **Manny Juarez**, Director of Science and Integrated Strategies at Museum of Science and Industry



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Jonathan Leal



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What would it mean for civic science to make scientific curiosity a public good, accessible to all as a shared civic resource?

Story by **Jonathan Leal**, Postdoctoral Fellow in the Society of Fellows in the Humanities at University of Southern California



Rabiah Mayas



## Contradictions: Rebuilding the House You're Living In

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Cindy Regalado



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Story by **Anand Varma**, National Geographic Society



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Childhood memories of science and progress

Story by **Ben Wiehe**, Manager, Experimental Practice at MIT Museum



## Planning Team

The team who compiled, edited, and designed this publication



## Advisors

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## Links



## A VISION OF JUSTICE IN SCIENCE: DREAMS OF A FUTURE

Science is key to how we pursue and understand progress.  
How can we make it work for everyone?



A few days after having started my new job I was still shining with curiosity and energy. And pride. I was the new Commercial Toxics Associate for the City of San Francisco, Department of Environment, and as part of my diving into the new world of science-based policy I was heading into a public hearing on pesticide regulation. It sounded like a bureaucratic, dry event but I didn't know what to expect, so I was amazed when I walked into a regal ballroom, packed with chairs filled with people. The state regulators sat coolly at the front of the room at a long table, far from the crowd, often staring down at their note pads. The event had started when I arrived so I sat on the first chair I could

find. As I scanned the room I noticed I was close to a podium and microphone, and also noticed a group of women on the other side of the room. I noticed how they seemed to be supporting each other. I noticed they looked like me. They were standing and many of them had scarfs around their head, reminiscent of how cancer patients cover their heads after chemotherapy.

The hearing continued, but before I could grasp the full context of what was being discussed one of the women from the group was called to the podium. As she got closer I thought that she reminded me of the women of the neighborhood I had grown up in in Mexico City. I looked down to my brown hands, up at her brown weathered hands. Her posture, the cadence of her voice — it was all familiar.

She spoke through a translator to the State's regulatory body. At first a bit overwhelmed but fiercely determined, she shared that she was the mother of a boy with neurodevelopment delays. I didn't need the translator — Spanish is my mother tongue — but I knew that the anger and courage in her voice did not need translating.

The boy was there, maybe 8 years old, a few steps behind her and being cared for by another woman as his mother described how throughout her pregnancy she was exposed to the pesticide in question. Working and living close to an agricultural field this pesticide was everywhere. Often without previous notice she would hear the *avioneta* nearby and feel the drops of pesticide wafting in the air touching her skin. She spoke of the children

in her community and described the life of her child and her hopes for him. When she stepped off the podium I was still consumed by the moment, feeling and pondering the anger and sadness her story had elicited when my ears perked up when hearing who was presenting next. Following her visceral testimony, a few scientists were brought in by several community organizations to testify in support of her. In that moment I almost physically felt the click of insight. The big yearning that had led me to that job — the desire to see science actually working out in the world to the support of communities — was happening in front of my eyes. It was like a log was added to the fire. I saw the scientific enterprise being accountable to the communities that surround and sustain it and all of us. And I knew I had found a path.

I had been searching for that path, or more accurately, that trail head, for a long time.



As a Mexican immigrant, a bicultural Latinx woman of color, and a scientist trained in the United States, science has also been at the heart of my dreams. Science is a key, yet subtle, component of how we pursue and understand progress in the United States. As I detail in [“What’s in a Name? Karen and the Aspiration to Whiteness,”](#) I grew up in Mexico City as a scholarship student at a prestigious international school. A child of the interstitial, I grew up learning different languages, navigating different spheres and believing in education as a pathway to upward mobility, a tool that might help me challenge the inequities and tragedies my family and community had to accept as normal.

I will admit that growing up I liked science and biology, but not quite as much as I enjoyed literature, history, and political science. A part of me has never bought into the compartmentalization of knowledge we insist on. Are they not all stories we use to understand, love, remember and change the world? I received a scholarship to attend college in the United States and, when the time came to choose a major, I put science and political science on the scale.

Which could help me stop cycles of poverty and exploitation? Political science afforded a “clear” path to change. But having grown up in Mexico, I knew that this path is often reserved for those with money and influence. Science, on the other hand, offered me the possibility of becoming a producer of knowledge. Knowledge, I reasoned, is valuable and powerful. As a producer of knowledge I would have something to offer, to trade for access. Access and power I could use to benefit communities like the one I came from.

Science is a meritocracy, science benefits the world, science leads to progress — progress for all. I fervently believed these dreams and like many dreams they carried me, inspired, and guided me. My faith was buoyed and challenged in many different moments, like the one I described above. But, shortly thereafter, I entered a doctoral program with the “secret” goal of becoming a scientist-activist. But the experiences I went through while I was being molded into the archetypal “American Scientist” took the spring out of my step, to put it mildly, and shook my core. I was part of the lab that discovered the sequences referred to as CRISPR and was

there at the start of the collaboration with the now Nobel laureate Jennifer Doudna. At that time, leaps in sequencing technologies were blasting through disciplines, fundamentally changing practices I had just learned. I knew I was living through a revolution; I just couldn’t see whose side I was on. I began to question the ethics and power dynamics of scientific knowledge production. I put the old dreams under the microscope and began to reshape them.

I love science. But I am also so angry. I feel so much anger at the ways in which science has historically been

center communities and justice, it can become aware of its own role in perpetuating problematic power structures. I am still dreaming and I wonder: What would it look like if the power of science was equitably shared?

The vision below is a fiction. One that I hope will turn into reality in the not too distant future. It is born out of yearning to begin to visualize and start reshaping science and its role in our dreams and in society.

#### **Does this dream speak to you?**

I remember the day I started believing this might not be another passing fad but actually a new era. It was my first flight in over two years, and it felt strange to do something I used to do all the time. Although

second dose. I wore my favorite face mask (the comfy one that doesn’t fog up my glasses).

The meeting I walked into had been convened by large and small community organizations. They had set the priorities for the meeting and pictures of their communities greeted you as you entered the room.

It was, in part, a reunion of my Civic Science Fellows “family”, colleagues from a fellowship who had nurtured my dream, and had held it up when I faltered. It was nourishing to hug so many I had not seen in person in such a long time.

There were high-level reps from the National Institutes of Health and the National Science

THE HEARING CONTINUED, BUT BEFORE I COULD GRASP THE FULL CONTEXT OF WHAT WAS BEING DISCUSSED ONE OF THE WOMEN FROM THE GROUP WAS CALLED TO THE PODIUM. AS SHE GOT CLOSER I THOUGHT THAT SHE REMINDED ME OF THE WOMEN OF THE NEIGHBORHOOD I HAD GROWN UP IN IN MEXICO CITY. I LOOKED DOWN TO MY BROWN HANDS, UP AT HER BROWN WEATHERED HANDS. HER POSTURE, THE CADENCE OF HER VOICE — IT WAS ALL FAMILIAR. SHE SPOKE THROUGH A TRANSLATOR TO THE STATE’S REGULATORY BODY. AT FIRST A BIT OVERWHELMED, BUT FIERCELY DETERMINED SHE SHARED THAT SHE WAS THE MOTHER OF A BOY WITH NEURODEVELOPMENT DELAYS. I DIDN’T NEED THE TRANSLATOR — SPANISH IS MY MOTHER TONGUE — BUT I KNEW THAT THE ANGER AND COURAGE IN HER VOICE DID NOT NEED TRANSLATING.

mobilized to further inequality, yet love for the promise that science holds. Science can be more. It can

CDC data said that vaccination rates were increasing much faster than expected, it had just been two weeks since my

Foundation as well as the biggest private science funders. But more than the usual suspects were trickling in, some





online and more than I expected in person. We had a real mix of races and ethnicities, ages and stages, disciplines, institutions and backgrounds. For the first time in my career I looked around and could not count on just one hand the other women of color in the room.

Our first conversation — about all the ways the new Community-Driven Science Initiative charged with shaking up the scientific status quo could fail and what had to be done to make it truly effective — was one of the most honest conversations I've ever seen between community and scientists, funders and grantees. And there was a moment, when a little Mexican lady that could have been my grandma stood on the stage, filling the room with her presence, the strength of her story and her offer to rally her community into action for research.

I stood in awe, with a knot in my throat, seeing the dignity and power of people talking to each other as equals. There is an indescribable magic in seeing people claiming and pushing against cycles of poverty and

colonization. In this room, the power of science was being distributed, put into people's hands so they could pull their communities out of centuries of oppression.

With lessons of the pandemic ringing in their ears, the new heads of both National Institutes of Health (NIH) and National Science Foundation (NSF) were pushing forward big bold civic science initiatives, putting their money where their mouths are. We could hardly believe how much support for community-based orgs and individuals they planned to disperse. They were taking concrete steps towards rolling out ambitious new programs so teachers and students at all levels could learn, do, and shape civic science. Hispanic-Serving Institutions, Historically black colleges and universities (HBCUs), Tribal Colleges, and Universities would see big funding increases. The programs, among many other things, aimed to fundamentally tackle the parts of the scientific system that have built the base of the worst of the ivory tower. We were finally moving beyond the trite isolated Diversity, equity,

inclusion (DEI) initiatives, supporting community-driven science questions and non-traditional approaches to science. It was a mission I had been working toward all my career. Maybe it's time had finally come.

Over the course of the meeting, we poked as many holes in the feds' draft plans as we could. And they actually listened. The sessions where we dreamed up radically new funding programs to promote equitable collaboration between labs and community members were my favorite part. Over drinks on the balcony that night, we swapped stories of personal and professional loss from the worst of the pandemic, but we couldn't help turning back to the day to marvel at the possibility that we might have just witnessed real change unfold before our eyes. ■

#### Attribution Statement:

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*to stretch my wings and for reconnecting me with the power of stories. Parts of this story are included in a scenario which is part of the Imagining the Future of Science in America toolkit.*

*This story was previously published by the author on [Medium.com](#).*



## Karen Andrade

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## IN PURSUIT OF ENERGY JUSTICE

How can science serve communities so that energy equity becomes another form of justice for everyone?

**M**y entry into graduate school and the field of energy justice was the culmination of a journey that is just starting. Growing up in Baltimore, I was always interested in building things with my hands, from Lego spacecrafts with my brothers to bicycle maintenance when I got older. My mother pushed me to go to a local arts and technology high school—the George Washington Carver Center for Arts and Technology—where I studied carpentry.

Learning how to build things however, opened more questions and possibilities. I wanted to understand the science behind everything. What were the governing equations of physics and math that allowed buildings to stand so tall? That motivated me to get into civil engineering as an undergraduate at the University of Maryland, College Park.

In Baltimore, you can see how neighborhoods look different depending on their demographics. I wanted to work to improve the entire community. And I needed to understand the legacies and how those systems worked and to make them better for everyone. That pushed me to become the person I am today: a community-engaged engineer and energy-justice scholar.

During my master's research at the University of Michigan, I used census data, coupled

with geographic information systems (GIS), to map out the age of housing stock and household incomes and racial demographics across Detroit. Those maps made it clear that people with the lowest incomes had also lived in the oldest homes, and those homes were in traditionally Black and Latinx communities. It was all perfectly aligned—demonstrating the disproportionate inequities in this country.

I helped facilitate some focus groups with local residents, which helped

us understand the impact of a warming climate and how people cope with increasing temperatures across the city. We put temperature probes inside and outside people's homes, and people wore temperature-sensing necklaces. And just being in the room with all of these Black and brown folks, talking about different resources around the city, opened my eyes. People talked about cooling centers—and I never heard of a cooling center in my life. But people's old homes don't have central air

**I'VE HAD SOME OF MY MOST POWERFUL ENCOUNTERS WITH SCIENCE WHILE DOING RESEARCH INTO ENERGY-EFFICIENCY DISPARITIES AND HOW THEY ARE DISTRIBUTED ACROSS RACE AND CLASS AND GEOGRAPHY. YOU CAN LOOK AT THESE MAPS AND SEE THE EVIDENCE OF HOW BLACK AND BROWN COMMUNITIES ARE STILL BEING HARMED BY REDLINING AND NOT AFFORDED THE OPPORTUNITY TO OWN A HOME IN A NEIGHBORHOOD THAT MIGHT PROMOTE ECONOMIC MOBILITY. THIS WORK HAS CRYSTALLIZED WHAT MY PURPOSE IS IN THIS WORLD: TO ADVOCATE FOR EVERYONE'S ACCESS TO AFFORDABLE, SUSTAINABLE, RELIABLE HOUSEHOLD ENERGY, BOTH IN THE UNITED STATES AND GLOBALLY.**

conditioning, so they have to go to city-run buildings to keep cool. But a pandemic presents its own special problems, like how do you manage a cooling center with all these additional precautions, such as physical distancing? I remember one woman talking about how at home she'd throw a wet rag in her freezer and take it out and wear it around her neck just to cool off. It was disheartening and heartwarming at the same time to hear about how Black and brown people have always had to be resilient and find ways to keep going despite their circumstances.

I've had some of my most powerful encounters with science while doing research into energy-efficiency disparities and how they are distributed across race and class and geography. You can look at these maps and see the evidence of how Black and brown communities are still being harmed by redlining and not afforded the opportunity to own a home in a neighborhood that might promote economic mobility. This work has crystallized what my purpose is in this world: to advocate for everyone's access to affordable, sustainable,

reliable household energy, both in the United States and globally.

\*\*\*\*\*

Right now a lot of people are recognizing the existing injustices in the world and thinking about how we might move forward from them. It's an exciting place to be in, because we're finally having conversations about the realities of the world. And I think that opens up opportunities for us to make real change.

But we aren't fully having these conversations until all of the voices in our communities are actively participating in it. For me, as someone who has chosen the academic world as one of my communities, I am particularly aware of who is included and who is excluded from that community.

I really enjoy teaching, I really enjoy working with young people and being part of a campus community that is bustling with bright minds. These students are curious and want to be on the frontiers of making a change. They want to have an impact. And that's something that I share with them. My dream is to build a living-learning lab that helps power people's homes, and from there

figure out how to build our energy future. I hope to continue doing that work. But I also see how frustrating my process has been in the academy in ways that it didn't need to be. And that experience informs my mentoring style and informs how I build coalitions and informs what grants I can write.

I was one of the very few Black students in the civil-engineering department and in the engineering school more broadly at the University of Maryland, College Park, and the only Black PhD student in the School for Environment Sustainability at the University of Michigan. So I've worked with others to create a sense of community, to start a Black grad happy hour and to bring together Black students from all the colleges across campus. It's such a rich and warm and loving community of badass brilliant people. We've organized Black-joy picnics, where we meet outside, physically distanced, do yoga and dance to music. It's liberating to see and to experience how central 'movement' is to Black community and culture.

Community has truly shaped who I am today. I dream of a future where we work more harmoniously

with one another as humans, with each other as a species and with the environment. It will require us to interweave our collective experiences in a way that promotes love, that moves us away from a mindset of independence and scarcity and toward community and abundance. As an energy-justice scholar, I want to be on the frontiers of creating a world where everyone has a home and where everyone has access to the energy they need to

be self-sufficient, to be able to create, to engage in their own artistic endeavors, whatever that looks like for them. I want everyone to live as freely as possible.

I'm just hoping to change the world in whatever way I can. What does that feel like? I think it feels like freedom. It feels warm. It feels like the sun. It feels like unity. It feels like a place where you can step out and be your truest and most authentic self.



## Dominic Bednar

### *Personal and Professional Identifiers*

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### *Job title*

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### *Pronouns*

He/Him

### *Homebase(s)*

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# THE POWER OF SCIENCE AND THE POWER OF PEOPLE

How can science better reflect and include the humans it is meant to benefit?

**T**he tangy smell of vinegar, the smell of our kitchen when Lola makes adobo, filled the air. I watched the older kid with anticipation as he held the red-dyed vinegar above the paper maché volcano full of baking soda. The beaker's contents tipped into the volcano and I gasped as the red bubbles overflowed and engulfed the tiny village at the base of the science fair display — this kid had the power to make the volcano erupt on cue! And his science fair display showed me how I could have that power, too.

Science became an answer to my childhood curiosity and a way to understand and use the world around us. It was thrilling to be able to take lessons learned from people who came before us and apply it to the world we know, and maybe even learn a little bit more.

However, I soon learned the limits of science. I was 14

when I learned about leukemia and visited Lola, my grandmother, in the hospital. I walked through the sterile hallways to say goodbye to Lola accompanied by a soundtrack of beeping machines. Science helped with her therapies and managed her pain, but there were still so many problems left to solve.

Lola was on my mind years later when I started my career writing software at a cancer research institute. This work was incredibly meaningful to me — I was helping find answers that could benefit someone else's Lola. But I soon realized that I was one of the few people who had found a way to contribute to science without spending years in grad school to get a PhD. I was outraged when I learned how common it is for researchers to fudge or hide their data for better results. If science is meant to further human knowledge, why is only a small portion of humanity driving the research?

*Science works best when **everyone** can contribute.*

The researchers who used the software I wrote didn't have the computer science experience I could provide. They also didn't have the experience of watching their grandmother fly from the Philippines to visit them in Canada, go through cancer treatment in a foreign country, then never return home.

Inviting others — not just PhDs — to contribute to research leads to more innovative and beneficial solutions. A diverse set of skills and ideas fuel innovation while the lived experiences from our broader society help form solutions that truly reflect and benefit humanity.

The power of mixing baking soda and vinegar belongs to all of us. I wish all of us were reflected back in the science and technology being built today. We all have valuable experiences that can make science better. Our stories, from cooking with Lola

to experimenting at a science fair, have the power to bring needed perspectives to research. Humans should be reflected in the work meant to benefit humanity. ■

# 7

## OPENNESS



Learn how working open can spark innovation in tech, education, research, journalism, and more

SCIENCE WORKS BEST WHEN EVERYONE CAN CONTRIBUTE. THE RESEARCHERS WHO USED THE SOFTWARE I WROTE DIDN'T HAVE THE COMPUTER SCIENCE EXPERIENCE I COULD PROVIDE. THEY ALSO DIDN'T HAVE THE EXPERIENCE OF WATCHING THEIR GRANDMOTHER FLY FROM THE PHILIPPINES TO VISIT THEM IN CANADA, GO THROUGH CANCER TREATMENT IN A FOREIGN COUNTRY, THEN NEVER RETURN HOME.

INVITING OTHERS — NOT JUST PHDS — TO CONTRIBUTE TO RESEARCH LEADS TO MORE INNOVATIVE AND BENEFICIAL SOLUTIONS. A DIVERSE SET OF SKILLS AND IDEAS FUEL INNOVATION WHILE THE LIVED EXPERIENCES FROM OUR BROADER SOCIETY HELP FORM SOLUTIONS THAT TRULY REFLECT AND BENEFIT HUMANITY.



## Abigail Cabunoc Mayes

### *Personal and Professional Identifiers*

Open Source Advocate and Specialist

### *Job title*

Program Manager

### *Organization*

Mozilla

### *Pronouns*

She/Her

### *Homebase(s)*

Toronto, Canada







Patient-Derived Xenographs is a sound file.  
Click on the play button to access the audio or visit:  
<https://audio.civicsciencestories.org/GregCarbonetti.m4a>

# PATIENT-DERIVED XENOGRAFTS

How might patients and medical scientists work together in a way that preserves the full humanity of both patients and practitioners?

IT'S MY JOB TO TAKE A PEA-SIZED SECTION OF THIS TUMOR, MOVE HASTILY DOWN TO THE ANIMAL FACILITY, AND CAREFULLY IMPLANT IT UNDER THE SKIN OF A MOUSE. IN A FEW DAYS, THAT TUMOR SHOULD START TO GROW AND SPREAD IN THE MOUSE, SIMILAR TO HOW THIS PATIENT'S TUMOR WOULD GROW AND SPREAD. OUR LAB AND OTHERS WILL BE ABLE TO STUDY THIS PROGRESSION AND EVEN TEST EXPERIMENTAL THERAPIES FOR THEIR ABILITY TO SLOW IT DOWN, OR EVEN STOP IT.

## Gregory Carbonetti

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Molecular and Cellular Biologist

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He/Him/His

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## SUSTAINING CIVIC SCIENCE IN NATIVE AND WESTERN WORLDS

**When the connection between people and the Earth is damaged, how can science and ancient traditions work together to bring healing?**

I grew up in Colorado, amid the mountains and plateaus, as my father chased one mining job after another. When I was old enough, in the late 1950's, I was enrolled in the Bureau of Indian Affairs (BIA) boarding schools, a harsh educational system whose intent was to get the Navajo-ness out of me. They discouraged me from speaking my own language and living my own culture.

I resisted this educational system and ran away often. So BIA sent me about seven hundred miles away from the Navajo reservation to an Indian placement educational system. This was better than the harshness of the BIA system and I had begun to grasp the English language. The placement system allowed us to get a formal education in the mornings. The afternoons were geared towards obtaining a career oriented towards special trades training: auto mechanic, welding, carpentry, architectural drafting and so forth. I decided to make the best of things.

Due to the distance from home on the Navajo reservation, I only came home 3 weeks each summer. During my high school year, I came back to the reservation and discovered something alarming. I saw that my dad had moved some of his belongings out of the house into a temporary shelter. After I said *yá'át'ééh* (hello) to my mom and we sat and hugged, I asked her, "What's with my father?" She said, "You need to go talk to him."

I greeted him, then sat with him for a while. But I waited a couple of days before I asked him what had happened. He gave me a long history of how he had been engaged as a uranium miner, deep underground. Then he told me that his doctor had found that he had severe lung problems. Upon his diagnosis, he was let go from any further uranium mining. The only instructions given were to take care of himself. No injury or worker's compensation, no follow up at specialized clinics. The doctors at the Shiprock Indian Health Service Hospital told him he had

several severe disabling nonmalignant respiratory diseases. In fact, he had five different types as we later found out. As many of his co-workers were also fighting, and losing their lives, he knew that eventually it might end his life too. In Navajo culture, if you die in a home, that home is condemned. So to spare my mother and siblings the prospect of losing their home, he moved into a temporary shelter.

I had so many questions for my father: "Why? How did this happen? Who is responsible for this? For what purpose or purposes?" Through these questions and subsequent research, I began to learn that the US government was responsible. The government was the sole procurer of this insidious element called uranium and that it used the uranium-238 isotope for weapons, energy, and medicine. From the 1940s to the 1960s, the US government heavily mined the Colorado Plateau, including the Navajo Nation, thus exposing many Diné and non-Indian workers to dangerous radiation.

Years later I found out through a close friend of mine, Stuart L. Udall, who had been the Secretary of the Interior during the Kennedy administration, that the US Public Health Service and the National Institute for Occupational Safety and Health (NIOSH) had conducted long-term studies on Navajo uranium miners (the original National Institute for Occupational Safety and Health document indicated over 700 Diné miners as part of a larger group of five-thousand-plus U.S. miners) on the Colorado Plateau. My dad had been one of them.

Along with others, I assisted Sen. Udall and sought compensation for these Diné miners, through the Federal courts and Congress. At the same time, I was

going back to school and becoming an environmental scientist. So that conversation I had with my dad, and the questions it raised, started me on the path I'm still on to this day. I've spent close to fifty years of my life's journey in an attempt to cleanse the destructive forces of this insidious evil and to cause transformation—restoring the land, the water, the air, the plants, human life back to this balance and harmony and peace.

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As a Diné, I know that true knowledge is in service to the creation of harmony and balance among all living beings here on earth. Otherwise it is simply knowledge. That's why, when I introduce myself to a

**DURING MY HIGH SCHOOL YEAR, I CAME BACK TO THE RESERVATION AND DISCOVERED SOMETHING ALARMING. I SAW THAT MY DAD HAD MOVED SOME OF HIS BELONGINGS OUT OF THE HOUSE INTO A TEMPORARY SHELTER. AFTER I SAID YÁ'ÁT'ÉÉH (HELLO) TO MY MOM AND WE SAT AND HUGGED, I ASKED HER, "WHAT'S WITH MY FATHER?" SHE SAID, "YOU NEED TO GO TALK TO HIM."**

**I GREETED HIM, THEN SAT WITH HIM FOR A WHILE. BUT I WAITED A COUPLE OF DAYS BEFORE I ASKED HIM WHAT HAD HAPPENED. HE GAVE ME A LONG HISTORY OF HOW HE HAD BEEN ENGAGED AS A URANIUM MINER, DEEP UNDERGROUND. THEN HE TOLD ME THAT HIS DOCTOR HAD FOUND THAT HE HAD SEVERE LUNG PROBLEMS. UPON HIS DIAGNOSIS, HE WAS LET GO FROM ANY FURTHER URANIUM MINING.**

fellow Diné, just after I identify myself by clan membership, I identify myself as a scientist. In other words, I explain how I am in service to the Navajo Nation, my people. One of our wise leaders, Chief Manuelito, said “Go my son, climb the ladder, use education for success. Come back and help your people.”

Restoring harmony and balance—we call it hózhǫ́—is the essence of Native American science. Imbued in knowledge is the essence of energy, the “spirit” that is the source of all life on this earth. It’s who we are. It’s our emotion, it’s our thoughts, our stories, our very being. It’s ingrained in our ceremonies, our rituals, our sacred Diné language. Hózhǫ́ is as complex as it is ancient. It is a state of mind and body defined as beauty, balance, peace, wellness and harmony. Achieving and maintaining it is difficult, losing it can be disastrous as it occurred in the uranium miners.

The radioactive energy that the US government unleashed on the Navajo Nation brought a lot of disruption and disharmony. We were in disharmony with our surroundings, with our health. True science as we see it is putting these elements of hózhǫ́; harmony, balance, and peace back into the world. That is our ultimate goal, from the perspective of Diné traditional ecological knowledge.

In service of cleansing and restoring the



earth, I went to work alongside the federal government—the US Department of Energy, the Nuclear Regulatory Commission and the US Environmental Protection Agency. I spent considerable time conducting environmental

risk assessments, developing engineering concepts of mine closures, radioactive waste disposals and remediating abandoned uranium processing sites, mines and mills, across the western part of the United States. I was doing that work in

Utah when I got an offer from the Navajo Nation to help my own people, my own land, by starting to clean up abandoned uranium mines there. That was a challenge, but I came back and searched for funding. We ultimately created the Navajo Abandoned

Mine Land Reclamation Program using funds through the Surface Mining Control and Reclamation Act of 1977.

I never thought I would be in academia, but then Diné College invited me in, and I saw the uniqueness



of what I could do as a researcher. It is a challenge to interweave Native science with Western science. But it is a worthwhile challenge. You have to be very careful, especially with the young Diné. You have to walk that fine line between Native concepts, which teach that the earth is our mother, and Western science, which treats the earth as a commodity for man to exploit. What does it mean to use Western technology to clean up areas that were contaminated through the use of Native science? Some students can accept this contradiction; others may have to work harder to understand it. I teach the Diné youth the Diné concept of and relationship to our environment and the natural elements of life are strongly linked to ancient Diné principles and values which must guide risk assessment and risk communication. That holistic healing (Hózhǫ́) is maintained by the inter-connectiveness of physical, emotional, psychological and spiritual existence. It is in this context that Native Science is often incomprehensible to Westerners because it operates from a different worldview.

Let me briefly explain. Western scientific risk assessments are largely based on western paradigms where measurements are superimposed on nature like a grid system and examined from that linear framework, like survey systems,

a grid framework of acres, sections and townships. From the Diné perspective, Nature is not mathematical. Western analysis leaves out so much from the Diné view of "Mother Earth" - her sacredness, the livingness, the soul of the earth. Measurement isn't the foundational role, it is only one of many factors to be evaluated. To "come to know and understand" Native science, one must understand the culture, the worldview, and paradigm of Native people. This paradigm includes ideas of constant motions and flux, existence consisting of energy waves, interrelations of all living beings, renewal and restoration, and all things being imbued with spirit and relationship in a "spider web" network of interrelation between the Five-fingered Ones (humans) and the environment, Mother Earth and Father Sky. This is hózhǫ́ in its purest form.

Language can also be a barrier between Native and Western science. There are so many technical terms that are used in the study of environmental science—for example, "radiation" and "gamma rays." In Native America we don't have words for many of these. In our culture, we call those concepts with no names "Nayee" or "monsters." Through the years I worked with a team of linguists to develop Diné glossaries that name these concepts and thus make them accessible. We now have glossaries on cancer, geological

terms, diabetes, nutrition, risk assessment, uranium mine clean terms, and currently developing a glossary on genetic terminologies.

Our Diné language ultimately ties us to our landscape that inspires a state of co-existence with all living species in a state of harmony and balance. Our language is honored and held sacred by the Diné. We used our language as a "code" which was never broken in combat and ultimately won WWII. Our language encompasses our whole essence of natural beauty and intimate relationship with our lands. This is the animating power of our language inherent in the spoken words that connect the breath of each Diné to the breath of the world. The spoken word is powerful and becomes a reality and therefore all must be mindful and careful of what is spoken. Western society concepts and terminologies cannot be explained well by mere use of literal translation by referring to its society's perspectives. We as Diné glossary developers and interpreters are familiar with the Diné way of thinking and understanding. We retain this degree of positive understanding and concepts of positive kinship, thinking, hope, compassion that fulfills our mission of harmony, healing and restoration.

One good example of a Western scientific term in need of a Diné translation was "COVID-19." We ended up likening it to

one of its symptoms: the coughing that comes with pneumonia. So we called it Dikos Ntsaaígíí-19, meaning "huge cough." And now people know that term.

We have many names now. Uranium is *leetsoh*. Radiation is "rays that is emitted (from uranium) and is dangerous." We give these names, and they are no longer monsters. Just like the western medical professionals have their medical terminologies and concepts, now our Traditional Practitioners have words that they can utter in ceremonies, rituals and prayers. That's another sense of balance that's being restored—not only the land but our inner selves. That's the power we have in science. The Glossary we're developed

specific to uranium mine assessment and clean terminologies is now available on on <https://dinecollege.edu/wp-content/uploads/2018/04/Tronox-Dine-Glossary-10-3-10-compressed.pdf>

Our great Diné Chief Manuelito instructs us: "Go forth, my son. Climb the ladder of education, but come back and help your people." I'm nearing seven decades of life here and past my retirement age. But using this Native science and passing it on to my young charges, who in return can continue to care for and protect the Earth—that's where my passion is at. And I've had many opportunities to retire, but for some reason, I hang on. And I think that's the reason why: to pass this knowledge on. ■



**Perry H. Charley**

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## TAKING ACTION: EMPOWERING FUTURE INNOVATORS IN SCIENCE

What does it look like to give more young people the joy of discovering the careers that connect them to their lifelong passions in STEM?

Looking back on my childhood, it seems clear that I was destined to be a mechanical engineer. I loved to tinker and to figure things out. I was an inquisitive kid, taking things apart, breaking them, then trying to fix them. My friends and I used to build remote-control cars, and in middle school I was in the science club at the Museum of Science and Industry. But I didn't know what engineering was—it wasn't until years later that I found my path, thanks to a chance encounter with a college career counselor.

One of my formative early experiences happened in shop class in the seventh and eighth grade. The instructor didn't put any limits on what we could create. He just said, if you can design it, you can build it. The only thing he asked was that we first make a detailed set of drawings from every angle. That taught me a lot about design, and those same principles ultimately carried over into my career.

Yet even with all those great early experiences that built the foundation for my love of science and engineering, I never knew that it was engineering that I was doing. Even by the time I reached high school, when I was enjoying hands-on projects in physics class, I decided to apply to college as a chemistry major, because I wasn't sure what type of science I wanted to study, and my mother suggested that I pursue a career in pharmacy.

I did well in chemistry, but I knew from the first semester of college that it wasn't where my heart was telling me I belonged. A lot of my friends were actually doing engineering at the time, and they would tell me stories about what they were working on, and it sounded exciting. So I went to talk to a career counselor, and she went down a list of different types of engineering disciplines. And when she got to mechanical engineering, it was like a light bulb went off. The things that

mechanical engineers do—designing cars, designing consumer products—it was all about finding the physical solution to a problem, and then also being able to take part in the manufacturing. I just knew that that's what my heart desired.

That second semester, I switched my major to mechanical engineering, and I felt like my future was set. I was finally able to take classes and work on projects that fully resonated with my interests. That first intro to engineering design class felt like a time warp back to some of the things I loved doing in middle school in that shop class.

THAT SECOND SEMESTER, I SWITCHED MY MAJOR TO MECHANICAL ENGINEERING, AND I FELT LIKE MY FUTURE WAS SET. I WAS FINALLY ABLE TO TAKE CLASSES AND WORK ON PROJECTS THAT FULLY RESONATED WITH MY INTERESTS. THAT FIRST INTRO TO ENGINEERING DESIGN CLASS FELT LIKE A TIME WARP BACK TO SOME OF THE THINGS I LOVED DOING IN MIDDLE SCHOOL IN THAT SHOP CLASS.

IT WAS INCREDIBLE, THAT CHANGE: BEFORE I FOUND ENGINEERING, I HAD FELT LIKE A LOST CHILD, JUST GOING THROUGH THE MOTIONS. BUT WHEN YOU FIND SOMETHING THAT RESONATES WITH WHO YOU ARE, EVERYTHING FALLS INTO ALIGNMENT. I CAN REMEMBER THAT MOMENT AS CLEAR AS DAY. IT CHANGED MY LIFE.

It was incredible, that change: before I found engineering, I had felt like a lost child, just going through the motions. But when you find something

that resonates with who you are, everything falls into alignment. I can remember that moment as clear as day. It changed my life.





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It's scary to think that I nearly missed out on finding my life's work. And I know I'm not alone: there are a lot of students who love math and science but don't know how to continue their development. That's one of the reasons I created the organization I run now, Project SYNCERE: to ensure that young people who come from communities like mine have firsthand access to programs and experiences that help them develop their passion for science.

One of the central reasons that there isn't a lot of diversity in scientific fields, including engineering, is that most students go into fields they're already comfortable with. And that comfort often comes from firsthand experience in those areas or having friends or mentors with that experience. That's what communities like mine lack.

I was privileged enough to go to magnet schools for my entire childhood, and even I had trouble making the connections between my interests and a career. And a lot of the extracurricular programs that were in public schools when I was growing up are no longer available. We need to bring them back, because when you're young, your mind is racing all over the place, and that's the time to

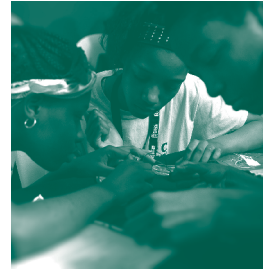
explore. We need shop class, and not only that but arts, music, all those classes that contribute to a well-rounded child. I think access to a good education should be every child's right. But unfortunately that's not the world we live in right now.

I think the world can be made better through the discoveries and application of science, but it's going to take people who have a lot of different ways of thought, who come from different communities and backgrounds. Young people need to have access to programs that help them develop their love and passion and knowledge within these scientific fields. And that needs to start early. We need to have programs for young people in grades K through 12. Our schools are doing our students a disservice by limiting their access to these fields. I'm trying to level the playing field at least a little bit by giving young people access to engineering programs. "Access" is so crucial for our youth.

It's also important for young people to have mentors who encourage them both inside and outside the classroom. I know that helped me starting at a very young age, having teachers who supported my journey in science and who pushed me toward excellence. I hear horror stories of some teachers who tell their kids that they're

not good enough, or that they should give up. I've always had the opposite sort of teacher, and I'm grateful for that. Your success along your educational and career path often depends on whether you're being supported.

When all is said and done, I just want the voices of our students to be heard. And I don't want small numbers: I want numbers in the thousands or millions. The problems that we have in Chicago are not just here but everywhere. So we need to ask: How can we ensure that young people have access to rigorous curriculum?



How can we ensure that teachers have access to the professional development they need so they can ensure that their students are developing the skills and knowledge necessary to transform their local economy? That's what I'm trying to work on now. In the end, I hope people will see my work as a vehicle for change in STEM education globally.



## Jason Coleman

*Personal and Professional Identifiers*

Mechanical Engineering Educator

*Job title*

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*Organization*

Project SYNCERE

*Pronouns*

He/Him

*Homebase(s)*

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## NORMALIZING THE TOOLS OF SCIENCE FOR USE BY EVERYONE

Science's greatest power may be the power to heal.  
How we share or withhold that power can also do great harm.

**M**y work has always been quite personal, driven by my connection with the urban industrial middle slice of the United States. Rivers were not bodies of water to swim in and bike trails neighbored the chain-link fences of industry. My response has been to build projects which demonstrate the benefit of science in the hands of people who can put methods and tools to work asking and answering questions about their environment. I continue to be passionate about these intimately connected yet intensely disjointed human and natural landscapes 30+ years on.

From [Public Lab](#) to the [Gathering for Open Science Hardware](#) to [Open Environmental Data Project](#) and [Open Climate](#), the ability to participate in creating knowledge, and distribution of that knowledge, has shown the potential for science in service to society. Here though, I'd like to share a personal story that speaks to the benefits of science as I came to experience them.

Several years ago, I gave a TEDx talk at CERN in Switzerland, directly after which my body started signaling that something was wrong. I landed home in New Orleans, headed to my doctor for tests, and then carried on the next day, going to a conference in Las Vegas. The conference ended and the next morning I received one of the hardest calls of my life — I'd been diagnosed with cancer.

Though my situation was in need of attention, the oncologist in New Orleans couldn't see me

for a couple weeks. So I left Las Vegas and went to Zion National Park where I sat at the top of the West Rim Trail, contemplating my 33 years, the cancer inside of me, and whatever was to come next.

What made me most terrified from my diagnosis was that I was going to be funneled into a medical system that made absolutely no sense to me. Upon my first appointment, I was given three clear tracks of care — a standard surgery that would clear everything from my body

REFLECTING ON MY OWN PASSION FOR CREATING A DIFFERENT FUTURE IN WHICH SCIENCE, DATA AND INFORMATION ARE NORMALIZED TOOLS FOR SOCIETY, I ALSO HOPE FOR A DIFFERENT FUTURE FOR PATIENTS FACED WITH MAKING DECISIONS ABOUT A CRITICAL ILLNESS, AND ESPECIALLY YOUNG PATIENTS WHO ARE CAUGHT BY SURPRISE WITH THEIR DIAGNOSIS. I WANT TO WORK FOR A FUTURE IN WHICH THE BENEFIT OF SCIENCE IN THE HANDS OF A PATIENT ISN'T JUST ALLOCATED TO PEOPLE WHO GET DIRECTED TO SLOAN KETTERING AND SIMILAR INSTITUTIONS. I WANT TO SEE SCIENCE AND THE SOCIAL INFRASTRUCTURE OF MEDICINE PUT TO WORK FOR PEOPLE WHO ARE FUNNELED THROUGH THE HEALTHCARE SYSTEM IN STATES LIKE LOUISIANA, RANKED 49TH FOR HEALTHCARE NATIONWIDE.

but make me reliant on drugs indefinitely, chemotherapy and radiation, or a rare surgery that would potentially be the least impactful on my body, but also require me to head to Memorial Sloan Kettering in New York City. I started with the chemo and radiation option (after a traumatic accident and major operation as a three-year-old, I definitely wanted to avoid surgery) and was told “wrong choice”. So up to New York City I went.

At Sloan Kettering is where I learned the difference between “here are your options, let me know what you decide by tomorrow” and “here are your options, we’re going to work with you to make an informed decision that you feel comfortable with” — it was the *benefit of scientific* information in my hands as a patient coupled with the expertise and training of my oncologist and all the staff — from the person who greets you at the front desk to the head surgeon — that ensured the patient experience was informed, factual and involved. When I had to designate a health proxy (and the problem

wasn’t so much who to name but that I couldn’t believe I was having to sign over control of my body), a social worker talked through each step, each decision I had to make and each place I was required to initial. When it came time to make decisions about my surgery, my oncologist sat down and described each step in the process, why they believed this was the right decision and what the potential impacts and benefits to me would be if we went that route.

Some may say, “well that’s the new age of medicine, that’s what it’s about” — patient involvement — but to me, this is also a clear story about starting out in a personally unknown situation with nothing but the internet to guide you, evolving to a situation where I felt some shift in power to being involved in the decisions about my treatment and care.

Reflecting on my own passion for creating a different future in which science, data and information are normalized tools for society, I also hope for a different future for patients faced

with making decisions about a critical illness, and especially young patients who are caught by surprise with their diagnosis. I want to work for a future in which the benefit of science in the hands of a patient isn’t just allocated to people who get directed to Sloan Kettering and similar institutions. I want to see science and the social infrastructure of medicine put to work for people who are funneled through the healthcare system in states like Louisiana, ranked 49th for healthcare nationwide.

While I don’t work in healthcare or a medical profession, I do know well that the air we breathe, the water we drink, and the security we feel in our own community, are intimately connected to how we *do* or *do not* have access to physical and mental health. My story is far from unique. Experiencing the duress of illness, how it captures not only you but your family and friends, makes me recommit every day to the work I can do in the places I know how best to make our human experience a bit more livable.



## Shannon Dosemagen

### *Personal and Professional Identifiers*

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### *Job title*

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### *Organization*

Open Environmental Data Project

### *Pronouns*

She/Her

### *Homebase(s)*

New Orleans, LA





## LEARNING TO DREAM AGAIN: CASTING NEW VISIONS FOR SCIENCE IN SOCIETY

How can more people experience the privilege of wonder—to delight in the magic and mystery of the natural world?

I still remember my first encounter with my life dream. It was in my high school science class — freshman year in 1987 or 88. The details are hazy but the feeling still lingers. Dreams can be that way.

It was something Ms. Carlton said that made a new thing happen in my brain. For the first time, she prompted me to make a connection between something I was learning in her class and something else I was learning in another class, around the corner, and down the hall. The connection was unexpected. It brought a new feeling of surprise and delight. It was like feeling the impact of two separate continents slamming together in my mind. I felt it! At that moment — through the simple act of discovering that two separate parts of my world were actually connected — my whole universe got bigger.

I still so clearly remember what it *felt* like. There was joy at my discovery—like an internal giggle of delight — and I wanted more of that.

As memorable as that remains, it wasn't my first encounter with wonder.

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Small-town Oberlin, Ohio, offered many childhood moments to delight in the magic and mystery of the natural world. The night sky was dark enough for me to see the Milky Way from my front yard, even near the street light.

And I still remember — and regret — how I had asked my mom to wake me up on the night in 1986 when Halley's Comet last made its closest approach to Earth, but then groggily asking her to let me keep sleeping. Lord willing, I'll live long enough to see the comet's next return in 2061. Just 40 more years...

Throughout my childhood, I had already begun to hear the early call of my life's dream which at that point was more of a general yearning than a clear vision. At that early age, my hazy, dreamy dream didn't scare me yet. And these encounters with wonder continued into adulthood.

Like when I had become a Physics teacher myself in Chicago: I was sitting alone in my lab at the end of the day, having just set up a demonstration of non-linear vibrations — a wobbling, unbalanced disk attached to an oscilloscope.

As I sat there staring at the oscilloscope screen, watching new patterns traced by the chaotic vibrations, it was like I could hear a mental airlock open inside my mind — a *hiss* and a *whoosh!* —like the sound you hear in movies as astronauts step toward the vast openness of space. Though it wasn't exactly a moment of full discovery (I knew that I didn't really understand what I was looking at), still it was beautiful and inviting. It made me hungry for more! I knew I didn't understand it and I knew I wanted more of it!

Again, a moment of wonder was calling me to expand my known universe.

And on and on the joy of discovery has gone in a growing timeline of encounters with the magic and mystery of

the natural world, and a growing realization — a dream, really — that since childhood I have wanted to spend my life having more and more of these moments.

Our Universe is amazing! I mean, did you know that on the north pole of Saturn there is a six-sided storm that's been spinning for decades?! A hexagon on top of the ringed planet...in *our* solar system! And did you know that scientists have not only developed a theory for how fluid dynamics produce this surprising structure, but they have also been able to reproduce the pattern in a laboratory using a rotating column of water? What?!

And you're telling me that I could have a job where I spend the rest of my days peering more deeply into the magic and mystery of the natural world?

Sign me up for that!

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### So What Happened?

How did I come to fear my dream?

Well, I actually was an Astrophysicist once, after college. That was my job title. Then I left.

I left because I was tired of being lonely, tired of being the only Black person in the room as a student and as a scientist. I was tired of the bitter, painful irony that I had been the only Black student in any of

my math and physics courses in four years at Yale despite the fact that it was at Yale that the first Black person, Edward Alexander Bouchet, earned a PhD in any subject in the United States, which he did in 1876...in physics.

But more than my loneliness in the sciences, I had chosen to leave my life's dream behind because I couldn't justify how my work as a scientist would help people. I couldn't see any clear connection between the wonder of science that lit me up and the issues in society that broke my heart. I was afraid that pursuing a life of discovery meant giving up on the dream of ever helping anybody. And I could see a lot of things in society that needed a lot of help.

So, because I couldn't see how pursuing the wonder of science would help people, I left my dream behind.



I then spent more than 20 years trying to help make society better. Helping people learn. Helping people teach. Helping people discover. Helping people help other people. And learning a ton about how not to help.

I'm proud of the work I did.

But that internal itch wouldn't leave me alone. As scary as my life dream remained, it never went away.

\*\*\*\*\*

### Now What?

Now, a quarter-century after college, I've just embarked on a return to a life of wonder in the sciences. In fall, I entered UChicago's Physics PhD program. Even as I make this major mid-career transition [back to physics](#), the dream still scares me.

Why does it scare me?

Because I know that, even though it's been 25

years since I graduated from college as a physics major and 145 years since Bouchet earned his PhD, and even though we've had our first Black president in the interim, still the sad fact remains:

According to [data](#) from the American Institute of Physics, the percentage of Black US presidents is still HIGHER than the percentage of Black US physics PhD earners.

That shouldn't be.

It's time for a new dream. For me, it's not just time for a personal dream (I'm already living that) but a dream for science itself. I want to believe in a new kind of science that commits to better sharing its power, benefits, and wonder with all people.

That's why I became a [Civic Science Fellow](#). Like the 14 other fellows in our inaugural cohort, I'm hungry for science to be something more in society. Throughout my fellowship, I have been working hard to invite new voices into the conversation. By hearing more of these visions from more people, I am hoping to live into new possibilities. I have a dream of seeing progress happen more quickly than I've seen in physics since 1876.

When I imagine a better future for science I want to see the widespread and commonplace encounters of Black people delighting in the magic and mystery of

the natural world. Our collective investment in the capacity of Black people to do what lights them up will be just one indication of the value of Black lives in science and society.

### How to Get There

To achieve the dream, I want to see **Triple-A Improvement** in science — **acknowledgment, action, and accountability**.

#### 1. I want to see robust ACKNOWLEDGMENT of injuries to science and society.

I agree with people who say "I'm tired of talk. I want action!" Yes! I want action, too.

But there can sometimes be something missing when we jump right into action without taking the important first steps that should always accompany any response to human injury: *acknowledgment*. When my loved ones are hurting — especially if I'm the one who hurt them — they need me to take action, yes, but not before I let them know that I see them and their pain. Our corrective actions should not skip over our acknowledgment of the harm that's been done and its impact on the people who've endured it and who are enduring it still.

Truly meaningful improvement in science begins with the acknowledgment of the dreams that

have been lost; of the people who have been excluded; of the erasure of contributions and advancements that were never made or that were made and never recognized or celebrated. Action, yes. But acknowledgment first.

And *robust acknowledgment* means more than saying it, though words do matter. Robust acknowledgment means doing something now to recognize that

as should providing adequate mental health supports for those whose needs have been neglected.

Any action that is about making up for past and present wrongs is a form of robust acknowledgment. Want to improve science's relationship with society? Start with robust acknowledgment of the ways that the scientific enterprise has fallen short.

AS I SAT THERE STARING AT THE OSCILLOSCOPE SCREEN, WATCHING NEW PATTERNS TRACED BY THE CHAOTIC VIBRATIONS, IT WAS LIKE I COULD HEAR A MENTAL AIRLOCK OPEN INSIDE MY MIND — A HISS AND A WHOOSH! — LIKE THE SOUND YOU HEAR IN MOVIES AS ASTRONAUTS STEP TOWARD THE VAST OPENNESS OF SPACE. THOUGH IT WASN'T EXACTLY A MOMENT OF FULL DISCOVERY (I KNEW THAT I DIDN'T REALLY UNDERSTAND WHAT I WAS LOOKING AT), STILL IT WAS BEAUTIFUL AND INVITING. IT MADE ME HUNGRY FOR MORE! I KNEW I DIDN'T UNDERSTAND IT AND I KNEW I WANTED MORE OF IT!

AGAIN, A MOMENT OF WONDER WAS CALLING ME TO EXPAND MY KNOWN UNIVERSE.

these harms are not bygone figments of the historical past, but persistent issues that people are still experiencing today. For example, the proactive recruitment and retention of underrepresented scientists should, I believe, fall under the category of robust acknowledgment,

#### 2. I want to see institutional commitments to ACTION.

Whereas robust acknowledgment is about addressing the injuries incurred in the past or being committed in the present, our *commitments to institutional action* should be about the future.





What does it look like to practice and support science in a way that shares wonder more widely? How might universities support institution-wide commitments to [broader impacts](#), for example, instead of asking individual scientists to devise broader impact plans on their own? How might external funders support institutional investment in these commitments to action? The institutional actions we take today are about ensuring a different experience for people in the future.

What kind of action — and what kind of future — would I most like to see?

Being Black in physics has often felt like being subjected to private emotional earthquakes that throw me to the ground without warning as I go about my day. These earthquakes often go unfelt by those around me. Their epicenter is the deep unseen cracks in the racist foundations of our world. I feel these quakes and tremors at all kinds of moments, expected and unexpected, throughout my day in science (and in society, for that matter). Even though I'm committed to pursuing and sharing wonder despite this sad reality, the emotional whiplash and instability of my everyday ongoing experience of being a Black man in the sciences and in America — it does take its toll.

So I want to see action that makes the sciences a more stable, supportive environment to work in. And of course, I want the same for society. How about this as a baby step: I want people in the sciences to stop calling me a *minority* all the time — a word that repeatedly identifies and defines me as “fewer than” or “less than.” I don't want to be identified or defined by a statistical measure as if it is not context-dependent or able to be changed.

And some associated acknowledgment would also be nice: a recognition of what it feels like to live and work with these destabilizing private earthquakes and how damaging that can be to creative productivity.

### 3. I want to see sustained ACCOUNTABILITY to those who have been most negatively impacted.

So action is good and necessary. But for action to be sustained, it must be done for the benefit of people to whom we are willing to be *openly* and *continually accountable*. Who has been hurt? Who has been left out? Who is carrying the burden of past missteps? Name them. But don't just acknowledge them. Be brave enough to be accountable to them. Commit to lasting action through lasting accountability to real people.

For example, if an academic institution uses a [Native American land acknowledgment](#) at its conferences, how might that acknowledgment also be matched by an ongoing commitment to be accountable to indigenous people who apply to that institution's academic admissions process? Or if we ask people to share their personal visions for how science should be conducted differently in the future, what accountability are we committing to those people who have shared their visions with us?

I want to hear new voices sharing diverse articulations of the future of science. I want to see through the eyes and imaginations of others what it might look like to better share the power, benefits, and wonder of science. I want to feel the heat coming from the flames of their hopes and hunger for something better. I want to smell what they're cooking. I want to be inspired by their dreams!

And I want to be accountable to these storytellers to do what I can to help make our collective dreams a reality.

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For my part, when I think about the goal of better sharing science's *power*, *benefits*, and *wonder*, I know where my own flame burns brightest:

I'm on Team Wonder! Despite the pain of persistent isolation within the sciences, *I am on this planet to delight in the magic and mystery of the natural world and to shine that God-given light to the rest of the world for as long as I'm blessed to be here.*

I still want to see Halley's Comet before I die. I can imagine myself pointing up at the night sky in the year 2061 with my adult children at my side and, perhaps, my grandkids in my arms. On that night, I want them and so

many others to know the pleasure of hearing that airlock burst open inside their minds — *whoosh!* — as they step awestruck toward the threshold of some new discovery. I want more people to feel the thrill of separate conceptual continents slamming together inside them, connecting them to the known universe in a new way.

Can you feel it too? ■  
*This story was previously published on [Medium.com](#).*



## Sam Dyson

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Aspiring Astrophysicist

**Job title**  
Physics PhD Student

**Organization**  
University of Chicago

**Formerly**  
2020 Civic Science Fellow, Science in Society Funder Collaborative

**Pronouns**  
He/Him

**Homebase(s)**  
Chicago







# SCIENCE IS A TOOL FOR LIBERATION

What was your doorway into science?  
How might society's many entryways to science be  
opened wider to enrich both science and society?

I AM NOT A SCIENTIST. TO BE HONEST, I THINK SCIENCE IS KIND OF MYSTERIOUS, IN THE SAME WAY THAT SOME PEOPLE THINK GOD IS MYSTERIOUS. IT'S KINDA SCARY AND AWESOME. I WAS NEVER GOOD AT IT AT SCHOOL. IN FACT, ONE OF MY FIRST AND VERY FEW MEMORIES OF CHEATING WAS ON A HIGH-SCHOOL CHEMISTRY EXAM, SNEAKING SLY STARES ACROSS THE AISLE TO MY BRILLIANT FRIEND'S PAPER. (THANKS, CHRISTINA!)

SOMEHOW DESPITE THIS, I'VE MANAGED TO CRAFT A CAREER IN SCIENCE. I SNEAKED IN THE BACK DOOR OF A MUSEUM. THIS IS MY STORY OF HOW I BECAME INVOLVED WITH SCIENCE, WHY I THINK IT'S IMPORTANT FOR EVERYONE, AND WHAT I IMAGINE THE FUTURE OF SCIENCE CAN BE IN OUR SOCIETY.



AUDIO TRACK

Science Is A Tool For Liberation is a sound file.  
Click on the play button to access the audio or visit:  
<https://audio.civicsciencestories.org/lvelGontan.mp3>



## Ivel Gontan

### *Personal and Professional Identifiers*

Informal science education revolutionary

### *Job title*

Director of Empathy Initiatives

### *Organization*

Woodland Park Zoo

### *Pronouns*

She/They

### *Homebase(s)*

Seattle, Washington





## FEARFULLY AND WONDERFULLY MADE: OUR BODIES, OUR LIVES

When facing the threat of rare disease, we see how the delicate balance of life can be altered by just one gene.

**M**y mom was a nurse and I was going to be the first doctor in my family. I grew up being so curious about bodies and how they worked. When my baby sister was born prematurely, I wondered why it took her so long to come home from the hospital and how she could be so small. I remember my mom teaching my older sister, younger brother, and me how to hold her, and all the other things we had to do and learn that shifted how we flowed.

Health was an important subject around our house. I would always hear my mom fussing at my grandma about her smoking and what it would do to her. When I was around ten years old, my aunt who lived with us, and who I was really close to, got throat cancer—which I didn't understand at all. And then suddenly she was just gone. I had a cousin who was addicted to heroin, and when he would visit, things would disappear. I'll never forget my dad and mom sitting me down with my older sister and saying, "Your cousin is not allowed in the house anymore."

And when we asked why, they had to explain to us this thing called drug addiction and what it did to you and why you never wanted to go there.

All these lessons that were coming into our household when I was very young related to the forces that could shape the body, mind, and soul. I think that's where the spark and desire came from to study science and become a doctor. But when I got to college there weren't a lot of mentors for people of color in the sciences. I majored in pre-med zoology—as a kid I would devour my dad's issues of *National Geographic*—but I didn't know the many paths that can take you to medical school. I was an athlete and if I had known about sports medicine I assure you I would be on the sidelines of some football or basketball game right now, as a sports doctor!

I may not have become a doctor, but I have never stopped experiencing and thinking deeply about the connection between science and health. I had two children with chronic illnesses. My daughter Ericka was diagnosed with this very rare blood



disease as an infant. She started getting sick as soon as I weaned her from my breast milk. We didn't understand why at the time, but it turned out that her immune system wasn't working. Her doctors told us that she was only the twenty-first person in the world diagnosed with a very rare blood disease: Severe Combined Immunodeficiency Syndrome caused by the lack of an enzyme called adenosine deaminase. It was called ADA-SCIDS. After she was diagnosed, our then 4-year old was also diagnosed with the same condition. Fortunately, there was a drug approved under the Orphan Drug Act of 1983 that was effective on both of our girls, that we were able to administer to ward off the challenges of the disease.

That's what the wonder of science means to me. It's one enzyme—one—that

changes everything. It's the autosomal recessive gene that both I and my husband carry. It's the wonder of what happens when that one enzyme is missing and your blood becomes toxic to your immune system, because adenosine deaminase is what washes our blood.

Although the shots that the girls had to take were effective, at 2 ½ years old, Ericka was diagnosed with hepatoblastoma - a fast growing liver tumor. She battled this cancerous tumor for almost one year, but lost that battle in September 1993. She now lives with the Lord in Heaven.

Our living children are now 34 and 26 years old. They are both true blessings to our lives and we thank God for their health and strength. I'm an ordained minister, and when I think about the scripture that says we are "fearfully and

wonderfully made" (Psalm 139:14), it is the wonder of science and the connection with community that has sustained our family.

My daughters' condition was genetic, but I also think a lot about those forces I came to know as a child—the ways our environments can influence our lives and health. At one time, I had the opportunity to serve as a facilitator for a meeting of the National Environmental Justice Advisory Council (NEJAC). During site visits hosted by the NEJAC, I visited San Antonio, Texas, and learned about how soil in the ground was poisoned by industry dumping toxic waste and how Mexican-American families in those communities grew vegetables and other foods in their backyards and got sick because they didn't know the soil had been contaminated.

**I MAY NOT HAVE BECOME A DOCTOR, BUT I HAVE NEVER STOPPED EXPERIENCING AND THINKING DEEPLY ABOUT THE CONNECTION BETWEEN SCIENCE AND HEALTH. I HAVE CHILDREN WITH CHRONIC ILLNESSES. MY DAUGHTER ERICKA WAS DIAGNOSED WITH THIS VERY RARE BLOOD DISEASE AS AN INFANT. SHE STARTED GETTING SICK AS SOON AS I WEANED HER FROM MY BREAST MILK. WE DIDN'T UNDERSTAND WHY AT THE TIME, BUT IT TURNED OUT THAT HER IMMUNE SYSTEM WASN'T WORKING. HER DOCTORS TOLD US THAT SHE WAS ONLY THE TWENTY-FIRST PERSON IN THE WORLD DIAGNOSED WITH A VERY RARE BLOOD DISEASE.**

Now, in the time of the pandemic, I think of how people of color have been disproportionately affected depending on where they live. There are going to be a lot of people returning to work with disabilities or chronic physical or mental conditions that they didn't have before COVID. We're all going through so much loss and upheaval. And I worry particularly about the Black and brown communities that have been hit so hard.

Those are the communities I've devoted myself to helping throughout my career. In my former role as Initiative Director at The James Irvine Foundation, I led an initiative that opened access to middle skill/middle wage employment for people living on low-incomes. Most of these folks are Black folks, brown folks, and other people of color. That's what my dad did, too, at the Urban League in Columbus, Ohio and at the National Urban League in New York. His job was to help Black folks get jobs. I

always said I wanted to grow up and be like my Dad. And I feel like I am. Before I joined Irvine, I led a national organization called the National Community Development Institute, whose mission was to build capacity for social change in communities of color throughout the country. We worked "on the ground" in places other people were afraid to go, working with residents, helping them to understand what forces were affecting their lives and how "Superman" wasn't coming to save them. We helped them build themselves up and find their own voice and their own power. I remember being in huge church basements with two hundred people, standing room only, listening to us encourage them and solidifying the fact that it's *their* neighborhood, that *they* are the experts, but that we could come in and be resources to them so that they could address social ills in their communities and develop homegrown solutions to social change.

Now that I'm in philanthropy, I get to invest in organizations that do this kind of good work. And you know, when Blacks are not in philanthropy, Black-led organizations don't get funding. I take my role as an African American woman in philanthropy very seriously. I carry an internal responsibility to be intentional about investing in individuals, organizations and communities that are serving the Black community. My experience as one of the youngest, and few Black leaders serving on two different occasions (in the late 90's) as CEO of two different nonprofits, gave me firsthand experience of dealing with philanthropy as a Black leader. It was a challenge to secure the resources to do our work effectively. We had the most support when over 85 - 90 percent of the program officers we worked with at foundations were Black. When they left, if they were replaced by folks who were not people of color, our grants generally didn't get renewed. And so now, I'm making sure that Black-led organizations are not ignored. Because these are the organizations that are at the intersection of science and society. They're what help people in these communities make real progress.

I want people to know that they do not have to be defined by the pain they have gone through, or by the things said or done to them. Part of my work in this world is to help people understand

who they are and that they can live—that they *deserve* to live—a fulfilled life. Sometimes we forget to hope—we feel down. Everybody has those days and those seasons in their lives. I want to give folks the hope that this too will pass and especially give this message to young people.

I was on a panel at a high school recently, where people got to talk about their careers, and they asked me where I started, and I said, "Well, I got a bachelor of science in pre-med zoology, and

then I went and got an MBA. I was going to be a doctor, but now I'm a minister, philanthropist and social change agent." So, the message is that you can go with the flow, that you don't have to be eighteen and choose exactly what you're going to do with the rest of your life. It's a journey. It's such a cruel question we ask little kids: "What do you want to be when you grow up?" We are still trying to figure that out in our fifties. It takes courage to go with the flow of your life and to discover and live who you were born to be. ■



## Kelley D. Gulley

### *Personal and Professional Identifiers*

Ordained minister; philanthropist; non-profit executive; community builder; servant leader; Co-Active Coach

### *Job title*

Chief of Staff

### *Organization*

The Arthur M. Blank Family Foundation

### *Formerly*

Better Careers Initiative Director, The James Irvine Foundation

### *Pronouns*

She/Her/Hers

### *Homebase(s)*

Atlanta, Georgia







## IN LIGHT OF AN UNEXPECTED ECLIPSE

Science helps us understand how things work. How can that be a foundation for making things work better?

**A**s a first grader, I loved school. I loved the Brain Quest trivia questions my teacher read to us each day, I loved recording observations in my “spy journal,” and I loved reading any book I could get my hands on. I was less enthused about science, though. Once a week, my class visited the science teacher who had us do worksheets. The only thing I remember from those classes is that one day she yelled at me for using too much glue on a dinosaur worksheet.

That same year, my parents decided our family would take a trip to the Caribbean. We had to reschedule the first trip they booked (the dates overlapped with Dr. Seuss’s birthday — of course I could not miss school on such an important occasion), but soon after, we boarded a flight from Boston to Aruba along with many people lugging large technical equipment. When my dad asked one of them what they were bringing, they were surprised we didn’t know

— they all had telescopes because there would be a rare total solar eclipse a few days later, and totality would only be seen from a few parts of the Caribbean and South America, including Aruba. Many people had booked this trip years before, but my family, not realizing anything special would be happening, had booked it two weeks prior.

On eclipse day, while my mom was supervising my sisters’ nap, Dad and

I headed outside. It was a bright, sunny day. We put on the disposable glasses we had bought the day before so we could safely look at the sun. Shortly after, we saw the moon, surprisingly visible in the bright sky. The moon seemed to be approaching the sun, and over the next few minutes, as they got closer to each other, the sky got darker until it was fully black. For just a moment, the moon sat directly in front of the

ON ECLIPSE DAY, WHILE MY MOM WAS SUPERVISING MY SISTERS’ NAP, DAD AND I HEADED OUTSIDE. IT WAS A BRIGHT, SUNNY DAY. WE PUT ON THE DISPOSABLE GLASSES WE HAD BOUGHT THE DAY BEFORE SO WE COULD SAFELY LOOK AT THE SUN. SHORTLY AFTER, WE SAW THE MOON, SURPRISINGLY VISIBLE IN THE BRIGHT SKY. THE MOON SEEMED TO BE APPROACHING THE SUN, AND OVER THE NEXT FEW MINUTES, AS THEY GOT CLOSER TO EACH OTHER, THE SKY GOT DARKER UNTIL IT WAS FULLY BLACK. FOR JUST A MOMENT, THE MOON SAT DIRECTLY IN FRONT OF THE SUN, AND WE SAW A RING OF SUNLIGHT PEEKING OUT FROM THE EDGES OF THE DARK MOON. PEOPLE AROUND US WERE CHEERING, BUT MY DAD AND I STAYED SILENT.

sun, and we saw a ring of sunlight peeking out from the edges of the dark moon. People around us were cheering, but my dad and I stayed silent. Just as quickly as the moon had approached the sun, it started gliding away. The ring shape disappeared, and the sky brightened. I think the entire event unfolded in 5-10 minutes, but in all honesty, I had no sense of time passing. I was floored by the power and beauty of the natural world, all that I didn't yet know.

Years later I realized what a privileged experience this had been. If my parents had not had the means to take our family on this trip as a brief reprieve from the New England winter, I would not have seen that eclipse. I would not have had that awe-filled experience, nor would I have recognized the power of the natural world and all there is to learn about it.

Despite the fact that I had that formative science experience in first grade, I did not identify as a

“science person” in elementary, middle, or high school. Science remained a subject of facts to memorize, which felt tedious and unimportant. I preferred reading fiction, which allowed me to inhabit vast, new worlds; writing, since it was an open-ended activity full of possibility; and subjects like foreign languages and music theory that paired beauty with structure and logic. I didn't realize that science has all of these traits, too.

My relationship to science began to change in college. I think this was because I had the opportunity to take social science classes, which connected my favorite topic — humans — to scientific methods and ways of thinking. I started to see science as a process that's both rigorous and creative, as I had the opportunity to design experiments to explore research questions I was curious about.

I learned that science isn't a compilation of facts about the world

as much as it is a way of understanding — iteratively, over time — how the world works. To me, this is science's biggest source of power because understanding how things work is a foundation for making them work better. But just because science can benefit us all, it doesn't mean that it will by default. The fact that my privilege allowed me such an awe-inspiring eclipse experience was not a fluke — science's benefits and power are, by and large, most directly experienced by people with a number of privileges. To make sure that everyone can benefit from science, we need researchers who reflect us all, asking questions that get to the heart of our greatest challenges, working with communities to explore those questions and apply their insights. This is civic science. Although it's not how science is generally conducted today, it's a world worth working toward.



## Rose Hendricks

**Job title**  
Program Director

**Organization**  
American Society for Cell Biology

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2020 Kavli Civic Science Fellow

**Pronouns**  
She/Her/Hers

**Homebase(s)**  
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## WHO ME? OVERCOMING MY IMPOSTER SYNDROME IN SCIENCE

What does it mean to be a scientist?  
Who gets to claim that as their identity—  
a fitting description of who they are and  
how they contribute to the world?

**A**t first I wasn't sure what I was feeling when I saw the young man at the Maker Faire. He was a high-school, with an afro, a young man of color, who very much reminded me of myself at his age. He had built a motorized scooter for his grandmother. This was ten years ago, and Segways were big then, but of course they were super-expensive, and he thought he could design and build one using spare parts.

I looked at this young man's homemade machine and thought, well, it isn't perfect and it's not beautiful. But it *actually works*! And what I loved even more than the Segway-like scooter was the way he had written a journal to capture his ideas and document his successes and failures.

It wasn't a wasn't the greatest looking notebook. It was dog-eared, the writing was illegible, with lots of scratch-y notes with absolutely no

organization, but I found myself powerfully moved by it. Why?

Part of the reason was that I finally understood why people had been trying to convince me to take Maker Faires seriously as models for STEM education. Before that, I couldn't understand how this sort of tinkering could be the foundation of scientific thinking. But here I immediately felt, "Oh, this is what I want young people to do!"

But the deeper connection didn't hit me until days later, weeks later, maybe even a year later: *That boy could have been me*. This is what I had wanted to do. This is what I missed. It was a glimpse from my own childhood, as I desperately wished it had been.

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My tinkering days began when I was eight or ten, when I started rewiring my home telephones. I was curious about how they worked, so I extended the lines

into different rooms and started buying up phones. It was a bit of a telephone frenzy. I didn't think of it as engineering or science as much as curiosity: I wanted to understand how things worked and what they meant to people. I loved the moment when my family said, "Oh, this is really helpful! Now I have a telephone right next of me instead of having to walk all the way to the kitchen." That was the payoff.

I remember how fascinated I was by my first biology class in high school. That really turned things around for me. It wasn't just fascinating and it was fun. From then on, I wanted to be a high school science teacher.

But when I went to college, that feeling of possibility began to slip away. I wasn't the kind of kid who was even supposed to go to college. I was a person of color from a Latinx

MY TINKERING DAYS BEGAN WHEN I WAS EIGHT OR TEN, WHEN I STARTED REWIRING MY HOME TELEPHONES. I WAS CURIOUS ABOUT HOW THEY WORKED, SO I EXTENDED THE LINES INTO DIFFERENT ROOMS AND STARTED BUYING UP PHONES. IT WAS A BIT OF A TELEPHONE FRENZY. I DIDN'T THINK OF IT AS ENGINEERING OR SCIENCE AS MUCH AS CURIOSITY: I WANTED TO UNDERSTAND HOW THINGS WORKED AND WHAT THEY MEANT TO PEOPLE. I LOVED THE MOMENT WHEN MY FAMILY SAID, "OH, THIS IS REALLY HELPFUL! NOW I HAVE A TELEPHONE RIGHT NEXT OF ME INSTEAD OF HAVING TO WALK ALL THE WAY TO THE KITCHEN." THAT WAS THE PAYOFF.

BUT WHEN I WENT TO COLLEGE, THAT FEELING OF POSSIBILITY BEGAN TO SLIP AWAY.



community where lots of my brothers and sisters—and not just the ones related to me by blood—didn't go on to college. I had been taught not to follow my every passion. It was too important to choose a career that would lift you out of poverty and into the middle class. That's why I dropped the music lessons that I loved—which is why today I listen to forty or fifty hours of music a week instead of *playing* forty or fifty hours of music a week.

And when I started my first introductory college science classes, I quickly discovered that they weren't meant for me. College science was a bit of a weeding out process. These classes were designed to train doctors, not science teachers. That was the mentality of the professors, who had been trained in the forties and fifties and felt that graduating as many doctors as possible was their legacy. So they didn't broaden their teaching to include young people who were simply curious about the world.

I was so disappointed. And it was my first smack of reality—that now-familiar message that science is not for everybody. Science is for

the special, for the few. Science is for people who can get through a boot-camp kind of training and learn to think in a certain way. So I believed that I wasn't a scientist and was never going to be a scientist.

I gave up the idea of majoring in the natural sciences, but I did take a lot of classes in psychology—child psychology, biopsychology, and so on. And that's how I got on a different sort of path, to science education. I happened to land a job at the Children's Television Workshop—CTW (now Sesame Workshop), doing research on child development. Educational research wasn't the kind of science I had ever imagined doing, or even knew existed. I had only stumbled across the job because I was doing a summer-school program with little kids in my community, and some CTW researchers showed up at my afterschool center. Once I saw the work they were doing with the kids, I said, "Hey, whatever you guys are doing is really cool. Could I get a job doing this?" And I could. And that's where I met some of the people who have been my mentors and dear friends through my entire career.

I feel lucky that CTW gave me that encouragement and support. But I can't help thinking about how much happier I would have been if I had gotten this as a curious young person.

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When I picture that boy and his scooter and journal at the Maker Faire, I can't help but grieve what could have been. I think about myself at that age and how I wish someone had been there next to me saying, "Dig deeper. See what happens. Why don't you write that down."

I had stick-to-it-iveness. I had that in me somewhere. But I couldn't figure out how to apply it to science. It didn't feel like I could ever be proficient. And that was both because I didn't know what proficiency looked like and also because I was told, in more than one way, that I didn't belong in that world. It wasn't open to me. And I still feel today that something important was taken away from me because my passions weren't encouraged.

But today, I am on a new path. My career has taken me to a place where I am influencing change in STEM education. I

want young people to know that science is open to lots of different kinds of people with lots of different kinds of expertise. It's not one thing—it's many things. It's for anyone who wants to really think about the world.

I want to expose more young people to the good stuff. And that's

the power of wondering, the power of curiosity, the power of asking questions. We need to stop thinking, "We need more engineers, we need more scientists." Science isn't all about contributing to the economy. We need to start thinking of science education as something that creates better citizens for the world.



## Andrés Henríquez

### *Personal and Professional Identifiers*

@STEM #Policy #DiversityinSTEM  
#STEMinCommunities

### *Job title*

Director of STEM Education Strategy

### *Organization*

Education Development Center

### *Pronouns*

He/Him/His

### *Homebase(s)*

New York, NY





## OLOGIES

What kind of civic action does science call us into?

**W**hen I went to college—which was

never in doubt—I was under the impression it was to learn. My parents never guided, pushed, or favored a profession to aspire to attain in any way.

I skipped my senior year in high school with Howard County Junior College just across town. A year and 2 summers later when my brother packed up to go to the University of Texas, I got in the car and went with him. The astonishing thing there was the university catalog. It was like the Sears catalog or, for me, the Whole Earth Catalog. Entering with the college credits already earned made all the difference: I bypassed the college counselors all new freshmen had to reckon with. I was free to enroll myself.

Free to enroll is rather a misnomer since enrollment took place in a gymnasium with the cattle panels up, creating

the maze the masses of students inched forward in, into their futures. In those lines, my destiny and so many others were forming, as we inched up only to find the class we had hoped to take was already full. My major had been undetermined. But that does not open doors to the upper-level courses with the most desirable titles. So I determined on the spot, or within the cattle panels to go all “-ology.”

Psychology, sociology, biology were already on the transcript, and in Austin, Texas, I discovered anthropology! As Cherokee, learning how non-Natives describe and consider our “ways” and describe our “culture” took me off campus a time or two to discover all sorts of cultures, starting with the “counter-cultures” clashing in a mountain

village in Taos, New Mexico where Anglo artists, local Chicanos, and Taos Pueblo members engaged with the new wave of immigrant Hippies.

I ended up 3 colleges later with a degree from Southern Colorado State College in—what else?—the behavioral sciences! Hours and hours of ologies...from geology, psych, soc, to the 9 hours of Hominology required while attending the small Black Hills State College.

There is a lot to learn in a college setting, but it does not stop when each of the classes ends. There was a wider world of activism. At the time I jumped in, there was the energy around stopping the draft, stopping the Vietnam War, stopping the bombing of civilians, which actually ended up leading me into political



HOURS AND HOURS OF OLOGIES... FROM GEOLOGY, PSYCHOLOGY, SOCIOLOGY, TO THE 9 HOURS OF HOMINOLOGY REQUIRED WHILE ATTENDING THE SMALL BLACK HILLS STATE COLLEGE.

THERE IS A LOT TO LEARN IN A COLLEGE SETTING, BUT IT DOES NOT STOP WHEN EACH OF THE CLASSES END. THERE WAS A WIDER WORLD OF ACTIVISM. AT THE TIME I JUMPED IN, THERE WAS ENERGY AROUND STOPPING THE DRAFT, STOPPING THE VIETNAM WAR, STOPPING THE BOMBING OF CIVILIANS, WHICH ACTUALLY ENDED UP LEADING ME INTO...POLITICAL SCIENCE IN ACTION. THEN IT WAS THE FIRST EARTH DAY AND THE AMERICAN INDIAN MOVEMENT. I MISSED ALCATRAZ AND HAD JUST BIRTHED MY ONLY SON OR WOUNDED KNEE WOULD HAVE BEEN THE NEXT CLASS OF ACTIVISM TAKEN.

science in action. Then it was the First Earth Day and the American Indian Movement. I missed Alcatraz, and had just birthed my only son, or Wounded Knee would have been the next class of activism taken.

All that anthropology gave me more pride in my own heritage and with a career in education, a Masters in Counseling, I had a paid position as an Indian counselor for 27 years in Oklahoma. But it was the role I took as the sponsor for the school's Indian Club that brought activism and hard science into the next half of my life.

Oklahoma does not have a nuclear power plant but early in the 1990s the NRC was searching for a place to store spent nuclear waste. All of the states had rejected it. Then Nuclear Regulatory Commission (NRC) began approaching tribes. Two of the local tribes in the county where I work asked to be considered. There are magic moments, pivotal moments in your life, and I had one while riding in the dark in a school bus with my Indian Club dance team, coming back from a presentation we had given at one of the most prestigious country clubs in the area. After they learned about the TRIBES wanting to store nuclear waste, one of the youngest who I had thought was taking a nap in the dark, sat up. This 5th grader began to speak, saying, "We are Indians. We are FOR the environment!" So the students organized a forum to

invite the community to hear a discussion led by proponents of the project to store nuclear waste—Eastern Shawnee Chief and the Chief of the Miami Tribe—and activists Carrie Dickerson, who organized the effort to STOP the only nuclear power plant in our state, and Grace Thorpe, the daughter of the legendary Indian athlete Jim Thorpe, who would speak against it.

As you have seen in this story, I love to learn. But you haven't read how I transferred colleges to avoid taking speech. So at this incredible gathering in the high school cafeteria, I said little. But the 6th and 9th grade tribal girls spoke so clearly that the 2 tribal leaders, in the midst of the full capacity crowd, learned that they were beat. Both rescinded their request for consideration and our county does not house the nuclear waste for America.

Leaping forward through time I found my voice and became the school HIV/AIDS educator, which made me for all purposes the activist on deck to speak out for sex education to be clearly protective of human health.

That carried me to Service Learning and how that program moved through my school and jaunted me on to taking on the largest superfund site in the country, discovering the link between what lurked in the soil, in the dust and in the surrounding water. The fish and every blackberry growing along

the streambed held toxins that affected the way my students learned, how they acted and how they lost their potential even before they were born. Heavy metals (primarily lead) came from the abandoned lead and zinc mines just 5 miles from my high school.

I had all those ologies, but never the chemistry that was working against the students in my life or the children they would bear in the future. But through my experiences, and my quest to learn—since isn't that what we do?—I sought help.

In the old days, if you wanted to find a phone number, you dialed zero and got a real operator who listened to you and helped you to connect with your party. After I had read a small article in a Harvard Newsletter about a researcher who found that lead exposure (one of our heavy metals) between the ages of 7 and 21 led to extreme obesity in later life. Well that phone operator helped me talk with that researcher, Rokho Kim, who listened to my questions and ended the conversation agreeing to be our "tooth fairy": he agreed to sample baby teeth, or any teeth we sent him, to discover if these people had been exposed to lead as young children, and if so how much.

That started a relationship with the Harvard School of Public Health and a birth cohort with 702 babies looking at the multiple metals they were born with and how those exposures



harmed their health and how they learned.

We kept learning, some of those babies graduated this year from high school. Some didn't graduate at all. But one as a valedictorian.

I bet that graduate will keep learning. And that is what we hope isn't it? That what we do somehow ends up being what helps those who follow learn their way in the brand new world they inherit. ■



## Rebecca Jim

*Personal and Professional Identifiers*  
Indigenous Environmental Activist

*Job title*  
Executive Director / Tar Creekkeeper

*Organization*  
Local Environmental Action Demanded Agency (LEAD Agency, Inc.)

*Pronouns*  
She/Her

*Homebase(s)*  
Cherokee Nation, Oklahoma, USA





# RAIN IN THE HIGH DESERT: SCIENCE, DESIGN, AND EDUCATION

The sciences—like architecture and design—give us the power to connect with the people and the spaces where we live.

**W**hen I was growing up, my dad worked for General Electric in Albuquerque at a plant that built aircraft engines. He'd love to spot an airplane on TV, because he could tell you the type of plane it was and the type of engine it was using. It was a family joke that when we were out driving with him, he might point out a plane in the air and say, oh, yeah, that's not one of ours, it's a this or that.

He was an electrical engineer, and he was always tinkering with something around the house—taking it apart, putting it back together again. Once it was our car engine. More often it would be something like a small radio. I can picture him laying out the parts in the order he had removed them and gaining an understanding of all the elements of a machine and how they interacted. And he would talk to me about the process along the way.

I look back on that really fondly. I loved watching him and seeing that process of discovery.

These were some of my earliest moments of thinking about how things work, how they come together. And how it doesn't just *happen*—people are part of the process.

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When I got to college, I didn't pursue engineering, much to my father's chagrin (engineering had fed our family, after all). Engineering just didn't grab me the way architecture did. Architecture made connections between technical fields and aesthetics, sociology, psychology, and urban planning. Everything came together in this beautifully integrated subject that I fell in love with.

For me, science was always emotional as well as technical. The natural

world brought me a sense of awe and wonder that I wanted to replicate in the built environment.

That feeling of awe would hit me the hardest when I was out on the west mesa in Rio Rancho, a suburb outside of Albuquerque. It was a short drive from where I grew up and where my parents still live, and often I would take my dogs out for long walks. I used to go there to center myself when I was in school and trying to figure out what my life was going to be, especially during busy or chaotic times.

Everything out there is so grand. The sky is so big, the light so intense, the view so expansive. And there's so much to notice, to be aware of. There's the topography of the high desert. It's not as sandy as you would imagine. There's a lot of brush and small plants. It has a distinctive feel that changes throughout the year.

And then, as you're walking across the mesa, a storm would begin to rise from the west, and you could watch this complex dynamic unfold in front of you. You'd start out in the sunshine, but then see the clouds start to form. And before you knew it, you'd feel the wind, and all your senses would engage. You'd start to smell the rain coming across the desert. And the wind would continue to pick up, and then the temperature would drop and the light would dramatically change—the natural light in New

Mexico on the high desert is really incredible and so intense. The whole experience was powerful but also calming like you were connected to the phenomena unfolding around you.

And it made me think about so many interesting questions about the natural world. That euphoric smell that comes off the desert floor when the soil has been dry for so long—what makes that smell? It's a small, magical thing, but there's science behind it. And there would be a palette of colors that appear for just a short time in clear, sharp contrast. You might see a tiny flower in an incredible shade of magenta that will be here and gone in a week, and you might not see it again for a year or two. Why?

That experience of being on the west mesa became an important touchstone for my work in design. I'd ask myself, when someone walks through a building, how are that person's senses engaged, even subtly? How does the light and perspective change? Can you create a sense of happiness or pleasure by using a color as an accent—by taking what normally would be a white wall and turning it into a color that touches a sense, so that when you turn a corner you see this nice bright orange at the end of a hallway that makes you feel something?

In high school I did some theater lighting and had the chance to experiment with this idea hands-on.

I had to create different sensations for the audience—of pleasure or of drama—using a very simple set of tools. It was an exciting challenge, figuring it out. Concert lighting made me think about these questions. I'd look up at the rigging as I waited for the show to start. Once the music was playing, I'd glance at the lights and then watch the people at the lighting board move from cue to cue, creating these really beautiful moments. Most people there were simply enjoying the experience, but I was always trying to take it apart and put it together again in my head.

And like the desert, it was all about awareness. It was about appreciating that your environment can have an effect on you and then figuring out how to spark those feelings in others. But it all starts with being aware.

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For me design certainly starts with being aware, but it doesn't end there. It also takes the confidence to know and appreciate that you have something important to share with the world and it builds from a diverse catalogue of life experiences within you.

Once I finished graduate school in architecture at the University of New Mexico, after working in the field leading a design firm for a number of years, I took a job designing and managing mentorship programs and other youth programming for the Chicago Architecture



Foundation (now the Chicago Architecture Center). I made it my mission there to show young people that they're all capable of finding their inner-creative self and achieving something beautiful.

One of the things I've always said, especially when I was working at the Architecture Foundation, is that we are all designers, and we all have an inherent ability to shape our environments. And people would always say, "I can't design anything, I am not creative". Or I can't do this, or I can't do that. So I'd go to that student—or even adult—first and say,

"Well, let's talk about that. When in your day, or someplace in your world, required you to make a decision? Tell me more about that moment and that process." And at the end of the conversation, if it went well, they'd say, "OK, I guess I made a critical decision or found a solution to something, and maybe I do have some part in me that I can express and share with others."

We all—children and adults—have valuable, inherent knowledge based on our own catalog of experiences. I wanted to help people understand that, and to help them find the ability to make their own

contributions to the world, no matter how large or consequential. That led me away from the world of architecture and design practice and into the world of informal education, using my training and experience as the foundation of my educational work. At the Architecture Foundation, I led a project to create a Design Studio used for facilitating creativity-focused educational programming, and I insisted we featured the phrase "We Are All Designers" on our walls and street facing windows because I felt strongly we all have the capacity for unique and innovative expressions, and the Design Studio

was a place to learn how to find them. This idea developed from my training and work in architecture, guiding clients and end-users to appreciate the many facets that make up the world around them and understand they have a capacity to engage and inform their environment as well, and this continues to inspire all that I do today.

I talk a lot about empathy in my work because just like design, I think science is fundamentally grounded in humanity. An interest in science starts with a sense of wonder and curiosity about the world, and putting science into

practice can mean having an effect on the lives of your friends or millions of people. And yet so often, science is treated like an abstraction.

So when we bring in a professional to talk to a classroom of kids, the first thing I ask that person to do is talk about their personal story and why they do what they do. Maybe it doesn't even have anything to do with the science they're working on right now. But I want the first thing the kids to hear are those stories of what sparked their interest. That personal connection makes the work feel more meaningful.



SO WHEN WE BRING IN A PROFESSIONAL TO TALK TO A CLASSROOM OF KIDS, THE FIRST THING I ASK THAT PERSON TO DO IS TALK ABOUT THEIR PERSONAL STORY AND WHY THEY DO WHAT THEY DO. MAYBE IT DOESN'T EVEN HAVE ANYTHING TO DO WITH THE SCIENCE THEY'RE WORKING ON RIGHT NOW. BUT I WANT THE FIRST THING THE KIDS TO HEAR ARE THOSE STORIES OF WHAT SPARKED THEIR INTEREST. THAT PERSONAL CONNECTION MAKES THE WORK FEEL MORE MEANINGFUL. BECAUSE SCIENCE ISN'T JUST IMPORTANT FOR ITS OWN SAKE; IT DEEPLY AFFECTS PEOPLE'S LIVES. IT DRAWS ON OUR NATURAL CURIOSITY AND SENSE OF WONDER, AND THROUGH IT WE CAN SHAPE THE WORLD WE LIVE IN.



Because science isn't just important for its own sake; it deeply affects people's lives. It draws on our natural curiosity and sense of wonder, and through it we can shape the world we live in.

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Part of making science personal is connecting it to the familiar. I had the chance to collaborate with a group of teachers and parents in northwest New Mexico on the Navajo Reservation, a four-hour drive from Albuquerque where my firm was located. We were training them in design thinking and the design process as a way to excite students around STEM and problem solving, and these were folks who were committed to engaging their kids in a way that

they felt they hadn't been able to before.

To make the material more personal for them, we took elements that were essentially in their backyard and made those the center of the lessons. For example, windmills were a common feature to pump water for a variety of household uses, because things are so spread out that there's no centralized infrastructure to rely on. And so one of the exercises we introduced was designing a better fin for a windmill. First, you'd learn about the design of the fin and how the air currents flow across it creating pressure on each side, and then you'd create a multitude of them, build a structure to hold them in place, add air currents

and then see how fast the windmill would spin.

Then we'd add a meter to the windmill so you could see how much energy it could create as a direct feedback element to gauge how well the design worked. And then you would modify that design, starting an iterative process to change and, hopefully, improve its performance. A person could gauge and track over time their process and progress between different design iterations. It was a fun exercise. We could have done a similar exercise based on a propeller for a submarine, but this was something they could immediately relate to within their environment.

I remember driving the four and half hours back from that school and

getting home at two in the morning, exhilarated about what had happened that day. We heard from the teachers and parents later that it had been a great day for them, too, that a switch had turned on and now they understood they could take the variety of experiences they ordinarily take for granted and use them to teach the kids about science and design, technology and engineering—that it didn't have to be something elaborate or foreign.

That was a really meaningful moment for me, knowing that I had helped these parents and teachers to then inspire their youth to discover a love of science and design, and in a way that inspired my own path into a life of design by being aware of the world around us, and being empowered to engage in it in a meaningful way.

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A few weeks ago I saw a photo on Facebook of a handful of young people who I had worked with eight years ago at the architecture foundation. They had been in high school then, and they were part of a group who we had taken out to Arizona to study architecture and to experience the desert as I had growing up. And here they were in that photo, such great people, still friends. Some of them have kept in touch with me and have told me that this time was a big part of their growing up.

When I saw that picture, I thought: the things you do matter. The thoughtfulness that you put into your work, the planning and the execution, the fight for funding, all of it—so that six kids can have an experience like this. It matters. And there's a lot of faith involved in this work: you can't know whether your efforts will pay off until years in the future, and maybe not even then. Isn't it funny that a subject so technical can, at the end of the day, turn on faith? It reminds me of being out there with my dogs and having faith that the rain is going to come, because you're smelling that smell and the light has changed in that familiar way.

When I think about the accomplishments I hope to leave behind me, of course I think first of my son. Whatever he ends up doing in his life, I hope he's passionate about it, and I hope he sees the passion I have for my own work and can take inspiration from that, as I did from my father. My hope for the people I've worked with in my programs is that some number of them, whether it's one, ten, or a hundred, feel that the experience has meant enough to them that they want to give back—that they're going to talk about their worlds in a way that gets other people excited. If I can help a few people find that beauty and wonder that I found in the desert and turn it into a love of science, then I think I'm doing OK. ■



## Manny Juarez

### *Personal and Professional Identifiers*

Educator, Designer, Father, Mentor

### *Job title*

Director of Science and Integrated Strategies

### *Organization*

Museum of Science and Industry

### *Pronouns*

He/Him

### *Homebase(s)*

Chicago







## SCIENTIFIC AND POLITICAL ACTIVISM IN ISRAEL/PALESTINE

How can we wield science's power with greater humility and humanity toward justice, equality, and inclusivity in challenging political situations?



**E**xperts hold great power over our lives. When I was twenty-four, I was diagnosed with thyroid cancer, and I'll never forget what it was like to walk into the doctor's office feeling like a healthy person and walk out feeling like a sick person, all because of the words spoken to me. I was told I had to choose between two different treatment options over which physicians disagree, each with its own implications—should I remove some of the thyroid gland or all of it?—and feeling stuck in an awkward situation, having to wrestle with

this heavy decision without really having the tools to do it well.

This was my first significant encounter with the uncertainty, biases and blind spots of what science can offer us, as well as the weight of its consequences. Following the decision I made, the doctors ended up removing my entire thyroid gland, so I had to live life without it, which was fine in the beginning, when I was young, but in my thirties and forties it became clearer that this was going to have long-term effects on my health. After giving birth, at the age of 35, I began a new sort of relationship

with medical institutions, which were telling me what to give my baby all on faith that the experts knew what they were talking about. It made me realize that I needed to be in a continuous process of questioning, collecting my own knowledge so I could make decisions I could feel confident with, which are not based on one dominant way of knowing but on a variety of knowledges and interpretations of the body.

Today I collaborate with other people in all sorts of situations where we are required to take back some of the power usually

wielded by experts with specialized tools and the cloak of authority. This work developed from my political activism in Israel/Palestine and started from my research into the legal mechanism and visual technologies used to enforce planning and building law in Jerusalem, which is one of the most powerful tools of discrimination and oppression used against the city's Palestinian residents. That got me interested in the techno-scientific tools that the people who enforce this mechanism use on a daily basis.

These enforcers, or inspectors, use

photography and GIS tools to create evidence of so-called illegal building—"so-called" because there's no other way for Palestinians to build. So this fundamental civic act or human act—building a home—has been criminalized, and visual technologies such as photography and mapping have become tools of criminalization.

I wanted to challenge the seemingly objective, scientific way that the authorities use visual evidence. Aerial photography in particular is often used and seems to carry an air of authority and objectivity,

because it is taken from above in a mechanized way, without a human being even holding the camera. But, in fact, like any other visual representation, like any other technology, it embeds existing forms of domination and requires critical interpretation. There can be no objectivity if we ignore the political and situated nature of such images.

I became even more conscious of the constructed nature of expertise when I learned that the city's planning and building inspectors were not even considered scientific experts: they are usually low-ranking workers who send their images to decoders to mine them for useful information. I became particularly interested in their work, because they seemed to have used these aerial photographs, along with associated GIS data, to acquire a unique view of what was happening on the ground. Using the GIS software, they could zoom in on a random house in a dense neighborhood without street names seen on an aerial photograph, and tell you the name of the family who lived there, which for me was mind-boggling. I also knew that these inspectors were patrolling the field all the time, even entering homes, registering people and documenting changes, which gave them a multidimensional view of life on the ground. All this made me think about how this same scientific tool that was being used for the sake of criminalization could be harnessed for civic

aims. Residents struggle with spatial and planning issues all the time but don't ordinarily have everyday access to such tools and advantageous points of view. What would access and hands-on experience aerial technologies do to people's perception of space, skill and agency?

With these questions in mind I began working in collaboration with Israeli and Palestinian residents and activists, experimenting with the political potentials of civic technoscientific tools. I started a project to create do-it-yourself (DIY) aerial photography with citizens and non-citizens in Jerusalem, using kites and balloons based on a toolkit developed by Public Lab. Together we reclaimed the social and political meanings and uses of the aerial view, and explored the links between scientific and political activism.

One of the things I remember most from my early experiments with DIY aerial photography was the way that the idea to create one's own aerial imagery created a spark of imagination that shined in the eyes of almost anyone I talked to or worked with. Activists are leading all kinds of struggles, and yes, this tool might serve them in these contexts, but besides those benefits, it also brought a sense of wonder. People always saw some personal relevance to the tool: it made their minds whirl with all the things they could do with it and learn from it. They talked about using it in

**I STARTED A PROJECT TO CREATE DO-IT-YOURSELF (DIY) AERIAL PHOTOGRAPHY WITH CITIZENS AND NON-CITIZENS IN JERUSALEM, USING KITES AND BALLOONS BASED ON A TOOLKIT DEVELOPED BY PUBLIC LAB. TOGETHER WE RECLAIMED THE SOCIAL AND POLITICAL MEANINGS AND USES OF THE AERIAL VIEW, AND EXPLORED THE LINKS BETWEEN SCIENTIFIC AND POLITICAL ACTIVISM. ONE OF THE THINGS I REMEMBER MOST FROM MY EARLY EXPERIMENTS WAS THE WAY THAT THE IDEA TO CREATE ONE'S OWN AERIAL IMAGERY CREATED A SPARK OF IMAGINATION THAT SHINED IN THE EYES OF ALMOST ANYONE I TALKED TO OR WORKED WITH. ACTIVISTS ARE LEADING ALL KINDS OF STRUGGLES, AND YES, THIS TOOL MIGHT SERVE THEM IN THESE CONTEXTS, BUT BESIDES THOSE BENEFITS, IT ALSO BROUGHT A SENSE OF WONDER.**

exploratory ways, artistic ways, experimental ways, activist ways. This spark in the eyes, it was almost contagious. As soon as I started this work, so many people wanted to take part, and I was invited to do workshops all over. I collaborated with dozens of groups, researchers, students, and community activists for one day or three months or a whole year. It was remarkable to watch how people discovered the wonder of technoscience through these tools.

My vision for the future isn't about a faraway goal that I want to reach. It isn't the classic Western idea of reaching the most advanced point, where all the lines meet. It's more about being part of a growing collective that cultivates change in many different ways. It's about a shared vision, one that's not only about changing science and its institutions but about changing ourselves and how we treat each other and take care of ourselves and others. It's also about

how we communicate, interact, and how that communication constructs worlds. I want to be on the non-dogmatic side of things, where experimentation is a way of life and where technology and science

isn't the domain of the privileged few. Through my work I am trying to do this, and collaborate with others in a similar movement, figuring out how to live together, care for each other, and for our world/s. ■



## Hagit Keysar

*Personal and Professional Identifiers*  
Researcher and Activist

*Job title*  
Lecturer

*Organization*  
Bezalel Academy of Arts and Design, Jerusalem

*Pronouns*  
She/Her

*Homebase(s)*  
Jerusalem





## ON WONDER

What would it be like to make scientific curiosity a public good, and wonder a shared civic resource?

I remember those boyhood nights, of which there were once many, when my father and I reclined on the sands of a remote beach in South Texas, at the rim of the Gulf of Mexico and the edge of two nations, swatting mosquitos insistent on blood offerings, breathing salted air, listening to lapping waves, noting the lean of our nearby tent, and seeing, before us, a bright foam of stars: glinting in the mirror finish of sloshing water, pinpricks of light from impossibly long ago, from so far away—and yet, then, so close, immediate.

I remember having read, by then, that stargazing was time travel, that every tiny orb was a memento of a ferocious explosion, a trace of a drama long passed, and I remember realizing that the night sky was thus a temporal tapestry, a quilt of all tenses, and that to

look up at it was to have innumerable destinies converge on wide eyes, and to greet an invitation to movement. I remember, too, timing, with a plastic wristwatch, how long it took a flickering dot, a satellite, to hurtle across the firmament and disappear below the horizon, and then to reappear, later, by miracle. A sky-sprinter; record time. I wanted to give it a medal.

My father, then a high school biology teacher, encouraged me to ask questions of the sky. I tried at first through books; I remember exhausting a local librarian one summer with frequent visits that meant small towers of astrophysics texts freighted with mathematical inscriptions and terms like “Schwarzschild radius” and “cosmic background radiation” and “quantum fluctuation” that I

couldn't have possibly understood as a child. These books, I felt, contained the runes of distant worlds, equations and theorems and formulas, descriptions, foretellings. A kind of poetics, really. I wanted, somehow, to learn this, or any, cosmic language—to acquire some frame or lexicon or code that would help me navigate the challenges of daily living and evade the difficulties of family conflict.

But my interests shifted. In subsequent years, I began leaning more heavily on the poetic and the musical for stability; I became intensely interested in depiction, representation, mimesis—in the ways different people around the world (all stargazers, I've always imagined), have sought to make life and experience meaningful through sounds, images, words, and associations.

I'm fortunate to be pursuing these interests still, now as a scholar-musician living and teaching in Los Angeles, asking new questions of the sky, albeit two thousand miles from the Gulf shores my father and I frequented. And though my primary focuses these days are artistic, theoretical, and political, I've never lost my love of science—or, better, my love of what science promises.

An example of this: a couple of years ago, while writing a dissertation on radical improvisatory music making, I collaborated

with a number of Rio Grande Valley artists, including media producer Charlie Vela, on a science fiction transmedia album that imagined a possible future for the South Texas border region, our home. Drawing as much on local folk balladry as on theories of ubiquitous computing, that album, called *Futuro Conjunto* (2020), essentially asked: if local folktales often commemorate both the tragic and the heroic, “what would acts of heroism look and feel like for the downtrodden in one hundred years? What events would be commemorated, what underdogs celebrated? By what means would dominant forces be resisted by the future’s underground? How would the border region reorganize itself in response to inevitable social upheavals, to the facts of impending environmental disaster, to a fascist capitalism with an insatiable thirst for souls? How would everyday people repurpose emergent technologies and subvert the logics of Big Silicon? Where and how would local knowledges live? Through what intimacies, rituals, repertoires, and archives would people find their connections to history?” One of the songs on the album, “*Amor superno*,” grounded some of those questions through the private crooning of two fictional characters—borderlands stargazing lovers, one earthbound, the other in space: “Past a moon, they took you / In the stars, I look for you / See my love through the

space you move / Off to Mars they shipped you / If I could, I'd follow you / Let the stars carry me to you." Our goals for that project: to champion our curiosity, to celebrate our homeland, to imagine a future together. To persist, really.

A few months ago, out of a similar set of science-related concerns and interests, I also co-edited an interdisciplinary book of scholarly essays (with Carol Vernallis, Holly Rogers, and Selmin Kara) entitled *Cybermedia: Explorations in Science, Sound, and Vision* (2021), which brought together scientists, humanists, and entertainment industry practitioners—from filmmaker Alex Garland to neural networks—pioneering computer scientist Jay McClelland—to analyze the same media objects "with the aim of creating more public engagement with the latest advances in science." As we wrote in that project: "Digital technologies are pushing the planet into uncertain socioeconomic, ecological, and technological futures. Advances in AI, robotics, big data, psychometrics, and biogenetics are redefining what it means to be human. On the one hand, these advances promise radical transformations, forging new worlds through collisions between technologies, living forms, and matter. On the other hand, these changes feed dystopian visions: robots undergirding a possible 40 percent unemployment rate,

social media platforms manipulating personal and community data, corporations extracting resources to exacerbate climate deterioration, militaries developing autonomous lethal weapons for armed conflict, stock-trading organizations deploying artificially intelligent systems, and scientists exploring biogenetics like CRISPR to facilitate altered biological forms. The list continues: the spread of biological contagions; the overflow of misinformation; the unequal distribution of vital resources; the ubiquity and biases of corporate algorithms (to say nothing of increasing economic inequalities)." The central argument of *Cybermedia* was: in order "to create useful analytics for the cybermediated world we've inherited and will eventually pass on, we need to find new ways to listen to one another."

This last point is key, especially here. The pressing need for horizontal communication—and being specific about a "we"—is at the core, I'd say, of what something like "civic science" might entail. Civic science's working definition, as provided by Alondra Nelson, is "broad public engagement with issues that arise at the many intersections between science and society." And *science's* working definition, as offered by astrophysicist Chanda Prescod-Weinstein, is: "a collection of activities that are loosely organized around

something we call the scientific method, but even what constitutes the scientific method varies from field to field. Some would say that science is about data, whether predictions from equations or experimentalists' data. All of this seems like it has nothing to do with power, until

father and I frequented years ago. Today, in the Rio Grande Valley, the utopic rhetoric of space frontierism, so relied upon to stoke national unity during the Cold War, is being resurrected along a borderlands shoreline; contemporary astro-capitalism and rocket-launch tourism is rendering already

that people are running for their lives beneath the same celestial structures that I get paid to think about every day.")

Now stargazing along a different shoreline and working up new creative projects, after hours, I've been diving into Black feminist science, technology,

**FROM MY PERSPECTIVE, THEN, TO THINK ABOUT CIVIC SCIENCE IS TO THINK VERY CAREFULLY ABOUT THE RELATIONSHIP BETWEEN CURIOSITY, LANGUAGE, AND LEGITIMATION—ABOUT THE LANGUAGES THAT CURIOSITY MUST SPEAK IN ORDER TO BE LEGITIMATED AS TRUE KNOWLEDGE... AND IT'S TO MAKE THAT THINKING PORTABLE, ACTIONABLE, ACCESSIBLE, PART OF THE STUFF OF CIVIC PRAXIS, THE VERY DOING OF DEMOCRACY.**

**...I IMAGINE WE'LL SPEAK ABOUT THE MATTERS MENTIONED HERE—ABOUT THE POSSIBILITY OF A SCIENCE THAT CENTERS COMMUNAL CURIOSITY AND ABANDONS THE LANGUAGE OF MASTERY, A SCIENCE THAT RELINQUISHES MYTHS OF INDIVIDUAL GENIUS AND EMBRACES DYNAMIC, DIVERSE COLLECTIVITIES...**

you ask: who has the power of observation? Whose observations are taken seriously? Who is deemed to be a competent observer? We judge each other's data and conclusions—is it always based on the evidence? Whose scientific method?"

Works like Prescod-Weinstein's *The Disordered Cosmos* have helped me as I've reflected, here in Los Angeles, on the fact that a new Space-X rocket facility is quickly and dramatically altering the physical and social landscape of the Rio Grande Valley borderlands, just a few miles from the shores my

overlooked residents newly invisible. Resource extraction, combined with ecosystem exhaustion, is creating the conditions for yet another round of colonial exploitation, dressed anew in the alluring rhetorics of privatized space flight. It is increasingly likely that the first manned mission to Mars will launch from the beach my father and I frequented. And so, perhaps like a good scientist, I join others in asking: at what costs? And to whom? (I'm reminded here of an argument by Prescod-Weinstein: "We cannot talk about the wonders of the night sky without talking about the fact

and society writings like Prescod-Weinstein's, as well as Safiya Umoja Noble's *Algorithms of Oppression* (2018), Alondra Nelson's *The Social Life of DNA* (2016), Katherine McKittrick's *Dear Science and Other Stories* (2021), and the work of a collective called Black Quantum Futurism, recently the recipients of a 2021 Collide Arts Residency at CERN. I've also recently returned to a book by the Martinican poet-theorist Édouard Glissant, entitled *Poetics of Relation* (1990), in which he offers ideas that are relevant, I'd argue, to a conversation about civic science. He writes:



"Live in seclusion or open up to the other': this was supposedly the only alternative for any population demanding the right to speak its own language. It is how inherited premises of centuries-old domination were given legitimacy. Either you speak a language that is 'universal,' or on its way to being so, and participate in the life of the world; or else you retreat into your particular idiom—quite unfit for sharing—in which case you cut yourself off from the world to wallow alone and sterile in your so-called identity."

Concerning civic science, these ideas could apply equally to people who have been historically excluded from (and even persecuted by) those in scientific circles and to those people who have actually *been part* of those circles, often holed up in laboratories, frustrated by public misunderstandings of research, as well as by the communication constraints presented by highly technical knowledge systems. In each case, people are subjugated; in both situations, people are forced to deal with the social fallout of individuals claiming "universal" knowledge. "What is it that you are demanding," Glissant writes, "when a language, one single language, would provide you with the key to progress?"

Another detour: a different book on relation I finished recently—*The Age of Analogy* (2016)

by literary theorist Devin Griffiths, which focuses on how scientific and literary imaginations connect—resonates, for me, with Glissant's question in *Poetics of Relation* by emphasizing the possibilities of analogical thinking, of making conceptual connections and leaps across domains and "languages," you might say.

"Analogies," "by their nature," Griffiths writes, "draw a connection between patterns in different domains. This . . . point can be stated in terms of set theory. When analogies draw relations between members of sets that are thought to be discrete, they put the nature of those sets at stake: whether the new patterns constitute a new set, whether the new set includes other examples, what the conditions of membership are, whether the set is real. In short, analogies make fuzzy sets . . . analogy troubles set theory because it can challenge the central principle of discrete membership." Thinking deeply, then, about analogy and metaphor as both disruptive tools and conceptual bridges between conversations—as ways of linking communities, ideally—seems crucial for anyone invested in what "civic science" might become. Analogy, metaphor, and above all *narrative* have the potential, if only briefly (and rarely without friction), to bring people together who have remarkably different life experiences. Stars, like rockets and seashores,

acquire meanings through stories; stories, like equations and pictures and movies, are born of stargazing, feeling, and wonder.

From my perspective, then, to think about civic science is to think very carefully about the relationship between curiosity, language, and legitimation—about the languages that curiosity must speak in order to be legitimated as true knowledge. It is to think about history—about the differentiating and classificatory logics necessary to build scientific knowledge that have been (and still are) used to taxonomize the living, the dead, and the possible. And it's to make that thinking portable, actionable, accessible, part of the stuff of civic praxis, the very doing of democracy.

In a few weeks, I'll be traveling back to the Rio Grande Valley from Los Angeles, after over a year of pandemic catastrophe. My father and I are planning to revisit the same shore we used to frequent. We'll return to the sands, to the heavy air, to the glow of a distant moon tugging at life-giving water. Together, we'll wonder and question, verbally and otherwise, looking with some skepticism at that new rocket facility while the summer night teems with life. I imagine we'll speak about the matters mentioned here—about the possibility of a science that centers communal curiosity and abandons the language of mastery, a science

that relinquishes myths of individual genius and embraces dynamic, diverse collectivities—a science de-coupled from the seductions of power, a science that doesn't profit from nor advance itself through suffering. I imagine, above all, that we'll just sit together, wondering at the stars, reunited after an apocalypse, marveling at what will outlast us. ■

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For more, see: Glissant, Édouard. *Poetics of Relation*. Ann Arbor, MI: University of Michigan Press, 1997.

Griffiths, Devin. *The Age of Analogy: Science and Literature between the Darwins*. Baltimore,

MD: Johns Hopkins University Press, 2016.

Leal, Jonathan. "Futuro Conjunto: A Transmedia Ballad." *ASAP/Journal*, "New Worlds of Speculation" 6.2 (Forthcoming Summer 2021).

Prescod-Weinstein, Chanda. *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred*. New York, Bold Type Books, 2021.

Vernallis, Carol, Holly Rogers, Selmin Kara, and Jonathan Leal, eds. *Cybermedia: Explorations in Science, Sound, and Vision*. New York: Bloomsbury Academic Press. (Forthcoming October 2021).



## Jonathan Leal

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He / Him

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## CONTRADICTIONS: REBUILDING THE HOUSE YOU'RE LIVING IN

Who gets to use scientific authority for their own protection and who is left to be marginalized by it?

I grew up in a household with parents who supported my twin sister and me in figuring things out on our own. I was raised to think and ask and discover in ways that are consistent with how science, I think should be taught, is taught when it's taught well. So since I was a child, I've experienced in some way how science is an important tool that should be part of the growth and discovery of all children. My parents answered all the questions my twin sister and I would ask about the world, nature, or our bodies with "Go look it up," "Go figure it out," or "What do you think?" This was in the days of encyclopedias, so we were always at the bookshelf or at the library.

I first felt at home in a science research lab when in high school I spent three summer weeks at Tuskegee

University—a Historically Black College and University—researching bacteria that could be used on the International Space Station to degrade the inedible parts of edible plants (peanuts, sweet potatoes, etc.). That was my first time doing real science—pipetting and culturing bacteria and learning sterile technique—and it happened in a lab run by a Black woman, Dr. Audrey Trotman, who was married with two children, tenured at a university, and getting funding from NASA. While I didn't really get it at the time, because it was an environment where everybody looked like me, including the woman in charge, I never questioned my place in it. I just thought about how cool it was to be doing this nasty bacteria-streaking in a fume hood for a project that could ultimately help astronauts. That was a moment when I thought, "OK, this is something I could do."

The truth is I might never have become a scientist had my parents let me pursue my dream of attending Brown, where I desperately wanted to go after high school. It was outside of my home state of Maryland and promised the kind of new adventure I was seeking. But in part because of the benefits of in-state tuition, my parents decided it made more sense to send me (and my sister) to the University of Maryland, Baltimore County, where we would join a then-relatively new program called the Meyerhoff Scholars Program, designed to support students of color pursuing science. Looking back, this was probably one of the best decisions for my career. Fundamental to the Meyerhoff program was the idea that you don't get a PhD in the sciences alone; it's not a challenge you take on by yourself. You do it with a community, setting

high expectations for each other and holding each other up. So, I had a science community - of predominantly Black students - before I had really committed to becoming a scientist. And I don't know that I would have been able to build that supportive scientific community for myself. I don't know many young people would be able to do that on their own.

It took until graduate school at the University of Chicago for me to witness for myself what science and elite education represent to so many people of color. It wasn't until then that academia began to feel like a walled city built to exclude. It was jarring to arrive in Chicago and to discover what limited school experiences many kids there had, so different from what I had grown up with in suburban Maryland. It was shocking and enraging to see that

where you lived and what neighborhood you grew up in had such a direct impact on what cool stuff you got to do. I grew up in a world where it felt like a foregone conclusion that young people get to do cool things. Have great teachers, have things to play with, go to camp, play outside—and so my own privilege was smacking me in the face. The kids I encountered in under-resourced Chicago neighborhoods were *just like me*. I didn't do anything to deserve the things I had, just as these kids didn't do anything not to deserve them. That disparity was clear.

Layered on top of that, it was a challenging experience to recognize the power and privilege that came with having a badge and key at the University of Chicago, to be able to say that I'm in the PhD program in biochemistry and be given respect that, in my view, I hadn't done anything to earn. Yes, I worked hard to get where I was, but respect is a human right, not a privilege. The kind of respect I was given as a PhD student in biochemistry had nothing to do with my character; it only had to do with my position in science, as a scientist in this university and what that meant to

people. And that was uncomfortable.

What was even more uncomfortable was that there were times when I knew I was using that power and privilege to my advantage—to impress people or to get out of a situation that I didn't feel like dealing with or to reassure people that I belonged. There were times when my physical Blackness on campus and in the lab was looked on with suspicion. I felt like I needed to justify my presence, so I'd draw on that scientific authority.

I'll never forget a moment from my time in graduate school when I acutely felt the vulnerability of being on the other side of the wall of scientific authority. I had to stay in the emergency room overnight and then in the hospital for one night more. The hospital was literally across the street from my lab. In the lab I was treated with the respect that came with my university badge and my status as a scientist. Here in the hospital as a patient I was just another Black body. And as I lay in my bed, the doctors would come into my room and speak to me without really seeing me.

I remember saying to them, "I'm in grad school. I'm in a PhD program across the street in

biochemistry. *Please talk to me like you would talk to a scientist, because that's what I am.*" That was important to me, both because I wanted to know what was going on with my body and because I didn't want them to treat me the way that I know they would have if I were seen as just another Black body coming into the hospital.

As I leveraged my scientific and institutional privilege they *did* start talking to me in a more respectful way, with the dignity that comes

with acknowledging a person's capacity to know, learn, and understand. They started using all the technical terms, and they even sat down with me and changed their tone. And they came back to the room later to follow up differently.

And despite all of the benefits of my scientific privilege, it all felt super gross. I had a right to have that more respectful conversation, and every other person in that hospital had a right to have that conversation, too—one

WHAT WAS EVEN MORE UNCOMFORTABLE WAS THAT THERE WERE TIMES WHEN I KNEW I WAS USING THAT SCIENTIFIC POWER AND PRIVILEGE TO MY ADVANTAGE—TO IMPRESS PEOPLE OR TO GET OUT OF A SITUATION THAT I DIDN'T FEEL LIKE DEALING WITH OR TO REASSURE PEOPLE THAT I BELONGED. THERE WERE TIMES WHEN MY PHYSICAL BLACKNESS ON CAMPUS AND IN THE LAB WAS LOOKED ON WITH SUSPICION. I FELT LIKE I NEEDED TO JUSTIFY MY PRESENCE, SO I'D DRAW ON THAT SCIENTIFIC AUTHORITY.

I'LL NEVER FORGET A MOMENT FROM MY TIME IN GRADUATE SCHOOL WHEN I ACUTELY FELT THE VULNERABILITY OF BEING ON THE OTHER SIDE OF THE WALL OF SCIENTIFIC AUTHORITY.



where they level with you and take the time to give you the whole picture.

That hospital visit happened to coincide with the time when my first published paper was in the proof stage. We had submitted the paper to the journal, we had gotten notes back, and I had the physical proofs with me in my backpack. I was carrying them everywhere to finish up, so I had them with me when I went to the hospital, and I was writing notes on them while I was there. And I needed to fax them back to the journal. So I told the staff that I needed to leave for a half hour. And they said, "Sorry, there's nothing we can do—you're still hooked up to the IV, we're waiting for tests, and you're having this active issue."

I said, "You don't understand, *I need to go*. It's important. Listen, I'm about to get published in a *Nature* journal." And I held up the proofs and showed them. I said, "Look: this is my name, right here in the article! I'm the first author. I have to go across the street to my lab and fax these back so that I can get published." And immediately the tone shifted, and they said something like, "Whoa! *Nature*? Wow, what do you do, exactly?" And I was like, "Wait, I just

need to go fax it." I didn't actually want to talk about my research while the clock was ticking. "Can you just take the IV out so I can go across the street and come back?"

And I really did need to fax in those proofs, but I also couldn't help thinking, why is this the thing that validates my need to leave? Did I need a recognizable credential for you to pay attention to my needs?

There were many moments like that when I was reminded of the power that comes with being a member of a scientific community. I became acutely aware of how I might need to use that to my personal advantage. But I also came to understand more and more on how that shouldn't be the case and that the true power was leveraging my privilege toward greater outcomes..

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When I think about my career, one of the goals that motivates me the most is moving us away from perceiving certain learners and communities as deficient or not scientifically literate and instead stepping back to consider the systems that are designed to keep the gaps wide and the

present power dynamics in place. Those are the forces that require people like me to show up with specific privileges to be viewed as worthy.

If we're ever going to turn science into what it should be, we have to eliminate the gatekeeping. I want to be a part of a movement that acknowledges that humans have been learning and doing science for as long as we have been here—not just since European codification or since the Western world created institutions of so-called higher education.

"Underserved people" are not innately underserved; they are people who live within systems that have chosen to not serve them. They are underrepresented because there are systems that preclude their representation. I dream of a world in which people are no longer minoritized or excluded—the entire world, but science in particular.

Science is a place where people should be able to find joy and peace and safety and community and freedom—a place where people are accepted fully as they are. We need to send the message: There's something here for you to create. We need to learn from you.

This doesn't work without you. We designed this with you in mind. You can be free, feel joy and have a full, authentic experience. You have as much a right to move science and society forward as anyone else.

I want a revolution. I worry that we won't be able to have the kinds of outcomes that we're talking about without a true revolution. And as I move forward in my career, I'm honestly

getting more impatient. I'm getting more activated and fired up about the need to deconstruct and rebuild.

Our kids deserve it. Our ancestors deserve it. Our parents and grandparents deserve it. And I want to be part of the revolution, to learn from our brilliant young people, communities, and educators, working to get it done together. Everybody else needs to get out of our way. ■



## Rabiah Mayas

### *Personal and Professional Identifiers*

Identical twin, learner, museum leader

### *Job title*

Davee Vice President of Education

### *Organization*

Museum of Science and Industry

### *Pronouns*

She/Her

### *Homebase(s)*

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## MY HARDEST CONVERSATION

In what ways do our definitions of “science” and “scientist” limit the ways we encourage the use of science as personal and public good?

**T**he hardest conversation I’ve ever had was when I told my father I was quitting my PhD program. I was crying so hard, he thought I was dying of cancer.

My father is my hero. He is a physicist, and at the time, a professor at UCLA. From the time I was very young, he shared his love of science with me. He gets tremendous joy out of science, in a way that I haven’t always found in the professors I’ve interacted with along my career. The joy of discovery is everything to him. Dinner-table conversations were often about what was going on in his lab or his work as a consultant or his travels to conferences. That made me want to do what he did—and I was good at it too. So I went to undergrad at UC Berkeley and studied biology, and a professor whose class I took my freshman year opened my eyes to plant ecology, which I had never even thought about.

After undergrad, I applied directly to a PhD program and chose a lab based on my father’s values. He was a big believer in the importance of basic science over applied science. To him, there was something beautiful in the fact that you didn’t know what the ultimate value of your work would be. And so at the ripe old age of twenty-one I enrolled at UCLA in a PhD program studying plant physiology.

It took three years for me to realize that I was miserable. I’ve never been so unhappy. It didn’t mean that I wasn’t good at what I was doing. But I was unhappy. I realized three things about myself. First, I love all of science, not just that super-narrow thing that my PhD thesis was about. Second, when I go home at night, I want to read novels. I want to be transported to other places. I don’t want to go home and read scientific journals. And third, I wasn’t willing to go wherever the job was. And to say any of those three things out loud,

at least in that insular research world I was in, meant that you weren’t a serious scientist.

So when I realized that about myself, I knew I had to quit. And then I knew I had to tell my father. When I sat down to do it, I could barely get the words out. Not only was he still at UCLA himself, but

he had recently been promoted to provost—my professors’ boss. He took it much better than I did. He already knew who he was. For me, leaving that program meant starting a new journey to figure that out. Who was I? What was I going to do with my life?

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I literally cried every day for two years. I kept thinking of my leaving the PhD as a failure.

Something I learned about myself in graduate school was that I am a person who loves science. But I want to *use* science. And I want to use it to heal the planet. My love of nature was

as deep and enduring as my love of science. There hasn’t been a day when I haven’t felt that connection. I grew up next to the ocean, hearing the waves as I went to sleep. My dad was a big nature lover too, as well as a Sierra Club member, so we would go on backpacking trips when I was a kid. Even today, when I’m not in nature for any length of time, when there’s too much cement around me, I start to feel a little sick, a little off. I’m not my best self.

After graduate school I tried high school teaching, and I loved the students, but it wasn’t quite right for me. I tried working at

THE HARDEST CONVERSATION I’VE EVER HAD WAS WHEN I TOLD MY FATHER I WAS QUITTING MY PHD PROGRAM. I WAS CRYING SO HARD, HE THOUGHT I WAS DYING OF CANCER. MY FATHER IS MY HERO. HE IS A PHYSICIST, AND AT THE TIME, A PROFESSOR AT UCLA. FROM THE TIME I WAS VERY YOUNG, HE SHARED HIS LOVE OF SCIENCE WITH ME. HE GETS TREMENDOUS JOY OUT OF SCIENCE, IN A WAY THAT I HAVEN’T ALWAYS FOUND IN THE PROFESSORS I’VE INTERACTED WITH ALONG MY CAREER. THE JOY OF DISCOVERY IS EVERYTHING TO HIM. DINNER-TABLE CONVERSATIONS WERE OFTEN ABOUT WHAT WAS GOING ON IN HIS LAB OR HIS WORK AS A CONSULTANT OR HIS TRAVELS TO CONFERENCES. THAT MADE ME WANT TO DO WHAT HE DID—AND I WAS GOOD AT IT TOO.

SOMETHING I LEARNED ABOUT MYSELF IN GRADUATE SCHOOL WAS THAT I AM A PERSON WHO LOVES SCIENCE. BUT I WANT TO USE SCIENCE. AND I WANT TO USE IT TO HEAL THE PLANET.

a science museum in San Francisco called the Exploratorium, where I helped to design life-science exhibits. Again, there were aspects that I loved, but it wasn't quite right.

I finally found my place—a place where I could use science to heal the planet—once I moved back to Southern California, where my husband had been offered a job. At the age of thirty-three, I landed an entry-level position with the City of Santa Monica. They hired me because of my background in science to implement environmental programs for the city. It was there I discovered that I could use science in the service of democracy and in a way that was expansive, not narrow.

When I started in local government, I was given a gnarly practical question that turned out to be exactly the kind that satisfied my scientific brain. The City of Santa Monica bought cleaning products to use on, among other things, its public bathrooms. We know that there are toxic chemicals in consumer products. We also know that there are city employees who are exposed to them eight hours a day. And those employees are often people of color, who are extra-vulnerable to asthma and other illnesses. How do we find

cleaning products that will both meet the needs of the task of cleaning bathrooms that are very, very dirty and also be protective of the humans who are using them?

This was 1993. There was not a lot of information out there on this subject, but that made the challenge all the more interesting. I had to look at the chemistries of all the alternatives to decide which one was the least harmful. We know that risk can't go to zero, but which was the safest? Then, once I had a list of products that were both safer and effective, I tested them in the real world like a scientist would, in a situation where actual custodians were using them—custodians who are on tough time pressure, who might not speak English as a first language, who need to be trained. And that was the start, as it turns out, of something very profound and something I'm very proud of: a whole field called environmentally preferable purchasing. This is something that EPA has since adopted and that you see now embedded in LEED construction requirements. But in 1993, it was me tackling the question with my scientific brain, breaking it into pieces, and still remembering the bigger question: how does this science and knowledge serve people?

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Science is so much bigger than I was taught in grad school. There, doing science meant being in a lab and taking measurements. It meant living where I didn't want to live because that was the only place where I could be a professor. It meant being around people who weren't finding joy in their work but only ambition. It meant being in a culture of arrogance.

My personal conviction is one of deep humility. It's a quality I didn't see much in scientists when I was in grad school. I've been thinking a lot recently about that word, "humility." It comes from a Latin root meaning "of the earth." So being humble means that we are grounded. I cannot separate my body from this planet. They shape each other.

We are bound to the earth, and we are bound to one another. I have found in my career that when we do science for the public good, with deep engagement and a love of humanity, real change happens. That is where the power is.

The most important thing I can do in my life is to empower those who come after me, to show them what is possible and to help them believe in themselves to make change. I hope I lead by example. I hope I show

people that you can find real joy in this work.

I hope I show people how important it is to find the good and the possibility in each other. Because my deepest belief is that not one of us holds the answers singly, that there's no way we're going to heal this planet without each other. And when I see people who I've worked with go out into the world and make a difference, my heart truly sings.

It's all much bigger than I was taught.

And maybe I am a scientist after all. ■



## Debbie Raphael

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### *Organization*

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### *Pronouns*

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### *Homebase(s)*

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## WE MAKE THE ROAD BY WALKING IT

What is science's responsibility for building bridges to other forms of knowing?

THIS WAS THE BEGINNING OF MY ROLE IN SCIENCE AS A FACILITATOR. IT'S IMPORTANT TO ME TO CREATE SPACES FOR INTERACTIONS AND EXCHANGES ACROSS BORDERS AND SECTORS. THE CENTRAL LESSON I'VE LEARNED ABOUT HOW TO MAKE THIS HAPPEN IS TO BE HUMBLE ABOUT ALL THE DIFFERENT SORTS OF KNOWLEDGE THAT ARE OUT THERE. EACH KNOWLEDGE DESERVES ITS OWN SPACE AND CONTAINS ITS OWN TRUTH, AND WE CAN BUILD ON ALL OF THEM TOGETHER.

**M**y mother was an Olympic athlete—a javelin thrower. She was also a single mom, at least during my early years. So I grew up with a lot of different types of nannies within the Olympic community. I was cared for by boxers, archers, gymnasts, track and field athletes, swimmers, weightlifters—you name

it. And even though they were all athletes, each discipline and each person had a different way of looking at the world. Being an Olympic athlete is a full-time and full-spirit commitment - building strong discipline and healthy competition requires camaraderie.

I recall as a child the atmosphere of athletes at the Olympic Committee campus creating

support communities. I remember them sharing techniques and advice on health, nutrition and injury healing but also forming support groups - for single moms, for example!

That was my very first experience with knowledge exchange within a community. From that time on, valuing these sorts of exchanges came quite naturally to me, because I had relied on them to survive.

We moved around a lot after that: to the south of Mexico during the

Zapatista movement, to Trinidad and Tobago, to India, to Canada, to Sweden. I developed the ability to translate between cultures and calibrate myself to each of these new environments. That further shaped my sense that the knowledge each of us holds is vitally important, as is learning how to share it so we can all enrich our understanding.

A pivotal moment in my personal education came when I went to live in a small town in Mexico called Cabo San Lucas. At the time, the town was



starting to be developed into a tourism hub and was growing in 2004 at a rate of 20 percent per year. The local government couldn't cope: it was having trouble providing even basic services. But that didn't stop community members from developing their own solutions and processes to fill a lot of those gaps. I was so humbled by their initiatives that as part of my master's degree, I returned three years later to [capture the stories of these communities](#). I wanted to document how they created these solutions and the networks to support their initiatives. One of these organisations was 'Democracia en Marcha', an indigenous-based organization that supported indigenous migrant workers that had been brought to Cabo with one-way tickets. The organization's main challenge during its inception was the development of a binding force that would unite all indigenous groups to a single cause. I learned that they turned to an ancient traditional practice that encourages

social commitment to repair and maintain their infrastructure. The founder explained: "... within the culture from which we originate there exists a type of work known as faena or tequio, which means 'to repair the rural paths', 'to do social work in the schools', 'to repair the public plaza'. These are common goals that the pueblo organizes to improve some institutions. We apply that here in our community". Coming from a Rural Planning background and with the support of local community mentors I also wanted to explore avenues for dialogue between communities and the local government's planning department, which I truly believed could learn from the communities and integrate their grassroots initiatives into their official plans.

This was the beginning of my role in science as a facilitator. It's important to me to create spaces for interactions and exchanges across borders and sectors. The central lesson I've

learned about how to make this happen is to be humble about all the different sorts of knowledge that are out there. Each knowledge deserves its own space and contains its own truth, and we can build on all of them together.

The company I co-founded, Tekiu, is about creating those spaces, those opportunities for people to learn from each other's success and failures and to learn what they don't know, pushing beyond their comfort zones. The name of the company is a direct inspiration from Democracia en Marcha's *binding* force. 'Tequio' is a Nahuatl word for barn-raising, essentially. It literally means "when people come together to build or to repair a common good." And an additional important aspect is that we also need spaces for young people to develop their own careers. At Tekiu, we support these young people in building ownership of their projects from an early stage, so that they have the autonomy to make decisions and to learn from their own mistakes in a safe environment.

I think this work will never be finished, because there are so many stories, so many initiatives, so many wonders, and so much power to harness. And there is also so much work to be done in our communities to address issues of inequality. I'd like to see the organizations we work with—as well as our own organization—be

stepping stones for others to create their own initiatives and have something solid to build from.

There is a Turkish saying: just give us the rope and we'll climb it. To me that means that you,

through struggle, shape yourself. You develop your own initiatives, your own methods and your own capabilities, to reach your goals. Creating the spaces to foster this is my passion. That is my conviction.



## Cindy Regalado

### *Personal and Professional Identifiers*

Entrepreneur, Community Organiser

### *Job title*

Managing Director

### *Organization*

Tekiu Ltd

### *Pronouns*

She/Her

### *Homebase(s)*

London





## SCIENCE IN SERVICE TO SOCIETY: FINDING MY MISSION

Science enables many paths, not just the path to academia.

WHEN YOU LEAVE SCIENCE, PEOPLE WHO WORK IN SCIENCE ALWAYS ASK YOU, "SO WHAT HAPPENED?" AND THEY DON'T MEAN IT IN A CURIOUS AND POSITIVE WAY. IT'S MORE LIKE "WHERE DID IT ALL GO WRONG?"

**W**hen you leave science, people who work in science always ask you, "So what happened?" And they don't mean it in a curious and positive way. It's more like "Where did it all go wrong?" But leaving was a conscious choice for me. I didn't get rejected from my dream postdoc. Nothing got derailed. It took a lot of self-belief to make the switch. I knew it was the right decision, but there's always pressure to stay within the boundaries of academic science.

When I was young, I thought everyone wanted to be a scientist. Every single one of my friends in Oak Ridge, Tennessee—home to Oak Ridge National Laboratory—had at least one scientist for a parent. My dad was the scientist in our family, and I loved that we traveled the world because of his job. It wasn't until I was fourteen and we moved to Charlottesville that I suddenly realized that not only is it not true that everyone wants to be a scientist but that people specifically *don't* want to be one. It's seen as a weird career.

But by then I was hooked. I was one of those kids who wanted to be a paleontologist. I loved dinosaurs. I was amazed that those huge creatures once walked the earth. And I was fascinated by the idea that you could look at the earth and figure out time. That blew my mind. Ultimately, I got interested in

developmental biology, and then transcriptional regulation. It took me until midway into a PhD to realize that I was not going to be a research scientist. I really, really loved science, and I really, really hated working in the lab. It was making me miserable.

For one thing, I was turned off by the fact that everything was oriented around competition rather than collaboration. I remember going to my first conference and a postdoc, who had been in my advisor's postdoctoral lab, walking up to me and saying "I did your project. It doesn't work." *That* was my introduction to collegiality in science. Second, I realized that I need to work on projects with endpoints, rather than a continual pursuit of knowledge that is forever moving and far away. I wanted to finish a project and know that it was done.

Making the decision not to be a research scientist was absolutely heart-rending. I went through a mourning period and tried to figure out what came next. I ended up finishing my PhD but not applying for postdocs. I remember explaining to the first reader of my thesis that I had decided to do science policy instead of research. He said, well, first you need to go and become a researcher and get expertise before you do policy work. He compared what I wanted to do to going to Carnegie Hall and just watching the orchestra instead of learning to

play an instrument myself. It took me until the next day, when I was in the shower, to think of my reply: no, it's like I'm going to be the *conductor* of the orchestra.

Science had, and to a great extent still has, a one-way door out. I had such a sense of leaving the fold. When I left, people who left the bench for even a year couldn't get back in. And if you weren't doing research, you weren't a scientist. That was the message everyone was sending, and I internalized it.

One of the things I did during that time that I'm most proud of was to create one of the very first websites devoted to alternative careers in science. It was brand-new: I didn't have any role models. It was even before the American Association for the Advancement of Science built their own website of this kind, and in fact I gave testimony for an early National Academy of Sciences (NAS) report on alternative careers in science. Since then I've talked to so many people who are making the switch just like I did. I have mentored dozens of them. Even today, people seek me out, and I will always do an informational interview with someone who's trying to make the switch from a PhD program. I will take anybody's call.

Science as it's done is very monastic. It's treated like a calling. And maybe for some scientists that's what it's is, but for most it's

a profession. When you tell people that science takes the ultimate dedication, many people will be discouraged from entering science; others will feel that they should put up with terrible work conditions, including harassment.

My personal mission is to work in organizations and facilitate teams to help bring science and society closer together. Because science isn't just a profession. Anyone can understand and use the scientific method, and I believe that we will live in a better world when we make more of our decisions in a science-based way. Even learning about scientific research benefits non-scientists, whether that means child psychology when you're raising your kids or climate science when you're thinking about the energy efficiency of your home.

I'm not a scientist anymore—I'm something else. But I've noticed that younger people seem to view themselves as scientists even when they're not working in research, and I think that's healthy. Today I see myself as a nonprofit manager and an informal science educator. I've worked in the museum community, and I've worked at scientific societies, so I also see myself as a science communication professional. I hope that I'm pushing forward the work of people who are science practitioners of various kinds—teachers, museum professionals, and so on. These are people

who aren't doing the experiments, but they're responsible for helping others understand the science. By empowering these practitioners to do their work better, we're ultimately getting science into the hands of more people.

If I think about the lessons science taught me, one of the most important ones was to persist. People say that you have to be smart to get a PhD, but persistence is much more important. And I know how to persist. I also know how to be resilient, which is especially important when you're a woman in science. I don't think I'm super pushy, but I can take the heat.

Now I'm a woman CEO, which comes with its own challenges. It's a pretty lonely job. If you're at the top, you don't have anyone you can fully lean on. So I'm grateful I learned those skills of persistence and resilience earlier in my life.

I have a lot of faith in humanity. I deeply believe that humans can make the world a better place, despite all the evidence to the contrary. And I hope that by helping science practitioners do their jobs better, more people will feel comfortable learning about science and will bring it into their lives and their decision-making. If I could be part of this change, I would feel good about that. ■



## Erika Shugart

### *Personal and Professional Identifiers*

Informal science educator and nonprofit manager

### *Job title*

Executive Director

### *Organization*

National Science Teachers Association

### *Pronouns*

She/Her

### *Homebase(s)*

Washington, DC





## HOW TO NURTURE OUR SCIENTIFIC FUTURE

We can easily miss our future geniuses if we aren't expecting to meet them in unexpected circumstances.

**W**hen you grow up on a farm, the wonder of science happens every season. You see the natural evolution of life: calves being born, chickens laying eggs, baby chicks growing into chickens. You sow your seeds and learn how to tend them.

I grew up on a small farm right outside Dubuque, and it came so naturally to be curious about the lives of the animals and plants around me. I was learning about them all the time. My grandfather also had a shop, where I would watch him do repairs and weld. That sparked my curiosity too, because I was actually doing things—going under the tractor or handing my grandfather tools.

So as a child I was excited to test and try and build and make. I also used to cook with my grandmother, and that was another kind of testing and trying. I was fortunate to grow up in a setting where my “makerspace” was my whole house and my yard and the shop. I was able to make and do and test and try to my heart’s delight. And I broke a

lot of radios and record players because I was curious. My grandmother started shopping at the secondhand store, because she knew that whatever she bought I’d tinker with.

Learning about nature is such a powerful way of accessing the beauty and wonder of science—and also our common humanity. I think about this all the time as an educator in Chicago. It’s one reason afterschool and summer programs first appealed to me: the formalities are swept aside, and you can learn in a situation that feels like it’s about the freedom to explore and follow your curiosity.

Before COVID-19 hit, my organization, Project Exploration, was working with 4-H because we were planning to give young kids the experience of watching an egg go through its stages until baby chicks are born. We had fish. We had lizards. We wanted our kids to think about how nature works and how we care for our environment: how we care for the grass, how we care for the trees, and how we care for each other. In my mind, we would be

better humans to each other if we had a richer understanding of our world through science.

To reach those kids, we’re going to need empathy for people and their unique circumstances. I’ve developed a strong sense of empathy by growing up in a melting pot of different ethnicities and worldviews: my mom was from South America, my dad was African-American and white, my stepfather is Palestinian, and I grew up in rural Iowa, a predominantly white environment. It’s important to me that all young people have their voices heard, whether you are a young African-American man on the South Side of

Chicago trying to find your way in the world or a young Latinx woman from Belmont Cragin who wants to explore STEM but whose mom is worried about what that means for a young woman. There are invisible cultural barriers in our system that we need to understand so that we can help our young people achieve their goals.

When Project Exploration opened the West Side STEM Learning Center back in 2017, middle school was our sweet spot. But we started to see that our middle schoolers were bringing in their cousins and brothers and sisters who were anywhere between

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kindergarteners and third-graders. One day I walked in, and there were all these little kids running around. One kid in particular was running all over, being chased out of the bathroom and in and out of closets. And I said to one of the staff members, “who is this?” And they said, “That’s Hakeem.” And I thought, wow, if we want to serve middle school, we’re going to have to think about what happens with their siblings and other relatives. So we did a crash course in early childhood STEM education and started to design a program.

Six or seven months later, I come into the classroom, and who do I see but Hakeem. And I was shocked, because first of all, he wasn’t running through the hallway. He was sitting in the classroom, working quietly on a project. So I went up to him and said, “Hey, what’s going

on?” And he turned to me and said, “Don’t bother me. Don’t you know I’m a scientist?”

That moment inspired me to do another five years of work at Project Exploration. When Hakeem said that, I thought to myself, “Exactly! You have created an identity for yourself. And you’re a scientist, whether you’re going to be a scientist for your career or not. The fact that you’ve planted that seed in your mind and you’re now in first grade means that the identity is there.”

I want every one of our kids to plant that seed, whether it’s “I’m a scientist,” “I’m a teacher,” “I’m a phlebotomist”—whatever it is. Plant that seed so that you can have something to look forward to.

And while they’re planting that seed, we have to build the pathways so that science is accessible

to them. That could mean helping school districts to identify and support robust opportunities for kids. But most of all it means helping our communities demand these opportunities. We need to instill the idea that parents should expect this for their kids. And then we can help you advocate for your child. We also want young people to get introduced to all these amazing STEM institutions, like the Field Museum of Natural History and the Museum of Science and Industry in Chicago.

Science is for everyone. It’s for the youngest kids, like my goddaughter Zola, who’s still a baby in my lap. It doesn’t all have to take place in the classroom. It’s not all about worksheets and filling in the bubbles. Learning happens because you’re actually doing things and chattering about them. Learning should be

robust and lively and real—all ways of being that kids love. We need to help parents recognize

that, and then we need to help them get that for their children.



## Natasha Smith-Walker

### *Personal and Professional Identifiers*

Community Organizer in support of children and youth gaining access to STEM

### *Job title*

Executive Director

### *Organization*

Project Exploration

### *Pronouns*

She/Her

### *Homebase(s)*

Chicago





# STAYING TRUE TO MY INNER PURPOSE FOR IMPACTFUL SERVICE

How can all scientific endeavors be understood to be relevant to society and worthy of the public's support?

SOON, I NOTICED THAT GROUP OF PHYSICAL GEOGRAPHERS HAD SAT APART FROM US THE ENTIRE TIME AND REMAINED SILENT, UNTIL ONE OF THEIR MEMBERS TENTATIVELY RAISES THEIR HAND. NOTICING A FELLOW AMERICAN, MY EARS PERK UP AND I LISTEN. THEY ASK, "HOW CAN YOU EXPECT US AS PHYSICAL GEOGRAPHERS TO DESCRIBE THE RELEVANCE OF OUR WORK TO OTHERS IN THE SAME MANNER AS HUMAN GEOGRAPHERS? I'VE NEVER HAD TO DESCRIBE THE BROADER IMPACTS OF MY WORK WHEN I APPLIED FOR NATIONAL SCIENCE FOUNDATION (NSF) GRANTS." I WAS AGHAST...AND MY HAND SHOT UP... "HOW CAN ANYONE DO, STUDY, RESEARCH ANYTHING IF IT ISN'T INTERESTING AND INFORMATIVE TO HUMANS AND DIRECTLY OR INDIRECTLY IMPACTFUL ON THE HUMAN CONDITION?"



AUDIO TRACK

Staying True To My Inner Purpose For Impactful Service is a sound file. Click on the play button to access the audio or visit: <https://audio.civicsciencestories.org/NuduGama.m4a>



## Natasha Udu-gama

### *Personal and Professional Identifiers*

Leader in the field of community science

### *Job title*

Manager, Community and  
International Relations

### *Organization*

AGU Thriving Earth Exchange

### *Pronouns*

She/Her/Hers

### *Homebase(s)*

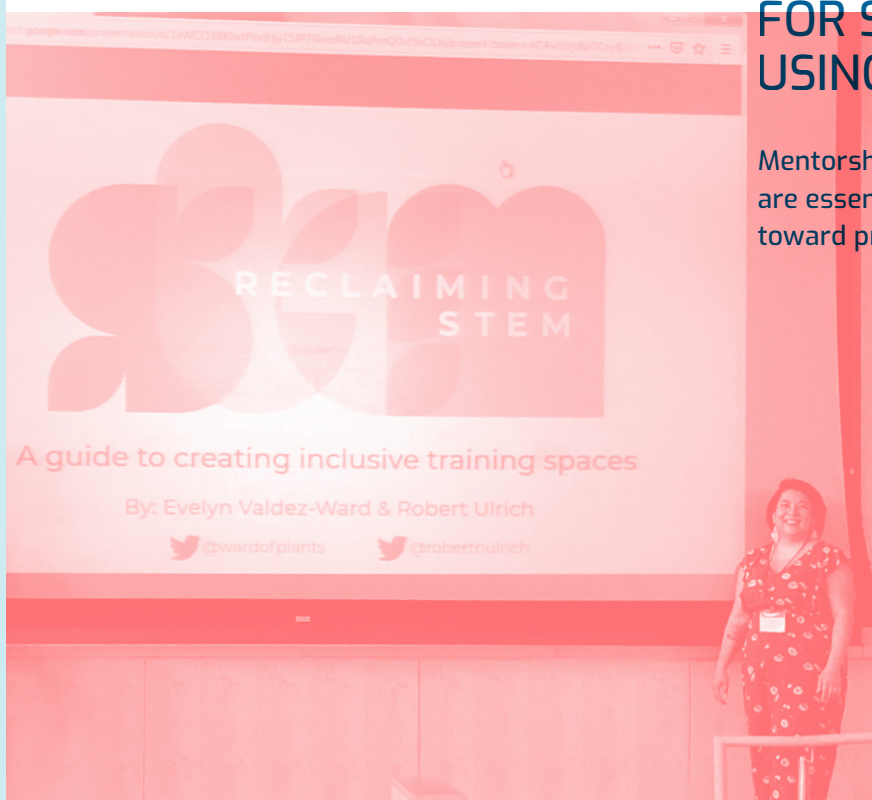
Washington, DC





## LEARNING TO FIGHT FOR SOCIAL JUSTICE USING SCIENCE

Mentorship and diverse representation are essential for success on the journey toward professional scientific careers.



**A**s a formerly undocumented, Latina, female scientist, it is an absolute honor to have made it this far into my PhD, only a couple months from graduating. However, the journey to this stage in life was not an easy one.

When I was younger, my father took me along with him on a grocery trip to buy milk. While in line at the cash register, I saw a teddy bear and began to cry as I reached for it. With tears in his eyes, my dad walked out of the store, holding me tight. He wanted to give me the world. And at that moment he decided to cross the Mexican-American border, for me.

My parents brought me to the U.S. through a selfless act of love so I could have access to higher education. The first words I ever heard in English on my first day of school were, "Speak English. This is America."

School was my top priority growing up. I wanted to honor my parents' sacrifices by becoming the first in my family to obtain a college degree. I worked hard in school, made

the honor roll, and was part of honor societies.

When my senior year finally came around, I began filling out college applications. The first question on the form is your social security number. When I asked my mom, tears streamed down her face as she told me I was undocumented. I didn't understand the true meaning of what that meant, until I asked teachers for a letter of recommendation, and they told me that as an illegal, I would never make valuable contributions to this nation.

I was distraught. I stopped attending classes, I lost my will to do anything. I fell into an eating disorder, and ended up in the hospital. It took my parents to give me the strength I needed to keep going. They told me they have been in this country much longer than I was, they know what I was going through, and they would find a way. So they went to sanctuary spaces where other parents like them were learning how to apply to universities with my status. And because of them, I learned how to

apply to places despite my status. Getting into the University of Houston-Downtown was an absolute dream come true. Additionally, I was granted a Scholars Academy scholarship for wanting to major in Biology.

The summer right before I began UHD in 2012, Deferred Action for Childhood Arrivals (DACA) was put in place by President Obama. And I was terrified to apply. It took a lot of fear and courage to submit all of my information over to the government for this application. Anyone who has ever applied knows how much the first application takes, and how much money it was. When I finally applied, and was approved, I was able to finally do normal things. I got a license to drive to school using the family van. I was able to get a job at Kroger, which I was terrible at! I couldn't tell the difference between lime and lemon, it was just limon to me.

However, as an undergrad with DACA status, I had limited access to financial aid. This led me to work multiple full-time jobs to cover tuition, and

took time away from my studies. Meanwhile, my father often traveled out-of-state to find work. As the eldest in my household, I helped my mom look after my siblings. Work, school, and having adult responsibilities at home were often challenging to juggle.

At the end of my first year, Scholar's Academy required us to apply to research programs. However, as an undocumented undergrad, even with DACA, paid research opportunities like this are limited to people with citizenship or residency. Plus, at the end of that year, my grandma fell and broke her leg in three parts. And anyone who knows my grandma knows how perfectly dramatic and fitting this fall was for her, because she's a dramatic person. But it meant the entire family had to get together and work to pay bills off. As the only one with a work permit, it meant I had to pick up extra hours at Kroger.

When I told Dr. Tobin, he seemed sad, but understood. After a few tears in his office, I went home. Later that day, I

got an email from him. He asked if I wanted to do research, all expenses paid, to California, to study how plants transport water. And I remember thinking... who in the world would ever care about that...? But I showed my parents. Dr. Tobin knew my status of being undocumented, and

to get an offer like this meant a lot. My parents encouraged me to take it!

The sad thing was, the research was in Bakersfield California. It's not like in the movies of what I thought California was like, with palm trees, and the beach. It's in the middle of nowhere. Which meant I got all this

time to do research on plants and drought! And I fell in love with plants. I fell in love with the way plants transporting water tells you a lot about what a plant is experiencing, and how much stress it's environment is putting on the plants. And California plants were tough! They honestly taught me a lot about being resilient.

That summer. Dr. Tobin took us to a lot of places around California. I got to experience a lot of the natural world out there. I came back not wanting to be a doctor, but to be a plant scientist.

In addition to my courses, I also participated in research. As an undergraduate, I studied the effects of drought on native California plants. With every plant I measured, the deeper I fell in love with science. I knew that graduate school was the next step for me. And I went with Dr. Tobin for two more years to do research in St. Louis, where I also studied plants and drought.

The beautiful thing about my research is the many opportunities to present research. Scholars Academy sent

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**SCHOOL WAS MY TOP PRIORITY GROWING UP. I WANTED TO HONOR MY PARENTS' SACRIFICES BY BECOMING THE FIRST IN MY FAMILY TO OBTAIN A COLLEGE DEGREE. I WORKED HARD IN SCHOOL, MADE THE HONOR ROLL, AND WAS PART OF HONOR SOCIETIES.**

**WHEN MY SENIOR YEAR FINALLY CAME AROUND, I BEGAN FILLING OUT COLLEGE APPLICATIONS. THE FIRST QUESTION ON THE FORM IS YOUR SOCIAL SECURITY NUMBER. WHEN I ASKED MY MOM, TEARS STREAMED DOWN HER FACE AS SHE TOLD ME I WAS UNDOCUMENTED. I DIDN'T UNDERSTAND THE TRUE MEANING OF WHAT THAT MEANT, UNTIL I ASKED TEACHERS FOR A LETTER OF RECOMMENDATION, AND THEY TOLD ME THAT AS AN ILLEGAL, I WOULD NEVER MAKE VALUABLE CONTRIBUTIONS TO THIS NATION.**



me to a conference in San Antonio called the Society for the Advancement of Native Americans and Chicanos in Science (SACNAS), where you meet all kinds of people doing science, who look just like you! I met a lot of other Latinos there, who inspired me to keep pushing, and consider getting a PhD. It just hits differently when you have an older latina in higher education telling you “echale ganas mija, tu puedes!”

But as I would present my research to a potential recruiter, I would always get the same answer: “We don’t accept illegals,” Distraught, I almost gave up on my dream.

During my last SACNAS conference, I thought this was my last chance. With a few minutes to spare during my last poster presentation session, the last judge walked up. I thought, “This is it.” It was my last chance for a shot at graduate school. As I gave my presentation, the judge seemed unimpressed and unengaged. “Thank you,” she said when I finished, walking away. With tears in my eyes, I began to take my poster down. The judge came back though, handing me a business card with three names on the back. She strongly encouraged me to apply. Trying to hold back tears I told her about my legal status.

“We will find a way,” she said. And, because of all of my research experience, and all the times I was able to present my work, I was finally seen as a scientist, and not just for my status. I was accepted into the University of California, Irvine.

I am now in the last year of my PhD in ecology. Although, these past five years have been crazy. During my first year, President Trump was elected. For someone with DACA status, with undocumented parents, I spent the entire next day after the election crying and planning. What would happen if my parents are deported? Who would take care of my siblings? If DACA ends, how will I continue my PhD? How can I continue my science?

When DACA ended in 2017 during my second year, my life changed forever. I finally decided to take action, and mobilized my department to join a rally against the decision to end DACA. This then led me to notice STEM spaces were staying silent. Did they not care for their undocumented communities? This is then why I reached out to [Science](#) and wrote my story about why DACA is a science issue.

I was also part of the University of California lawsuit that sued

President Trump over his decision to end DACA, and we won in a Supreme Court ruling. I was invited to speak at March for Science, Invited to tell my story at the story Collider, and was on Telemundo!

Everything changed about the way I viewed science, I wanted to do more with my research. While yes, studying plants was important, what could I do to help advance social justice in science? I wasn’t the only one that was being affected by racist, homophobic, and anti-immigration policies both academically and federally.

While I was being trained on immigration policy, and speaking with the press, and learning to lobby, I yearned for this in science communication and policy spaces. And I did not find a place that taught these skills and used research for social justice. I co-founded a workshop called ReclaimingSTEM. It’s a training workshop for folks from marginalized communities. And it teaches people to use their science for social justice. This is where my career is now headed. I am interested in STEM education policy, to help change the policy that is making it difficult for students like me to succeed.

So here I am, making my parents’ sacrifices

count as a fifth year PhD student at the University of California-Irvine, where my work focuses on the effects of climate change on the interactions between plants and soil microbes. And have now dedicated the last two chapters of my dissertation to ReclaimingSTEM research to understand why marginalized scientists want to do science communication and policy and how to best inform these training models.

And indirectly, I’m helping make a difference for marginalized students and undocumented students who want to pursue higher education, because we must harness the powerful work of all students and professionals contributing to the sciences, this means providing support regardless of their backgrounds, sexual orientation, religious beliefs or citizenship status.



## Evelyn Valdez-Ward

### *Personal and Professional Identifiers*

Ecologist and Science communication and policy researcher

### *Job title(s) & Organization(s)*

Postdoctoral Fellow at the University of Rhode Island and Executive Director, ReclaimingSTEM Institute

### *Pronouns*

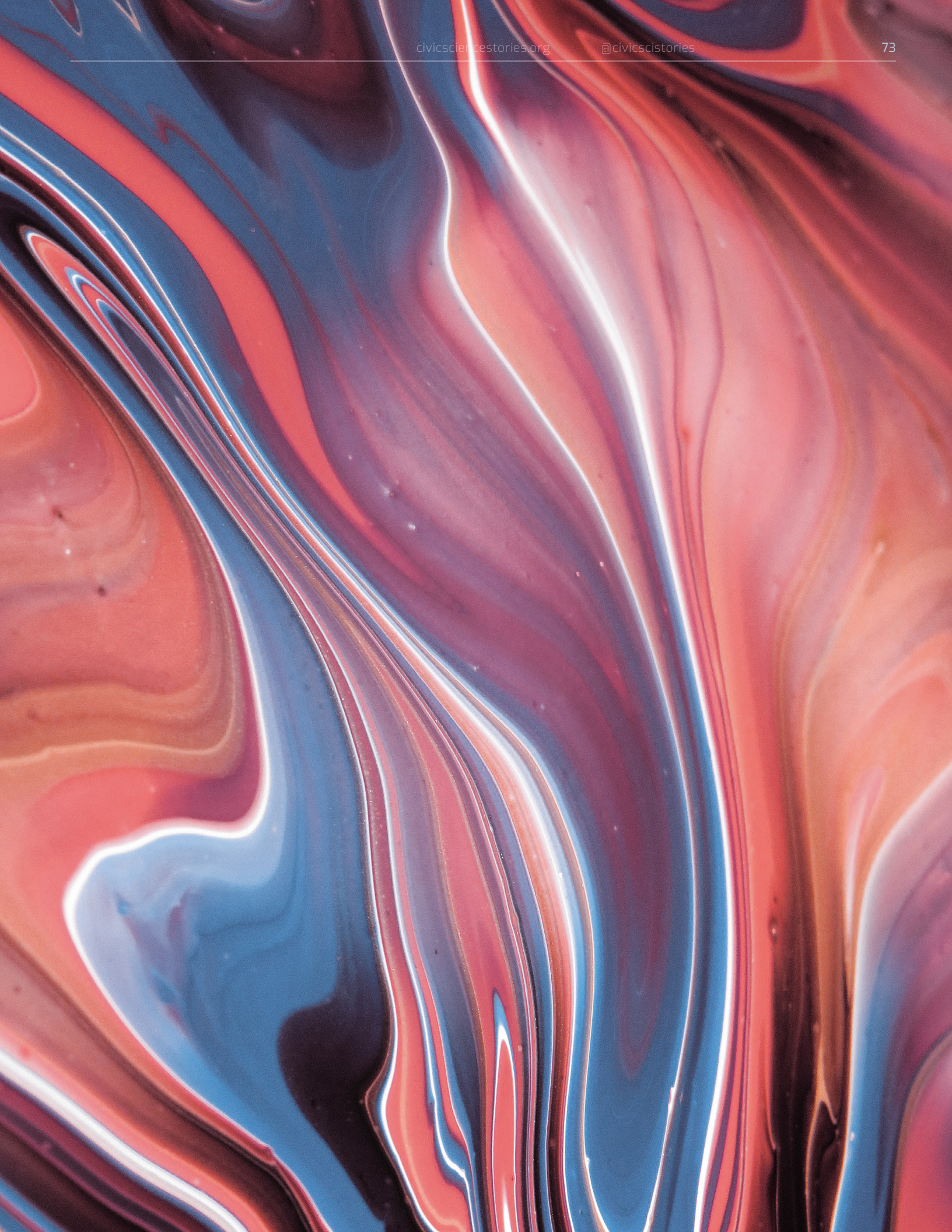
She/Elle

### *Homebase(s)*

Texas









## A PATH TOWARD MY PURPOSE IN CIVIC SCIENCE

When does science's potential for positive change feels the most real?

**A**s a kid, I loved animals, and I especially loved learning about endangered animals from faraway places. Komodo dragons, red pandas, cassowaries—I was fascinated by them all. I approached my love for endangered animals with a childhood rigor that was probably unusual for most kids. I borrowed scientific books from the library that detailed different families within the animal kingdom. Instead of Saturday morning cartoons, I'd watch *Jack Hanna's Animal Adventures*. During family trips to the zoo, I was the kid who read every single information placard. I was a nature nerd from a very early age.

It wasn't long before my interest expanded beyond the animals themselves to why they were endangered, and how I could help save them. As I learned about pollution, I got my family to commit to recycling, so we could do our part. I tried to use as little water as possible while brushing my teeth and washing my hands so I could conserve resources for

the animals that needed it. I even ran a lemonade stand from my front yard so I could donate that money to protect endangered species.

My generation was forced into political consciousness on September 11, 2001. I can vividly remember sitting in study hall during middle school and high school watching news coverage of the US becoming entrenched in wars in the Middle East and realizing that politics was an inescapable force that would impact my life. And as politics was thrust upon me, I decided that I might as well get involved in campaigning for the leaders and causes I agreed with. It didn't hurt that my class on American Government heavily relied on reruns of *The West Wing* to keep us entertained.

Inspired by that overly romanticized take on politics, I started college determined to become the next Sam Seaborn. My romance with campaigns was kindled by pep talks from organizers not that much older than myself who taught me the basic tenets of organizing while sitting in folding chairs in rundown, vacant offices in rundown, increasingly vacant small towns in Ohio near where I grew up. The idea of coming together for a leader who could fix all of our problems fueled me through campaigning in subzero snowstorms in New Hampshire before the presidential primaries, and knocking on doors in the sweaty humidity of summer in Ohio. I loved that working on campaigns made me feel like I was part of something bigger,

knowing that every weekend leading up to the election there were dozens or hundreds or thousands of people who were knocking on doors and making phone calls just like I was, as a way of standing up for what we believed in.

Still following those *West Wing* dreams, I moved to DC. My first internship was at a fundraising firm, and it was there that some of the sparkle of politics really began to dull as I peeked behind the curtain to what really makes DC tick: money. While I still got a jolt of excitement meeting members of Congress in person, the realization that they spent up to half of their free time in offices like ours asking for money left a bitter taste in my mouth. I realized that my vision of electing smart,



I HAD ONE WISE PROFESSOR WHO HELPED SNAP ME OUT OF MY HOPELESSNESS, AND IT WAS HIS CLASS ON GRASSROOTS ORGANIZING THAT HELPED RELIGHT THAT SPARK IN ME TO MAKE CHANGE HAPPEN. THINKING BACK TO WHAT MOTIVATED ME—FROM THE LEMONADE STAND IN MY FRONT YARD TO CAMPAIGNING FOR CANDIDATES IN SWING STATES, AND CONTINUES TO DRIVE ME—IT'S THE FEELING THAT WHEN PEOPLE COME TOGETHER, WE CAN MAKE A DIFFERENCE. IT FEELS LIKE MY HEART RACING DURING THE MARCH FOR SCIENCE IN DC IN 2017, WHEN TENS OF THOUSANDS OF SCIENCE SUPPORTERS SHOWED UP IN DEFENSE OF SCIENCE; WARM FUZZY FEELINGS WHEN A SCIENTIST TO WHOM I OFFERED SUPPORT SAYS "ENOUGH IS ENOUGH," AND SPEAKS OUT PUBLICLY FOR THE FIRST TIME; A BUZZING SENSE OF ACCOMPLISHMENT WHEN I LOOK AT ALL THE LEADERS WHO HAVE PARTICIPATED IN UNION OF CONCERNED SCIENTIST SCIENCE NETWORK PROGRAMS AND GONE ON TO ORGANIZE OTHERS TO GET INVOLVED. THOSE MOMENTS FEEL LIKE ENERGY JUST WAITING TO BE HARNESSSED, WHERE YOU CAN ALMOST TASTE THE POTENTIAL FOR IMPACT—WHERE YOU FEEL PART OF SOMETHING MUCH BIGGER THAN YOURSELF.

dedicated individuals so they could talk to scientists about climate change and endangered species conservation and then craft brilliant legislation to address the issues I cared about was something that only happened on a TV show.

I had one wise professor who helped snap me out of my hopelessness, and it was his class on grassroots organizing that helped relight that spark in me to make change happen. Thinking back to what motivated me from the lemonade

stand in my front yard to campaigning for candidates in swing states, and continues to drive me, it's the feeling that when people come together, we can make a difference. It feels like my heart racing during the March for Science in DC in 2017, when tens of thousands of science supporters showed up in defense of science; warm fuzzy feelings when a scientist I offered support to says enough is enough and speaks out publicly for the first time; a buzzing sense of accomplishment when

I look at all the leaders who have participated in Union of Concerned Scientist Science Network programs and gone on to organize others to get involved. Those moments that feel like energy just waiting to be unharnessed, where you can almost taste the potential for impact—where you feel part of something much bigger than yourself.

I now know that I cannot tackle huge issues (like endangered species conservation or climate change) on my own. But I

also know that in order to achieve transformational change, individuals must step up to help shift the balance of power. My journey was also a journey of the many ways that science intersects with society, from education to advocacy. I envision the future of the science advocacy

movement intertwining with the future of civic science—a future where scientists embrace their responsibility to use science for the public good, and where a curious public continues to try new approaches to paths where they feel called to make a difference. ■



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# THE UNTAPPED POTENTIAL OF WONDER

What new human capacities open up during moments of discovery and wonder?

AND I THINK ABOUT THIS LITTLE DISCOVERY AND THE FEELING OF SURPRISE AND DELIGHT AND AWE AND HUMILITY AS I SAT THERE NEXT TO THIS BUCKET THINKING "HOW CAN THIS CREATURE POSSIBLY EXIST IN REALITY—EXIST ON THE PLANET?" I THINK ABOUT THAT FEELING TODAY AND I THINK ABOUT HOW TO TRY TO ACCESS THAT FEELING, ESPECIALLY THROUGH PHOTOGRAPHS AND STORIES. HOW CAN I SHARE THAT FEELING? AND WHAT DOES THAT FEELING REPRESENT?

TO ME IT REPRESENTS THE POWER OF ATTENTION AND HOW PAYING ATTENTION TO THE DETAILS AND THE SURPRISES AND THE COMPLEXITY IN FRONT OF US HAS THE POWER TO RESHAPE OUR ASSUMPTIONS ABOUT THE WORLD. MY VISION FOR THE FUTURE—ESPECIALLY FOR THE FUTURE OF SCIENCE—IS ONE IN WHICH WE EMBRACE THE POWER OF WONDER TO CHALLENGE OUR ASSUMPTIONS AND TO SHINE A LIGHT ON OUR BLIND SPOTS.



AUDIO TRACK

The Untapped Potential Of Wonder s is a sound file. Click on the play button to access the audio or visit: <https://audio.civicsciencestories.org/AnandVarma.mp3>





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# A CERTAIN AMBIVALENCE

## Childhood memories of science and progress

Once was a precocious child. A little redhead that knew all there was to know.

I knew all the fish in the aquarium, and all the animals in the zoo. I knew earth's molten metals all the way to the planet's core. I knew the layers of the atmosphere and classifications for clouds. I knew how to chart a graph, solder a circuit, and focus a scope. I knew the elements that make everything, locking together like Legos.

I knew the shortcuts through the woods out backdoors. I knew that all trails are interconnected, woven together like webs. I knew where rock outcroppings peaked out at the sky. I knew the trees with climbable branches, and gave them names.

I knew how to find the moon whenever it could be found, and I would seek out strangers to show them how it works. I knew how to point at sun and moon with my arms outstretched and explain, "It always rises full at sunset, you see."

I knew how to induce a euphoric vertigo by leaning into a moonrise.

I knew the trick was working when we could feel ourselves moving under a motionless moon, hurtling forward, stuck to the earth's skin.

I knew how to weave the facts to make them wondrous: Earth and moon are tied by tidal forces that keep their axes stably spinning, dependably serving up seasons for millions of millennia. Without this balance of size, spin, and speed, everything goes wobbly. Evolution needs these time scales and reliable cycles. Everything we are depends on this improbable, incredible coincidence of coordination.

I knew this knowledge made me. It situated and connected me. It told me what and where I was.

I knew this knowledge also made me special, and I knew the adults approved. With each affirmation my eight-year-old ego's star kept rising, and I knew science was the key.

I knew science unlocked the future too. I remember dreaming up moon bases on graph paper. I recall looking up and squinting, imagining where a base

would nestle among the craters. I knew someday someone really would build something on the moon. I wondered if maybe it really would be me.

I don't know why I kept looking up that evening. But I suddenly realized that someday something built on the moon would be so big and bright that all earth would have to stare at it, like some celestial billboard with all eyes tied to it by those tidal forces. In the future everyone would see this.

They could disagree with it, but they would see it regardless of whether they consented to the act. I saw a future in which no one would see the moon for free.

I don't know why the first US spacecraft to land on the moon was named Surveyor, but it did not have good connotations for me. When surveyors' flags popped up it meant my childhood woods had been punctured by private property. It was a harbinger. It meant that trees with names were about to be cut down.

I now know I am not special. And I'm doing great at keeping the ego in check. I've let go of things I knew, but the wonder isn't gone. Neither is the ambivalence. I still feel uneasy every time I hear the next bold plan for the future. My plan is to hold on to this feeling, nurturing it as my own. It situates and connects me. It tells me what and where I am. ■

I DON'T KNOW WHY I KEPT LOOKING UP THAT EVENING. BUT SUDDENLY I REALIZED THAT SOMEDAY SOMETHING BUILT ON THE MOON WOULD BE SO BIG AND BRIGHT THAT ALL EARTH WOULD HAVE TO STARE AT IT, LIKE SOME CELESTIAL BILLBOARD WITH ALL EYES TIED TO IT BY THOSE TIDAL FORCES. IN THE FUTURE EVERYONE WOULD SEE THIS. THEY COULD DISAGREE WITH IT, BUT THEY WOULD SEE IT REGARDLESS OF WHETHER THEY CONSENTED TO THE ACT. I SAW A FUTURE IN WHICH NO ONE WOULD SEE THE MOON FOR FREE.

I DON'T KNOW WHY THE FIRST U.S. SPACECRAFT TO LAND ON THE MOON WAS NAMED SURVEYOR, BUT IT DID NOT HAVE GOOD CONNOTATIONS FOR ME. WHEN SURVEYORS' FLAGS POPPED UP IT MEANT MY CHILDHOOD WOODS HAD BEEN PUNCTURED BY PRIVATE PROPERTY. IT WAS A HARBINGER. IT MEANT THAT TREES WITH NAMES WERE ABOUT TO BE CUT DOWN.



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## PLANNING TEAM

Over 2020-2021 we convened a series of individual and group calls and spoke with close to 50 people working in the civic science space. Our first calls were with the Civic Science Fellows and members of the network, colleagues, and friends. From witnessing, supporting, and influencing the crafting and molding of this project to contributing stories, our Civic Science Fellowship family stood by our side. Whether you contributed a story or not, your co-creative spirit in that early phase was essential to the continuation of the project. Thank you.

Later on, we held group calls with people from our networks, that we knew would answer our call to have these conversations. Many contributed stories, some did not, but nevertheless influenced our vision and fueled our drive. Finally, we had individual calls with others, most of who contributed stories, some who did not, but nevertheless shared deep moments of connection and reflection. Thank you all for what you shared. After the calls some contributors worked individually on their stories, joining us at office hours to get feedback. Some contributors agreed to interviews after which we worked with a story editor to iteratively craft a story.

We also want to thank the members of the Civic Science Network for their helpful comments and advice on the open draft of this framework. This has been a collaborative effort that has been buoyed by a shared brilliance, humanity, and fire for a better world. We deeply thank you all for contributing to it.

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