

FEEHLEER

The Unintentional Development of Plastic that Advanced Society

By Verónica Zaragovia

Verónica Zaragovia: I'm Verónica Zaragovia. And in this story in the Goethe-Institut's series about mistakes we'll look at happy accidents in the invention of plastics. Over time, plastics evolved through trial and error. Inventors didn't usually set out to have a 'eureka'-moment. Instead, they've had to test things out – make errors like creating flammable plastics ...before getting to their useful discovery. Today, so much of our built world depends on plastics — and yet we grapple with how to embrace them while also caring for the environment.

Sebastian Zaragovia: Well, I certainly don't think that we would be where we are today without plastic.

Verónica Zaragovia: One person who has particularly mixed feelings about this is my younger brother Sebastian, in Fort Lauderdale. He tries really hard not to use too many of those single-use plastics like yogurt cups that you just get rid of after one use. But at the same time, he tells me so many things in his apartment are made out of plastic.

Sebastian Zaragovia: I can readily see tons of things that are plastic, for example, the door of my washing machine, my dryer, dish detergent bottles, soap bottles, that are plastic — the polyurethane wheels on my longboard....

Verónica Zaragovia: That long board is like a skate board — sometimes he takes it out along the boardwalk near the ocean — a very sunny South Florida thing to do! Right now, I'm living close by to him in my father's home in Miami. Each week we put out our recyclables in a big, black...and yes, plastic...bag. [*Sounds of Verónica putting plastic in a bag*] The local solid waste department picks our bag up every Friday. The bag's size has ballooned ever since I got here. I believe most of this ends up in a landfill. Luckily, my father, Angelo, is far more optimistic.

Angelo Zaragovia: [*Speaking Spanish*]

Verónica Zaragovia: He says in Spanish that 99 percent of the single-use plastics we have here at our home go into this bag for recycling. It's our contribution to preserving the environment. Now, I came here from Berlin, where often the background to my thoughts sounded more like this [*Sounds of church bells*] as opposed to waves. In my apartment in Germany I had to sort things out carefully for recycling — you couldn't just dump all sorts of different materials into one bag. This careful process is something Wolfgang Meyer knows about.

Wolfgang Meyer: I am the principal of Plastic Business Consultants.

Verónica Zaragovia: He grew up in Western Germany, where he studied mechanical engineering. It was thanks to an unexpected internship around 1969 that led him to a career in plastics. His college courses at the time were paused because there was a student strike going on at the time, so he went to intern with the plastics application development department at Bayer. And he says that's how he learned a whole lot about plastics.

Wolfgang Meyer: In college we had practically no real plastics education. I keep kidding about this that this happened on one Friday afternoon.

Verónica Zaragovia: They didn't really offer this study path in Germany at the time. Today, he's passionate today about helping the next generation get into this industry. He focuses a lot of his time as the president of the Plastics Pioneers Association on tuition scholarships. Students at colleges and universities may get funding to study topics like plastics engineering, polymer science, chemical engineering and product design. He's a big supporter of plastics, pointing out how they're lightweight and save energy, they're used for medicine.

Wolfgang Meyer: Just banning plastics and a life without plastics in all these areas is just unthinkable

Verónica Zaragovia: Speaking to experts like him made me look at the plastics in my own life, and I'm observing them in a new way. [*Sound of an alarm clock*] From the time my alarm clock goes off in its plastic case, I see plastics everywhere. And so many times a day too, like this green soap bottle. [*Sound of hand washing and singing 'Happy birthday to you...'*] Twenty seconds each time to disinfect my hands. From all the books out there on plastics, I was drawn to Susan Freinkel's. She's the author of the book *Plastic, a Toxic Love Story*. In her book, she documents how it came to be that our modern world is made out of plastics and the fascinating stories behind the discoveries. She also describes her own list of plastics she made in her home, and how it kept getting longer as she found stuff that didn't seem at first glance like it had plastics.

Susan Freinkel: Things like my dog leash, which was nylon, which is a kind of plastic, or I looked at the doorknob, which I had always thought was a brass doorknob, and I realized oh, it's actually not, it's just plastic painted to look like brass.

Verónica Zaragovia: I have a bad addiction to carbonated soft drinks — and just as Freinkel was surprised to find that the door knobs were actually plastic, I was surprised to find that there's a plastic lining inside aluminum cans. I learned from Freinkel, though, how it's a good thing that billiard balls ARE made out of plastics. They used to be made out of ivory — which required killing elephants for their tusks. The man that made this discovery in the late 1860s is John Wesley Hyatt. He worked as a printer in New York State, and one day he saw an ad in a newspaper offering 10-thousand dollars....

Susan Freinkel: ...in gold for any “inventive genius,” who could come up with an alternative to ivory billiard balls.

Verónica Zaragovia: The game had become really popular...

Susan Freinkel: ...so much so that people were afraid there was the demand for ivory to make billiard balls was driving elephants into extinction. So Hyatt read that ad and he thought, okay, let me think if I can come up with something to replace ivory billiard balls. He built himself a little workshop behind his house and he spent some time, a couple of years, tinkering with different things.

Verónica Zaragovia: And he comes up with a mix of cellulose and other chemicals. It had a shoe-leather consistency, and he called it celluloid. It could be made to look like other rare materials, too — like tortoise shell or coral.

Susan Freinkel: That sort of shows the democratizing effect of plastics. Hyatt was working from a problem: there was this scarce natural resource, we needed to find a substitute for it, he figured out a way to make a substance that was made from plastic.

[FaceTime sounds]

Verónica Zaragovia: I call Susan Mossman in London using FaceTime. She’s the vice chair of the Plastics Historical Society in London. She tells me how John Hyatt and his brother Isaiah took credit for celluloid

Susan Mossman: They made a completely fantastic commercial success of it.

Verónica Zaragovia: But here’s a mistake. Celluloid was also flammable. What’s more, he capitalized on someone else’s invention that also had flaws. Some twenty years before Hyatt, British inventor Alexander Parkes created a material called Parkesine in the late 1840s. It was a precursor to celluloid, and it was brittle, expensive and had quality-control problems. Later on, Parkes’s company even went bankrupt. Now around this time, shellac was used to paint on coils. Shellac is a resin secreted from female bugs — but it melts at high temperatures. It took almost a half century before someone came up with a material that did not melt. Leo Hendrik Baekeland, a Belgium-born chemist who was eager to discover a substitute.

Susan Mossman: And he knew he needed to be first, he writes that, he says it, these days I need to be first.

Verónica Zaragovia: So Baekeland set up a lab behind his big house in Yonkers, New York. [Excerpt from the documentary *All Things Bakelite: The Age of Plastic*] The recent documentary *All Things Bakelite: The Age of Plastic* by John Maher brings us into his lab where he invented a fully synthetic plastic using phenol and formaldehyde. That means all of it could be made in a lab. He called it Bakelite and patented it in 1909. Lots of people are fascinated by Baekeland and his process. Joris Mercelis is the author of *Beyond Bakelite* and a professor at the Johns Hopkins University in Baltimore. Mercelis says Bakelite contributed to a growing acceptance of other synthetic materials, too.

Joris Mercelis: People started to think about them as not just being inferior substitutes for natural materials, which had been the common attitude during World War I, for example. So in those early years, Baekeland and his associates really had to convince people to accept that Bakelite was not just an inferior substitute for materials like amber.

Verónica Zaragovia: At the time, inventors like Baekeland who were based in the U.S. felt motivated to come up with innovations because of competition across the Atlantic.

Joris Mercelis: Before World War I, many chemists in America were kind of envious about what chemists in other countries had accomplished, especially in Germany, which was a real leader in the discipline of chemistry. Several earlier synthetic products, which had been invented, had been invented in Germany, things like synthetic dyes, synthetic pharmaceuticals.

Verónica Zaragovia: Baekeland went from trying to replace a product like smelly camphor that reeks of moth balls to Bakelite. Bakelite doesn't melt. There was nothing like it. And it could be molded into any shape. And so it was used for practical things like phones and radios but also jewelry. They could make intricate carving on bracelets for women. Even Andy Warhol the pop artist collected these. Established designers were commissioned to make Bakelite products like for home décor. You can find round and sleek Bakelite-made lamps on eBay for hundreds of dollars, designed by Germany's *Bauhaus*. Decades later, in 1965, the chemist Stephanie Kwolek had her own happy mistake. She worked at DuPont where around that time, her male colleagues were busy,

Stephanie Kwolek: ...and they left me alone. And I was able to experiment on my own. And I found this very stimulating. It appealed to the creative person in me.

Verónica Zaragovia: Here she is in a video from the Science History Institute, headquartered in Philadelphia, Pennsylvania. She was working on creating a synthetic material that could make lighter tires. That's because there was a possible shortage of gasoline looming at the time. And consumers wanted a better fuel economy, which meant replacing the steel wire in tires.

Stephanie Kwolek: In the course of that work I made a discovery...

Verónica Zaragovia: She ended up creating a liquid solution that could be turned into fibers five times stronger than steel.

Stephanie Kwolek: I knew that I had made a discovery; I didn't shout "Eureka," but I was very excited.

Verónica Zaragovia: Kevlar is made from these fibers.

Kevlar commercial: Outer space is really the most foreboding, incredibly hostile environment. We can't go into an environment as challenging as that with any doubts, "is my spacesuit going to protect me today." Without the presence of Kevlar I think it would be terrifying. From thirty-four million miles above us to several miles below us, and every point in between, you're going to find Dupont Kevlar. Kevlar is pushing the limits on light-weight, fuel-efficient planes.

Verónica Zaragovia: Kevlar is lightweight, heat resistant, and is so strong it's used in things like bulletproof vests,

Kevlar commercial: Kevlar allows us to do these things that hadn't been possible before.

Verónica Zaragovia: Spacecrafts, helmets, and protective gloves. Today, we're surviving on plastic gloves, but a different kind. The ones we're putting on to avoid getting infected with COVID-19. [Susan]

Mossman of the Plastics Historical Society points to how vital plastics have been in treating the new corona virus and fighting it.

Susan Mossman: Those plastic visors that they use when they go in close in the level 3 or 4 contact with patients, they're made of a whole range of different plastics, it could be polycarbonates, it could be PET, they might have other bits of foam in there, there might be acrylics, all those types of bits and pieces. The rubber gloves, they're usually either neoprene or latex rubber, those type of materials. The clothing, again for the high-level, particularly hazardous contact with patients, they'll use polyethylene-coated materials, but they might be layered with another plastic material underneath...

Verónica Zaragovia: Also, take the ventilators for breathing that are made out of plastics. I can't negate the importance of plastics, while also worrying about their impact. I spoke to Shelley Wilks Geehr about this. She works as a director at the Science History Institute and focuses a lot on education and outreach. She worked as part of a team that created a curriculum for students in schools to engage in role-playing within the world of plastics. In this way, the students discuss and learn about all the different viewpoints — just as we're doing in this story.

Shelley Wilks Geehr: Not everything that improves your life is entirely without consequence. And that does not mean that you shouldn't embrace these things, it means that you need to mitigate those consequences when need be. And it just feels like plastics is the perfect material to consider this from, and hopefully is a launching-point for students who go through the full curriculum to develop that ability to think about many, many things.

Verónica Zaragovia: Wolfgang Meyer of the Plastics Pioneers Association says we also have to take responsibility for how we dispose of things.

Wolfgang Meyer: My opinion is that plastic does not pollute, people do. And so it's up to people to keep the ocean clean.

Verónica Zaragovia: And as Susan Freinkel pointed out when we spoke, everything we use has trade-offs.

Susan Freinkel: It's not black and white, you know, it's, it's we have to sort of, we're always going to be walking a sort of ambivalent line in our relationship to plastic.

Verónica Zaragovia: Here in Florida, I'll be walking that ambivalent line in plastic flip-flops for a long while.

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