Episode 1: The Fourth Kingdom

Trace Material Season 2: Stories from the Plastics Age

[Rainbow Road Music]

Burgess Brown:

A little over a century ago, plastic was born out of a test tube in a chemist's barn. In just a few generations, this material has grown to define our world. Our homes, our environment, and even our bodies have become plasticized.

Ava Robinson:

This season we're sharing the stories of how we got here. From Parsons Healthy Materials Lab at the New School. This is Trace Material Season 2: Stories from the Plastics Age.

[Rainbow Road Music]

"The Monsanto House of the Future stands in Tomorrowland…"

Ava:

We'll start off this season at Disneyland in 1957. The chemical company Monsanto erected a space-age model home to illustrate what domestic life might look like in 1986.

Burgess:

It looks like this smooth white UFO that's just landed in front of Sleeping Beauty's castle.

"But would people really be interested in it? Here's just a part of the answer: 5 to 10 thousand people a day who wanted to get an idea of what a home in the future might be."

Ava:

And Monsanto had a pretty clear idea of what the future would be made out of.

"Is everything of plastic? Almost…dishes, cups, countertops, walls, floors, ceiling, table tops, shelves and cabinets. Plastics in all their colorful, functional, and beautiful versatility."

Ava:

We're starting in the Home of the Future because, even though we aren't all living in pods that look like they belong to the Jetsons… a lot of these predictions did come true. We live in plastic homes, drive to work in plastic cars and sit in plastic offices. It's in our water and in our air. And that has had mind-boggling effects on human health and the health of our planet.

Burgess:

We're also starting here because we didn't arrive at this plastic present by accident. It took clever and calculated marketing campaigns, like this one by Monsanto, to convince the American public that they wanted and needed a plastic future.

Ava:

This season we'll be tracing the path of plastic proliferation over the last century. We'll look at innovations that have made our modern life possible, and the unforeseen consequences that will shape our lives for generations to come.

[Music]

Burgess:

Okay, that's a tall order. Let's take a breath and start from the beginning. We need to talk about what exactly we mean when we say "plastics" and where exactly they come from.

[Music]

"Now, the dictionary tells us that a plastic is any substance which is capable of being molded…but to the chemist, it is actually more complicated."

Ava:

To help us break down that complexity, we called up expert Jess Walthew.

Jess Walthew:

I'm an objects conservator at Cooper Hewitt, which is the Smithsonian design museum, where our collection contains examples of every kind of different medium. Historic through contemporary design and all different materials. You know, plastics are a big part of the collection. You can't tell the history of modern and contemporary design without plastics.

Burgess:

Okay so we've got to start with the obvious question which is: what is plastic?

Ava:

Yeah, it *seems* like a simple question. But I think for a lot of us, coming up with a simple answer is more complicated. Like I'm thinking about everyday plastic objects and what they all have in common. I mean, a lot of them are hard and shiny?

Burgess:

Yeah, but then something comes along and breaks the mold, and we're back to square one. Like I'm looking at the plastic coating on all the wires in front of me right now, and they're not hard or shiny.

Ava:

Yeah, you're right. But we're not getting anywhere with this, so let's go back to Jessica.

Jess:

Sure so yeah, plastics is a very difficult word to define because we use it in a lot of different ways. So a dictionary definition would be both defining it as a material and also defining that material based on its functional properties.

Burgess:

Right. Plastic is a material that can be defined by what it's made of, or its chemical composition, and by what it does, so it's function.

Jess:

Conservators are very concerned about the chemical definition of, of different materials. So we would say plastic is a polymer. And there are lots of different polymers. Some of them… some polymers are natural polymers. So derived from creatures, parts of our bodies, the proteins that make up our hair, our skin, all of these different types of things. Those are also polymers.

Burgess:

So I promise we're not going to do deep dives into chemistry, but knowing what a polymer is is really important to understanding plastic.

Ava: Polymers are special because a polymer is essentially a super long flexible molecule. So they can be shaped and twisted without losing their properties.

Burgess:

I was admittedly terrible in chemistry, but this clicked for me when I read this great book by Susan Freinkel on plastics. She describes polymers as a super long string of beads. You can stretch them out or tightly coil them together- if they're stretched out you get flexible plastic like a squeezable bottle but if they're packed together, you get hard plastic.

Ava:

But as Jess was saying, not all polymers are created in a lab… think about the parts of animals we use for how flexible they are, like how gelatin is often made of animal collagen.

Jess:

Synthetic polymers are the things that we really associate with plastics. And in that case, we're talking about polymers that are derived typically from the oil and coal industries, and then manipulated through chemical engineering.

Burgess:

Alright so this is the plastic you're probably most familiar with: a synthetic polymer derived from petrochemicals. But that's just the chemical side of plastics, there's still the functional aspect.

Jess:

We're really thinking about things that have this property called plasticity. The main property is the ability to be molded, but it's associated with a lot of other things. Plastics are durable. They can be transparent, they're resilient, they can be shock absorbing. In the popular imagination, plastics can be anything. They're in everything. And that definition has gotten so muddied.

Ava:

Okay, okay -- but for the most part during this series, we're going to be talking about those synthetic polymers.

Burgess:

Exactly, but those synthetic polymers first came about because people were trying to create imitations of what are known as natural plastics.

Jess:

Natural plastic materials were usually coming from plant and animal sources. So animal sources we're thinking horn, tortoise shell, bone, and ivory. Horn, which can be cattle horn or also hooves from horses. Those are much more like everyday accessible materials.

Jess:

But when we think about tortoise shell, bone and ivory, we're looking at luxury materials. A lot of those luxury materials are very involved in imperialism and the colonial project. So European interest in these luxury materials and the kind of people who are filling their cabinets of curiosity, this is very, very intertwined with displays of power, wealth, and particularly imperialism. So that sort of a context in which the scarcity of these particular materials also lends them greater value.

Ava:

And you might be familiar with some of this story, because, hey, it's still happening. We've all heard of animals like elephants and rhinos being poached for their ivory. But ivory was a very big deal during the nineteenth century, and it's scarcity was becoming a problem.

Jess:

Well, modern societies have a tendency to really overdo it when things become fashionable. In terms of harvesting materials from the natural world. Sort of an understatement.

Burgess:
Ye, we're absolutely still doing that too. In the mid 19th century, this was becoming a big problem for one product in particular: billiard balls. And, this was news to me, but billiards was a huge deal (and big business) around this time. So this shortage was such an issue that Phelan and Collender, a major billiard ball manufacturer, offered up a $10,000 reward to whoever could come up with a substitute for ivory.

Ava:
And that's $10,000 in nineteenth century money?

Burgess:
Yeah, so over $200,000 today, which as you might imagine, got quite a few people thinking.

Ava:
Yeah, I can imagine!

Burgess:
So, an inventor named John Wesley Hyatt came up with a pretty good ivory imitation in 1869: celluloid. He never actually got the $10,000 prize, but he did kind of change the entire world.

Ava:
Celluloid is far from the plastics we know today, and it wasn't a perfect ivory substitute, but it was the spark that started massive innovation in the field of plastics.

Jess:

So, you know, the traditional sort of history, cultural history of plastics is that you start with these imitations and then you move towards substitutes and then you opened the Pandora's box and now plastics can be engineered to do anything you possibly want them to do. So these sort of substitute magical alchemical transmutations where you're taking plastic and making it imitate these other materials. That's one of the real drivers of experimentation in the plastics field early on.

Burgess:
So plastic began as a substitute for scarce, precious materials that occured in the natural world, it looked and performed like materials like ivory or tortoiseshell. And it made a lot of luxury goods way more accessible to the average person.

Jess:

I think maybe what's missing from the conversation is that it was actually an eco-friendly development in some ways to create these plastic substitutes and that's something that's maybe lost and something to call out that a lot of the arguments for these synthetic plastic substitutes were to preserve wildlife. Not necessarily the main marketing tactics, but definitely a sort of a part of the whole story.

Ava:

There's a quote, I think Burgess and I are both obsessed with, that basically—it's a quote from an ad, that was like, "we no longer have to like torture the animals to get these goods. Like, we are free..."

Ava:
Okay so I got that quote wrong when we were talking to Jess, it's from an 1878 pamphlet, and it actually goes: "As petroleum came to the relief of the whale, so too has celluloid given the elephant, the tortoise, and the coral insect a respite in their native haunts; and it will no longer be necessary to ransack the earth in pursuit of substances which are constantly growing scarcer."

Jess:

It makes you wonder, like, who are you marketing toward? Was there an eco-conscious society that you were trying to appeal to here? Or is this really about a triumph of man over nature?

Burgess:

Yeah, knowing what we know now, that is such a wild angle to take. But, Man triumphing over nature is really the next chapter in our story, the one that begins after Pandora's box was opened. And this is where our story starts to feel a bit like a sci-fi film.

[Music]

Ava:
Welcome to the Fourth Kingdom.

[Sci-fi music]

Burgess:
Woah… the Fourth Kingdom is intense.

The Fourth Kingdom:
"Our modern complex industrial world has turned elsewhere to fulfill its needs. Turned to a fourth kingdom. A kingdom of scientific research, a new domain of man's own creation. A world of primary substances which never existed before."

Burgess:
It's hard to imagine the world before the chemical revolution, before man created a new domain. Society was limited by what nature gave from it's three kingdoms: plant, animal, mineral.

Ava:
Houses were made of wood, straw, stone or clay. Candles were made from animal fat or beeswax. Clothing was made from spun natural fibers or animal products. Things came from the earth, and when they had outlived their use, they returned to the earth.

Burgess:
But we can't fall into the trap of thinking everything was local and equitable. Societies in the west had been traveling across the globe taking all that they could from nature's kingdoms. You could guarantee that the stores on New York's 5th Avenue were well stocked with ivory from India and tortoiseshell from the Caribbean.

Ava:
And those animals that were being killed for their usefulness and luxury were growing scarce. But it wasn't just the luxury market that was fueling the need for new materials. Industry needed more rubber, iron and coal than the earth could provide. The mountains were becoming hollow and the jungle was becoming sparse.

Burgess:

Enter the era of the inventor—the press at the time touted the 'discoveries' of these great chemists. They were characterized as descendants of European explorers colonizing new worlds… but these were worlds of man's own making. Fortune magazine even printed a drawing of an imagined new continent called Synthetica, that included places like Rayon Island, the Isthmus of Natural Resins, and Formaldehyde River.

[Music]

Ava:
But it was here, in the real world, on the East Coast of the United States that this new class of inventors opened Pandora's box, introduced plastic to the world, and changed the landscape, our bodies, and our way of life forever.

Burgess:
And there was one man who perhaps represented this era better than any other...Leo Baekeland. Think of him as the Elon Musk or Mark Zuckerberg of the early 1900s.

Ava:
But unlike Mark Zuckerberg, he wasn't a Harvard dropout. He has a pretty stereotypical immigrant success story. He was born in Belgium to a shoemaker and a domestic servant. His dad wanted him to be a shoemaker too, but his mom thought he was too smart for that, and helped him go to night school to study chemistry.

Burgess:
When he came to America, he pretty quickly made it big. He spent a few years working for a photography company before going to work for himself. And this is where hits his first jackpot: he invented a new kind of photo paper, and sold that invention for a million dollars...in 1893!

Ava:
Okay so I looked that up, and that's 30 MILLION DOLLARS in today's money. That is SO much money!

Burgess:
I know, it's insane! And he was just getting started.

Ava:
Instead of simply retiring early, he used that money to fund more personal research into plastics. He considered himself an artist and wanted to keep trying to create new materials in his barn.

Burgess:
Around that time the biggest plastic in the game was celluloid, which remember, was first invented to solve that ivory billiard ball problem. But celluloid had a big problem too… it exploded. Now this

definitely made billiards more interesting, but it meant that celluloid just wasn't going to cut it in an industrial setting.

"Originally a cheap, plentiful and man-made substitute for ivory, celluloid, one of the earliest of plastics, made its way into the manufacture of novelties such as combs, toys, billiard bills, slide rules, and frames for glasses. But it had one serious defect. It could burn..."

Ava:
Baekeland was trying to create a plastic that could be used in engineering, something tough and durable, and something that certainly wouldn't explode. He believed that heavy machinery, more than luxury items, was where the real potential of plastic lay.

Burgess:
But unlike a Zuckerberg or a Musk, Baekeland was not particularly interested in becoming a mogul. We've got excerpts from his diary and he's always complaining about how much he hates business people and being in the office. Basically he's just a guy that wants to live in his laboratory and leave the rest to somebody else.

Ava:
So that takes us to 1907 when he started experimenting with the chemical composition for Bakelite—or phenol formaldehyde.

"The aristocrats of this new realm are the phenolic plastics, of which Bakelite resinoids are the first family…"

Burgess:
Okay! Another mini-chemistry lesson. We promise it's the last one of this episode.

Ava:
Take it away, Burgess!

Burgess:
So phenol, which was originally extracted from coal tar, but is now, like so many plastics, a petroleum by-product, was mixed with formaldehyde and pressurized.

"Dr. Baekeland put together two compounds of carbon, hydrogen, and oxygen. One, a preserving fluid called formaldehyde, and the other phenol, commonly called carbolic acid."

Ava:
Baekeland thought this tough, durable, non-explosive material would be perfect for the varnish that surrounds electrical coils. He had drawing after drawing imagining how Bakelite could be used in automobiles, or for other industrial purposes.

Burgess:
In the early 1900s, investors were interested in plastics that had very specific purposes, and that would replace a naturally-occuring material. So Baekeland thought that to sell Bakelite, he would have to sell a specific use.

Ava:
But Bakelite wasn't just a replacement for vulcanized rubber. It's problem was that it could actually do quite a lot of things.

Burgess:
But still, he went with his drawings for valve parts and bobbin ends to a presentation in front of industrial leaders in 1909. Think early 1900s Shark Tank.

Ava:
And it was there that Bakelite really became a game changer.

Burgess:
Oh yeah. What Baekeland had brought these Wall Street tycoons was a plastic that could be molded into anything and then hardened and polished. It wouldn't burn, or melt, or crack.

Ava:
And that made it great for valve parts. But it also made it great for a whole host of commercial goods.

Burgess:
And Wall Street noticed that.

Ava:
Flash forward to 1924 and Baekeland was what he never wanted to be: a businessman. And Bakelite,was being used for what he called, "fancy goods," that mostly didn't interest him. But money, as it so often does, had taken over his invention.

Burgess:
That year he graced the cover of Time magazine. And I mean his headshot took up the entire cover. He sat in a suit and tie, with small glasses and a lush mustache, looking every bit the dignified businessman. Under his name, Dr. Leo H. Baekeland, Time printed a quote: "It will not burn. It will not melt."

Ava:
Bakelite wasn't being sold as a single product anymore. It was being sold as the future. It was being sold as the building block of the Fourth Kingdom.

Burgess:

And with that, Pandora's box had been opened.

"Out of the discoveries and patents of Dr. L. H. Baekeland has grown a world-circling empire of plastics..."

Ava:
Bakelite could be used for almost anything. And it was.

"The industries must have the protection of chemically-resistant varnishes and paints. Furniture and product finishes demand gloss, lustre retention and durability… all types of these materials have the structure and resiliency necessary to withstand turning, drilling, threading, buffing...or any of the operations employed in machining metal."

Burgess:
But what Bakelite is most remembered for today are those fancy goods: the jewelry you might be able to find at vintage shops, and the radios that are now special collectors items. Baekeland scoffed at these uses of his material, but they were what introduced a generation to plastics. It's perfect curves and how it felt against the skin. The promise of plastic was limitless and affordable. The costs we think of now, those of human and environmental health, were far from anyone's mind.

Ava:

Bakelite is hugely important to the history of plastics because it did take us into a new world. It moved plastic away from just being an imitator. No longer were inventors trying to create something that felt like ivory or tortoiseshell. After Bakelite, plastic was able to stand on its own as a material.

[Music]

Ava:

The Monsanto House of the Future was only built 30 years after Baekeland posed for that Time Cover, and exactly 50 years after he first invented Bakelite. It's doubtful he could have seen our world coming or known exactly how powerful his creation would become.

"Is everything plastic? Almost…"

[Sci-fi Music]

Burgess:

Bakelite became famous for its durability, which on the surface is a great trait for a material to have, but durability can also mean indestructible, and everlasting. The story goes that when the House of the

Future became dated after about ten years, the wrecking balls that Disney hired to destroy it just bounced off, and instead they brought in chainsaws to cut it up into small enough parts to throw it in the dumpster.

Ava:

Those hacked up pieces of Tomorrowland might be anywhere now. But I think we can safely bet that they still exist.

Burgess:

Durability is one thing when plastic objects were meant to be used for generations, like Bakelite was, but that doesn't quite explain the world we're living in now...where many plastic objects are made to just be used once.

[Music]

Ava:

Join us next time to fill in another piece of the puzzle. We'll be talking about the era when plastics really came into their own...the 1950s.

[Music]

Credits:

Hello, this is Catherine Murphy from the HML team. Thank you for listening.

Trace Material is a project of Parsons Healthy Materials Lab at The New School. It is hosted and produced by Ava Robinson and Burgess Brown. Our project director is Alison Mears, and our research assistant is Olivia Hamilton.

For behind-the-scenes photos and more information, head to our website at healthymaterialslab.org/podcast. And be sure to give us a follow on Instagram @healthymaterialslab.

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