PLASTICS:

MAPPING THE CHILDHOOD OF MODERNITY’S WORST MATERIAL

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Abstract:

This dissertation, “Plastics: Mapping the Childhood of Modernity’s Worst Material,” traces plastic’s fall from grace, from its utopian interwar beginnings to the proliferative and detrital form it takes today. It seeks to answer the question of why certain plastics are regarded as disposable and finds the answer in part in children’s toys. Children’s toys are a vital manifestation to understand plastics as fit for disposal. Starting with a historical background in early plastics to set the stage for its later deterioration, it then takes three key thermoplastics – polystyrene, polyethylene, and polyvinyl chloride – and their key material interlocutors – pez dispensers, hula hoops, and pool toys – and demonstrates how the growth of the toy industry was intimately intertwined with changing ideals of consumption, obsolescence, and discard with respect to plastics. The pairing of polystyrene with foodstuffs is the subject of the second chapter, focusing on the intimate and intertwined relationship between toy and packaging. The role of the hula hoop in changing ideals of hygiene, and in the rise of the use of synthetic detergents, is the subject of the third chapter. Finally, the fourth chapter regards the role of polyvinyl chloride pool toys in teaching postwar children that plastic is a fundamentally ephemeral material, while indelibly associating it with childhood. This association meant that ultimately the material was infantilized, and one of the things that one discards when they “put away childish things.”

Dedication

This dissertation can only be dedicated to one person, my son, Thyme. He has provided the inspiration, drive, and meaning behind the words. It started with a pink plastic diary and ends with a seventeen-year-old kid who is wise beyond their years, who teaches me more about life and love, change and constancy, than anyone else ever has, ever. Their future is, and always has been, what I have had in mind when I write about plastics - the future that could have been, the future that still might be. My continued sense of optimism in the face of an uncertain future is for him.

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I want to first acknowledge the immense struggle it has been to get to this point. Here at the finish line, I look back like the angel of history and see the detrital remains of the past decade of my life. I started this journey in September of 2012, and I end it in the late days of 2021. A lot of life happens in nine years, but even by those standards this dissertation has been through a lot - a divorce, a displacement, moving home, a new relationship, a head injury, moving into the city, two strikes (one of them the longest in Canadian Labour History), a departmental restructuring, an adolescence, a transition, a Trump presidency, a #metoo and a #BLM movement, an engagement, and last (but certainly not least) a pandemic. While quoting Winston Churchill is not really what I wanted to do here, he was correct about at least one thing: if you're going through hell, keep going.

I couldn't have done this without an immeasurable amount of love, support, and patience from my friends and colleagues. My supervisor, Katey Anderson, deserves singling out for the immense amount of support, care, patience, (and at the right time) push to keep me going. Joan Steigerwald, Aryn Martin, and Jan Hadlaw were likewise incredibly insightful, helpful, and encouraging. This dissertation would not exist without them. Jeffrey Wajsberg provided so much help over the course of my doctorate that it would be impossible to stick to just one thank you - from my SSHRC application to a final readthrough, a thousand thanks wouldn't be enough. My colleagues in the STS program at York were all unbelievably inspiring and genuinely caring. In particular, I value so much the time I've spent with Aadita, Aftab, Cath, Einar, Ellie, Erin, Drew, Jordan, Nanna and Yana. I am sure I am missing people. You are all utter gems of human beings, and amazing scholars to boot. Outside of my program but no less important to my development as a human being and a scholar, have been Ingrid, Hined, Lee and Mitch and the rest of the NESTS network, Shayna, Oliver, AJ, Noa, Kate, Marlee and Nasra, and the rest of the Pandemic Dissertation Club. The PDC was a buoy in the stormy first days of the pandemic that I would not have survived without. Max Liboiron, as a plastics scholar, has provided the inspiration and the template for work in this field, which is unapologetically activist in nature, as if there were never a split between academia and activism to begin with. I hope to one day be a sliver as effective as they are for affecting change inside the academy and out. Outside of academia but no less important, have been my incredible friends: Brigid, Scott, Sam and Emily have all been there at every turn. My parents, of course, deserve more than I could ever repay them. My fiancé, Clay, has been an amazing muse, cook, step-dad, editor, and cheerleader, as well as learning nearly as much about plastic as I did as I bounced different ideas off of him throughout the crafting of these chapters.

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Plastics

Mapping the Childhood of Modernity’s Worst Material

Introduction: The Ages of Plastic

Figure i-1: A princess diary. From Google image search.

A pink plastic princess diary, sat on the edge of my desk with a tag from Value Village and some crayon decoration over the decals, started this dissertation.

My master's thesis, *Distributed Landfill: Living Materialisms and Junk Culture*, was an autoethnographic account of the stuff that we keep but do not use, written in a series of "onto-stories" to delve into the reasons we keep what we do, from that stuff's molecular composition to its place in the world. One of my central objectives was to access the affective reasons we keep some objects and throw out others, the thought process involved in that decision making, and the ways we value or devalue certain things. At the end of my thesis, after analyzing books, clothes, junk drawers, and paper, I was left with a strange and burning question: why can't I develop an affective relationship with plastic?

Materially, there should be nothing that stops me from developing that relationship. I should be able to value plastic objects in my life in much the same way I value wood, stone, or metal ones. But try as I might, I was unable to access plastic in the same way I was able to access metals, paper, cloth, or wood. I tried to remove all my preconceptions as an environmentalist, reminding myself that my prejudice against plastic was a product of many campaigns, readings, teach-ins, and direct action against the petro-cultures that dominate so much of our lives – plastic as ocean pollution, plastic as endocrine disruption, plastic as detrital proliferation, plastic as litter, plastic as capitalism. But even when I tried to remove all the real and rhetorical harms of plastic and access the material itself, I was unable – plastic was flat, light, surface. There was no depth ontology to plastic that I could find, despite years of reflection.

Having a child changed my relationship to plastic, as so very much of childhood requires plastic objects – from the car seat I brought my child home in, to the diaper they wore, to the bottle they drank from, to the potty they toilet trained on, to the dolls they played with, to the furniture they preferred. Plastic was virtually the only material my child touched on a regular basis. In the summer, of course, there were camping trips and outdoor play; but those too required plastic: the tent, the sleeping bag, the blow-up mattress, the stroller, the cooler for our lunches, the sand toys and buckets I took to the beach.

The objects that I value as an adult are, for the most part, made of "natural" resources – I automatically shy away from pressboard, microfibre, nylon, polyester. My underwear must be cotton. I despise wearing synthetic fibres otherwise, preferring cotton or wool to the point of prejudice. I move dry goods and other bulk food from their plastic bags and put them into recycled glass jars. My coats, my shoes, and my hats for winter wear are all wool or leather. I only begrudgingly wear my nylon "puffy coat" on the coldest of days, and only because I cannot, today, get away with wearing fur. I greatly prefer my potted plants in ceramic, terra cotta, or glass to the plastic pots they sometimes must live in for lack of a better option. I drink out of and eat off ceramic or glass. Never plastic. As soon as my child was old enough, all the plastic tumblers and plates I acquired over their childhood were immediately donated in preference for the glass or ceramic dishware that "the adults" use.

As my child has gotten older over the course of this dissertation, the plastic objects that surround them have become fewer and fewer; as they pick up art and music as their two main passions, the beautiful wood of an acoustic guitar and high-quality sketchbooks become the two most ubiquitous things they interact with. Beyond the common-sense arguments of plastic being the inexpensive option, there are other value judgements being made here: plastic delineates what is childish and what is not. For my kid, the beginner sets of paint brushes, the brightly coloured markers, and the plastic paint pots that come home after their twelfth birthday party at their grandmothers' are now rejected for being too "babyish," and requests are made for sable brushes, glass ink pots, and high-quality wooden pencils. There is still plastic, naturally, but it is a muted plastic, plastic that does not announce that it is plastic, plastic that pretends to be otherwise. Dark colours and matte surfaces denote quality, in converse to the bright and shiny surfaces of the Crayola markers that were so prevalent a few years before. And I wonder: Is the rejection of plastic a rite of passage in the twenty-first century? Is it what we discard when we "put away childish things"?

These questions sat in the back of my head for an entire year between my master's and my PhD. I finally decided that the only way I was going to satisfy my curiosity of why I cannot access any sort of affective relationship with plastic was to dig deep into its history, so that I could comprehend how we recognize plastic as being the material we love to hate. The product of that quest is contained within these pages: They are the intertwining stories of the unintelligibility of what we understand as plastics, the bewildering array of materials that have been labeled with that term, the wartime projects that scaled the ingredients for the elaboration of the consumer subject postwar, and the ugly proliferative wasting of those resources under the guise of convenience and profit. I found that not only was childhood heavily plasticized in the baby boom years of 1945 to 1970, but plastic toys in particular taught people how to devalue and discard the plastic provisions that were previously regarded as the miracle materials of modernity. The way that we understand plastic is indelibly rooted in our collective understanding of the transience of childish things.

The length of a PhD necessarily means that your life continues outside of it, and my life is no exception to that. My PhD was interrupted midway by the dissolution of a partnership, home, and life. My child and I moved, pink plastic diary (and everything else) in tow. The decisions I was required to make (in that move, and since then) have made stark the fact that, as a mother, I am largely the arbiter of what stays and what departs the domestic realm. I spend a truly enormous amount of time and energy making those decisions: from weighing the relative attachment my child has to an object against its age appropriateness; to judgements on size, style, ease of care, and projected weight loss or gain; to space and storage considerations; and to every other factor imaginable. Those decisions are often dictated and predicated on the perceived quality of materials. And in those moments, if it is a question to keep the plastic object or one of a different material, the non-plastic object nearly always wins.

It occurred to me, eventually, that much of the domestic labour I do in a household is this kind of work. When consumption and convenience-above-all-else are ideals, the decisions of waste and wasting become paramount for this ideology to reproduce itself. Disposal is so important in a household, particularly one with children, that to neglect it is seen as neglecting the children within – not throwing things away that are perceived as trash is considered a valid reason to call child protective services, for example. The ways in which disposability is fundamentally co-constituted with care is played out even more acutely in the case of plastics, as our primary relationship with plastics is through the disposability/recyclability nexus. That is the association we have with plastics: a paternalistic admonishment to recycle as much as we possibly can, lest the plastic end up in our oceans, our parks, and our bodies. The expectation that we know the universal code numbers found on the bottoms of many plastics encourages us to labour under the assumption that, with proper stewardship, plastic will be disposed of responsibly and turned into other material goods – as carpets, as polar fleeces, as decking – in some kind of re-birth.

In the meantime, curbside recycling programs allow us to gloss over the actual effects and devastations that plastics exact upon the world. Max Liboiron, in a short documentary about plastics waste, used the evocative description that "recycling is like putting a band-aid on gangrene."[1] I agree with them but want to extend the simile to the nurturance that is assumed by a bandage. As a mother, I have put many bandages on many little fingers, and I do it for the exact same reason I recycle: because far beyond the practical value, it is a symbolic expression of care. When recycling, we are not just attempting to put a bandage on an afflicted part, we are doing so as a wildly ineffective expression of how much we cherish the rest of the body. Even though the objects I focus on within these pages are largely toys, the story they tell extends beyond hula hoops, Pez dispensers, and blow-up pool toys. The chronicles of plastic playthings open a door to the feminization and domestication of plastics and, conversely, the paradigms of care and concern we perform to address them.

Domestication and Disposability: The Social Life of Plastic

The "Age of Plastics" is generally regarded to have started in 1979 when the worldwide production of plastic by volume surpassed that of steel.[2] Plastic manufacture continues to increase unabated, with the amount produced worldwide in the first decade of the twenty-first century surpassing the amount of plastic created in the *entire* twentieth.[3] Plastic has had devastating effects on marine, terrestrial, and human life, and some estimates predict plastic in the oceans will surpass marine life by weight by 2050.[4] Since 2009, bisphenol-A has been banned in Canada and California due to its xeno-oestrogenic potential, which contributes to decreased reproductive fitness and infertility, an effect that is both real and socially constructed around existential threats to masculinity and heteronormativity.[5] There is hardly a day that passes without some new and dire prediction of a world effectively drowning in plastic.

Understandably, plastics have become an increasingly central concern to a variety of scientific disciplines: marine biology, toxicology, and ecology, to name just a few. No one could defend the current uses and abuses of plastics, but the common critiques mobilized against plastics have social, temporal, and political bases, and to approach the plastics problem ahistorically or atemporally is a mistake. Since the late 1960s, plastic has been a metonym for artificiality and inauthenticity, standing in for everything that is wrong with the world.[6] Susan Freinkel, author of the popular book *Plastic: A Toxic Love Affair,*[7] writes in her contribution to the Smithsonian's Museum Conservation Institute white paper that "our history with plastic is a love affair gone wrong … today we are completely reliant on plastic even though we recognize that aspects of that dependence are not healthy for the environment or us. Such unhealthy dependence is the classic definition of a dysfunctional relationship."[8] Here we can see the anthropomorphization of plastic as a dysfunctional relationship. I want to understand *how* plastic developed as the material that we have come to know today and to show its many shifting identities in the process.

Plastic itself complicates efforts to think about it, as it is the first truly novel class of material the world has arguably seen since we began to alloy metals. Neither is it a stable object, as even 150 years since the invention of Celluloid, innovations in polymers continue to change how we understand the materials of modernity. The early notion that plastic is beyond grasp, a magical material transmuted from a black viscous liquid into a colourful, lightweight, and insubstantial object, has never completely left the common consciousness. Unlike other technologies, plastic does not display readily available mechanics we can understand; it presents as smooth, insubstantial, and whole. In this view, there is no depth with plastic, no inside, no underneath, as plastic is all surface. While one can draw diagrams and schematics of plastics moulding equipment, one cannot do the same with plastic itself, the only avenue to its comprehension a dizzying array of precursor chemicals, condensation reactions, and catalysts operating in a reaction vessel. Further, plastic – as a material – is defined against that which it is not. Today, there would be no "real leather" without vinyl, no "real glass" without plexiglass, no "real silk" without rayon. Walter Benjamin reminds us that "the authenticity of a thing is the essence of all that is transmissible from its beginning … [and] since the historical testimony rests on the authenticity, the former is jeopardized by reproduction."[9] Current cultural anxieties and obsessions about commodity authenticity – from handbags to sneakers to air pods – only exist insofar as there is a complementary fake or pirated form. Plastics have always defined themselves primarily by what they are not, rather than what they are, despite the sometimes-valiant efforts of those in the industry to establish a positive identity.

Beyond being able to think more deeply *about* plastic as an object, to think *with* plastic as a commodity is also a generative endeavour. Thinking with plastic destabilizes notions of both temporality and durability in the commodity world. Plastic is, at once, cast in instantaneous and eternal temporalities, in that the most transient objects in our society are made with a material that, paradoxically, never goes away. Its vanishingly short use-value – often only seconds long, once it arrives in consumers' hands – stands in sharp contrast to the eons it took natural processes to form the petroleum from which polymers are made and the millennial timescale of its breakdown after its disposal. Further, plastic packaging is *not* the commodity, though its use greatly changes the *appeal* of the commodity.[10] Partly for these reasons (amongst many others) a strict Marxist analysis of the political economy of plastic struggles to contain it. As Vance Packard points out in *The Waste Makers*, nearly every example he gives of disposability or planned obsolescence in 1960 refers to the increasing use of plastic parts, which "snapped or warped" what were previously durable appliances, for example the "throwaway plastic" of a disposable razor.[11] This trend has only increased since 1960, and today has become one of the only ways in which we understand plastics.

According to the anthropologist Arjun Appadurai, one of the most famous omissions in Karl Marx's *Capital* is an analysis of the commodity outside its commodity phase, as the commodity phase of an object does not exhaust its ontological status.[12] In contrast to Marx, Appadurai understands commodities at the intersection of temporal, cultural, and social factors, rather than just products of modern industrial economies. Appadurai's argument regarding the commodity being a simple phase of the object's life opens the possibility of being able to address the ways in which plastic grew and developed. Thinking about the "childhood" of plastic, in both material objects and temporality, therefore captures both the transience of the moment and its shifting development.

As a result of this dynamism, plastic, particularly as packaging but also as low-value objects like children's toys, needs a different set of critical toolkits to supplement an analysis of its political economy. Children's toys (and other small, low-value domestic objects) offer several advantages when it comes to studying disposability, as they embody both the short-term interests of an increasingly novelty-driven economy chasing the next rush and a key battleground for a more sustainable future. The *next generation* and *the children* are both commonly mobilized in environmentally emotive pleas, in what Lee Edelman calls a "reproductive futurity."[13] The ways that reproductive futurity is mobilized in both environmentalism and consumerism allow for a convergence of the two discourses, where the schizoid experience of being a parent today demands both an unbridled consumption and near-perfect environmental stewardship.

Waste – and wasting – under capitalism are essential to its perpetuation, as consumption must continually accelerate to "grow the economy." In addition to this role, Martin O'Brien defines "waste [as] simultaneously a production resource and a consumption good: a bipolar object of political regulation and economic exchange."[14] O'Brien is pointing toward the fact that waste management has become its own billion-dollar industry under present-day capitalism, and that the active process of wasting can be regarded as "not a loss of value from objects but as a regulated exchange of value between objects: a framework or system for the conversion of value comparable to … a system of production or consumption."[15] Wasting is therefore a social process, and as O'Brien suggests, industrialized societies are "*rubbish societies* … whose modes of self-understanding, whose political, social and cultural systems are infused by a relationship to waste and wasting but which, at the same time seek to deny the very fact that wasting is the basis on which those societies are able to develop and change."[16] While O'Brien calls this system bipolar, it touches upon the schizoid aspect of parenting I referred to earlier – there cannot be growth without waste, but parents are expected to be near-perfect environmental stewards and strive towards the impossible "zero-waste" ideal.

Andrew Herod helpfully expands upon the language of wasting when he differentiates between devalorization (when a commodity is used up) and devaluation (when new objects replace the former before the end of their useful life).[17] Plastic quickly encounters devaluation, but that devaluation is separate from its devalorization. Postwar American capitalism depends on the quick devaluation of plastic, which is simultaneously never "used up." Appadurai's life history approach is therefore useful when considering materials like plastics, which spend most of their lifespan as discard. Discard has become more prominent as a research subject in the past twenty years, even spawning a nascent discipline, "Discard Studies," as disposability crises have mushroomed across the world. This locus of concern has sought to rectify O'Brien's assertion that the "social processes through which wasting is organized are under-researched and under theorized."[18] Toy objects are a useful demonstration of the devaluation/ devalorization dichotomy, as they often carry enormous rhetorical weight in visual examples of waste. Toys are familiar goods that show the frivolity that goes into their creation and then, conversely, exposes the same in their discard. It is their recognizability that has them act as effective nostalgia-inducing articles, bringing the travesty of how we treat things into sharp focus. My study of plastic toys' role in the greater shift towards disposability uses the same rhetorical methods to examine the larger issues behind the rise of disposability and takes an underexamined area of social inquiry as well as several underutilized material interlocutors – small plastic toys and other domestic objects – and combines them to show how they form a crucial stepping-stone to our current plastic crisis.

Plastics' social histories, however, cannot be easily separated from their material ones. There are specific material realities of plastics, beyond what I have touched upon thus far, that dictate the ways we understand, interact with, and waste and discard plastic. A base level of plastics literacy is therefore essential for understanding the material history of plastics. This subject is therefore what I turn to next.

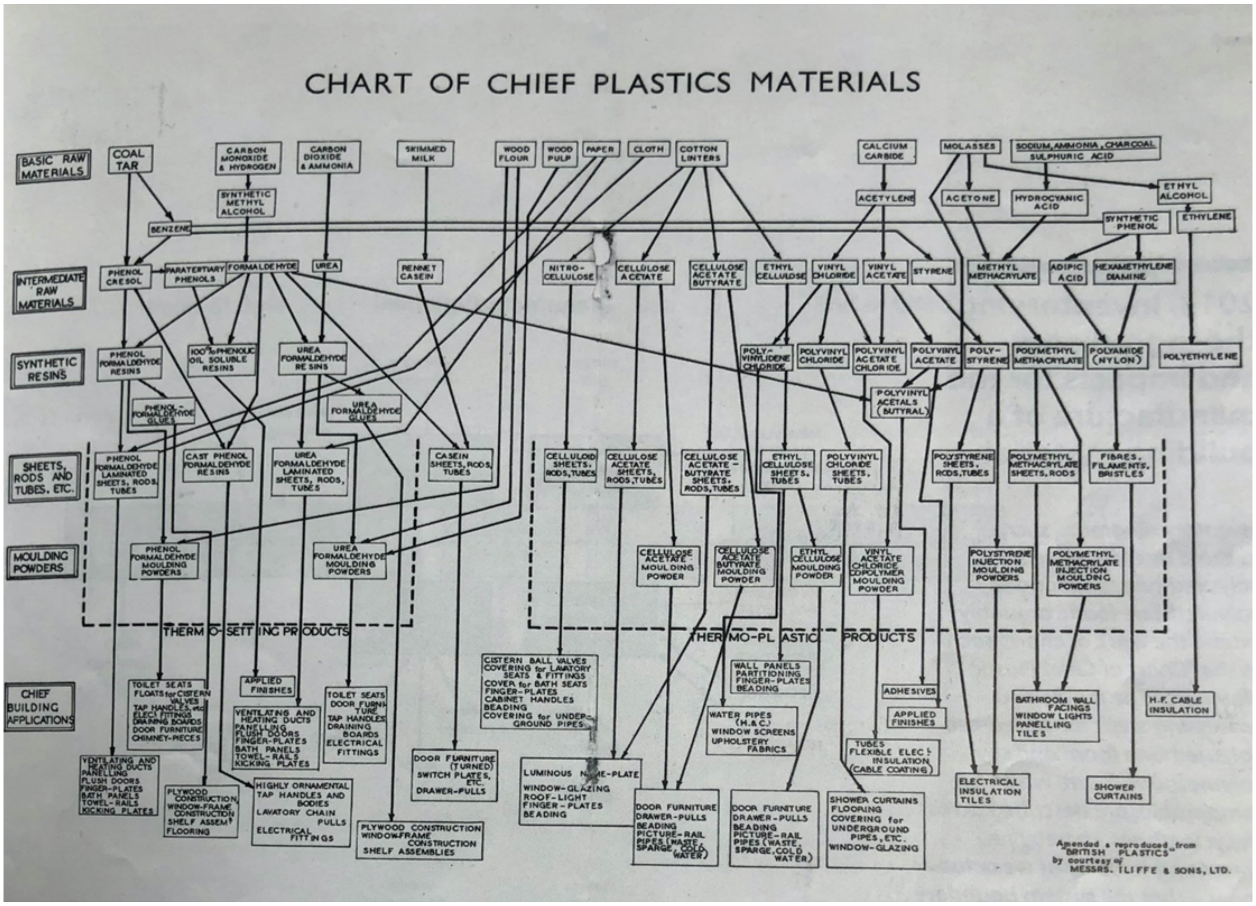


Figure i-2: Chart of Chief Plastics Materials. From Post-War Building Studies No. 3, by a committee convened by the British Plastics Federation, 1944. Reproduced in Plastics Now: On Architecture's Relationship to a Continuously Emerging Material *by Billie Faircloth, 47.*

To be able to understand plastics in anything other than the most superficial way, we must first comprehend certain terms and timelines in their development. The first and most important thing to understand is that to speak of the singular "plastic" means grouping together approximately 10,000 different types of plastics available today. "Plastic" as we know the term is an empty signifier: it has come to stand in for so many different materials that it references, at once nothing and everything. Talking about "plastic" as a singular noun obscures its complexity and inhibits public understandings of the materials.

In Billie Faircloth's excellent history and in-depth survey of plastics' use in architecture, she spends over fifty pages going through a comprehensive definitional exercise on plastics in the building and design industries.[19] Early on, she reproduces a chart taken from the British Plastics Federation's *Post-War Building Studies No. 3*, published in 1944 (Figure i-2 above). The purpose of the chart is to provide a sense of what the plastics industry can do for the building industry and a sense of where the growth markets will be postwar. I include it to emphasize the inevitable incompleteness and the gross simplification that follows; even in 1944, there were many, many more types of plastics than I have chosen to focus on. While a complete understanding of the breadth of the plastics industry is not necessary to engage with the arguments that follow, it is important to familiarize the reader with certain terms, classes of plastics, and manufacturing methods to understand the growth of the industry and how it reshaped the world. Figure i-2 gives a summary of the names, dates, and types of pertinent plastics, which will be elaborated below.

The first set of terms that need to be distinguished are not actually found in the chart: semi-synthetic and fully synthetic. The two types of plastics are instead distinguished by the groupings listed at the top of the “Raw Materials” column. The first three boxes contained coal tar, carbon monoxide and hydrogen, and carbon dioxide and ammonia, respectively. These, collectively, were considered the fully synthetic plastics, in that they come from the combination of two or more precursor chemicals that bear no similarity to the final product. Bakelite, the first fully synthetic plastic, was created by combining phenol – a white, crystalline solid originally synthesized from coal tar in 1831 – and formaldehyde – a clear gas under normal atmospheres – with heat and pressure to create a hard, infusible, and mouldable product.[20] Bakelite was seen as a material breakthrough of alchemical proportions. When Victor Frankl wrote about “industrial chemistry rival[ing] alchemy” and how “base materials are transmuted into marvels of beauty” in 1930, he was writing about Bakelite and its immediate cousins.[21] Bakelite and its like were the dominant plastics in the interwar years, which is evident in their prominence in the chart. Many of the art-deco and machine age designs from the era for radios, telephones, and other appliances were moulded of Bakelite.

The next six boxes contained skimmed milk, wood flour, wood pulp, paper, cloth, and cotton linters, respectively. These encompass both filler for phenol formaldehyde and its derivatives (in the case of wood flour, wood pulp, and paper) and the precursor chemicals for semi-synthetic plastic. Semi-synthetic plastics come from a chemical modification of an existing natural resource for the listed thermoplastics. The first commercially successful semi-synthetic plastic was Celluloid. To create Celluloid, one adds nitric acid to cotton linter and then dissolves it in alcohol, which causes a chemical reaction much like the addition of eggs to flour to create dough. This category of plastic also includes casein, an odd border category material, as it is derived from a natural resource (skimmed milk) but also uses formaldehyde to change its composition far more extensively than other semi-synthetic plastics. Retrospectively, it is considered a semi-synthetic plastic, but in 1944 it was put in a category of its own.

The second set of terms are in the two dotted line boxes that designated two product types: thermosetting and thermoplastic. Bakelite is a thermoset material, which means it cannot be re-melted and re-formed because of irreversible chemical cross-linkages (as one cannot change the cake back into dough and make cookies instead, to revisit the baking analogy). This is called the curing process. Thermoplastic materials, by contrast, are more analogous to wax. Thermoplastics can, in principle, be re-melted and re-formed indefinitely (though not always with the same properties as the original material). Thermoplastics are therefore the only plastics that are theoretically recyclable, though recyclability also depends on other a myriad of other factors like additives, plasticizers, and plastic types.[22]

Now that I have established these four crucial terms and related their relative importance to the plastics industry in 1944, let's examine the top right-hand corner of the chart. This corner holds the three plastics of my project – polyvinyl chloride (and its close cousins polyvinylidene chloride [PVDC], known better by its trade name "Saran," and polyvinyl acetate [PVA], known as Vinylite), polystyrene, and polyethylene (not yet divided into the high- and low-density designations). The oldest of the three plastics pictured here was eighteen years old (polyvinyl chloride, introduced in 1926 and better known at the time as Koroseal). The youngest was six (polyethylene, introduced in 1938 and known as Polythene, was still under a shroud of secrecy due to military usage in radar applications). The third, polystyrene, was seven years old (introduced in 1937 as Styron). These are the dates that I take as their "births," rather than their conception, as all three plastics have complicated pre-histories, discoveries and re-discoveries, and production process woes before they were able to be successfully scaled as consumer goods.

Plastic:	Initials:	Tradename:	Conception:	Birth:	Company:
Polyvinyl chloride Polyvinylidene chloride Polyvinyl chloride/ acetate copolymer	PVC PVDC PVC & PVA copolymer	Koroseal Saran Vinylite	1872 1933 1933	1926 1939 1939	BF Goodrich Dow Chemical Carbide and Carbon Chemicals Corp.
Polystyrene	PS	Styron	1839	1937	Dow Chemical
Polyethylene Low-density polyethylene High-density polyethylene	PE LDPE HDPE	Polythene Polythene Various, including Hi-Fax, Alkathene, Ziegler type and Phillips type.	1898 “ “ 1953	1938 “ “ 1957	Imperial Chemical Industries Max Planck Institute for Coal Research/Phillips Petroleum

Figure i-3: A simplified chart of the fully synthetic thermoplastics in this analysis.

As can be seen by the complexities of this chart, talking about plastics is difficult. Taking a few plastics from a field in its absolute infancy, before all of the bifurcations, formulations, splits, trademark wars, and modifications that were to come postwar as the industry grew and diversified, and attempting to simplify the terminology as much as possible (for example, by not including their chemical formulae or resin identification codes), we still end up with three different names for each of the plastics – their tradenames (Koroseal, Styron, and Polythene), their initials (PVC, PS, LD/HDPE), and their generic names (vinyl, polystyrene, polyethylene). Further, after only eighteen years, polyvinyl chloride has trifurcated into PVC, PV-C/A, and

PVDC. This is the converse of the work that the singular noun "plastic" does in obfuscating difference in the arena of plastics. The rapidity of change in the industry throughout the twentieth century has made anything but a singular noun very difficult to grasp.

I have focused on these specific plastics as they were all birthed in the interwar era. All were products of research and development by major chemical companies, and each of these plastics experienced a significant supply-side–driven scaling of production during World War II through government military contracts. After the war, those cancelled contracts led to large, underutilized plant infrastructures searching for new consumer and commercial markets mid-century. Ultimately, these three plastics found substantial outlets for their postwar industrial capacity in children's toys during the halcyon days of the baby boom when the concept of the child consumer was being explored, elaborated, and exploited. They eventually became important in disposable packaging applications as the children of the baby boom grew up into fully fledged consumers at the end of the 1960s and in the early 1970s. The three can also be used to track the introduction of plastic into toy boxes and kitchens and to show how this informed changing notions about plastics' identity, as each has an iconic toy associated with their dissemination into childhood. Pez dispensers, pool toys, and hula hoops respectively form important bridges between durability and disposability. Finally, polystyrene, polyvinyl chloride, and polyethylene are amongst the most produced plastics in the world today, with much of their manufacture going towards single-use products, and they make up most of the plastic waste in the ocean and on land. They are now, ironically, the problem children of the plastics industry.

Literature Review: Materialities, Environments, Technologies, Economies

As there are many different threads of scholarship that intersect with the materiality of plastics and toys in postwar baby boom America, my approach is interdisciplinary by choice and necessity. I pay critical attention to the material and technological trajectories of plastic to analyze what greater social, environmental, and economic forces were at play in how they became devalued and disposable. I situate those trajectories in a particularly evocative time and place – North America in the years immediately postwar – and follow the trajectory up to the birth of contemporary environmentalism and the recycling movement (1945–1970). Science and technology studies (STS) provides a theoretical framework that allows for a nuanced and multi-faceted approach to all the different and proliferating uses of plastics during this period. The works on critical plastics scholarship I cover first below draw their influences from the larger disciplinary nexuses of environmental, discard, and material culture studies. I will discuss plastics in environmental studies and environmental health, with a specific focus on how endocrine-disrupting chemicals – particularly those found as leachates from polyvinyl chloride and by-products of polycarbonate manufacturing – pose a nascent reproductive threat. I will then consider plastics in the context of recycling and waste management, highlighting some of the problematic paradigms extant in mainstream recycling discourses. Finally, I will suggest that an approach that takes advantage of material culture studies is a useful counter-tactic to those problematic paradigms. STS provides a model for the integration of these three disparate fields by offering accounts that situate large-scale technologies, particularly from the Cold War period, in their social, material, and political contexts. As such, I intend my dissertation to be unique in its contribution to both critical plastics scholarship and STS in that it will focus on the ways in which plastic toys and other domestic objects developed – as both a petrochemical technology and a material for teaching discard.

When I looked to the literature on plastics, I found there is a general dearth of scholarship surrounding plastic as a cultural artifact, with most scholarship focusing instead either on the technical aspects of plastic preservation in the context of museum studies, technical and scientific texts about plastics chemistry and manufacturing, or the ever-growing problems with plastic pollution.[23] There are a few notable exceptions, however, which provide much of the background and scaffolding that my current project rests upon.

The first foray into a rigorous history of plastics was published in 1963 by Morris Kaufman, though there had been popular and technical works that preceded it.[24] Funded by the Council of the Plastics Institute for the occasion of the Plastics Centenary Year in 1962, Kaufman's text is a surprisingly rich history of the early days of plastics, focusing initially on the British invention of Parkesine, a semi-synthetic plastic material that preceded Celluloid by nearly a decade. It is a foundational text that continues to be a touchstone for other plastics historians.[25] Kaufman was largely the sole academic who published on the history of plastics for the next twenty years, his next two books being *Giant Molecules: The Technology of Plastics, Fibers, and Rubber* (published in 1968) and the *History of PVC: Chemistry and Industrial Production of Polyvinyl Chloride* (published in 1969).[26] These early texts, proximal to the events and written during the time period I am interested in, can be read as both primary archival and secondary source materials, in that they capture vestiges of the utopian modernist vision for plastics as well as the increasingly defensive attitude toward their devaluation common to the childhood of plastic. Kaufman was later one of the founding members of the Plastics Historical

Society in 1986. Their publication, *The Plastiquarian*, remains the sole journal devoted exclusively to the histories of early plastics.

The first American publication on the history of early plastics was Robert Friedel's *Pioneer Plastic: The Making and Selling of Celluloid.*[27] His account of the development of the first commercially successful material in the lineage of modern plastics is an early (and often overlooked) text that nonetheless details the historical, social, and economic environment that proffered the invention of Celluloid in the second half of the nineteenth century. Friedel and Kaufman both figure prominently in my discussion about "plastic language" in chapter one as the invention and dissemination of Celluloid – also known as cellulose nitrate and various other trade names – are essential to understanding the ways in which the language surrounding the material was moulded.

The most comprehensive history of the American plastics industry written to date is Jeffrey Meikle's *American Plastic: A Social and Cultural History*.[28] Meikle's text is breathtaking in both its depth and scope, giving an overview of an industry from its very beginnings to the present day. Meikle had been writing about plastic in the context of industrial design since 1979, but his first dedicated foray into the topic can be found in the edited volume *Imagining Tomorrow: History, Technology, and the American Future.*[29] There, he begins to develop his thesis surrounding the utopian vision of plastics within the context of the American machine age (1920–1950). Important to my argument about the co-constitution of the feminization, infantilization, and devaluation of plastic, Meikle's earlier works look at the re-design of many household objects as a way of stimulating sales during the Depression. This led to the accelerated obsolescence of goods before their devalorization. From this observation, Meikle develops the concept of "thermoset utopianism" that dominated in the interwar years (1919–1939). Plastic was a material that spoke the language of modernism and held unlimited potential in its grasp, and much of the postwar devaluation of the fully synthetic thermoplastics can be contrasted to that heady time. The images from *Fortune* magazine at the beginning of the next chapter both capture thermoset utopianism at its zenith and beg the question of whether a different trajectory for the material that everyone loves to hate was possible.

The question of the trajectories of plastics is addressed by Billie Faircloth's *Plastics Now: On Architecture's Relationship to a Continuously Emerging Material*, which surveys forty years of mentions of the word *plastic* in architectural journals to map the rise and fall of plastics in building applications.[30] While enormous amounts of plastics are used in building applications currently, they are mostly hidden and used in internal applications; they are not the frankly synthetic forms such as those used for the Monsanto House of the Future that debuted at the National Plastics Exposition in 1956 and resided at Disneyland from 1958 to 1968. Faircloth largely argues that we continue to lack an "all-plastics" moulded and modular architecture, despite the obvious advantages of using plastics in building materials: amongst other things, plastics that could be used for building are virtually earthquake-proof, impervious to water, highly insulating, and able to be endlessly flexible according to the changing needs of a community.

In addition to the limited historical scholarship on plastics, there is also a small amount of philosophical and political scholarship on plastics before the explosion of discard studies in the past decade. By far the most influential is the short missive *Le Plastique* that Roland Barthes included in *Mythologies*.[31] Only two pages long, it nonetheless captures the feeling that plastic somehow fundamentally changed how we regard materials. In his words, the "hierarchy of substances is abolished: a single one replaces them all: the whole world *can* be plasticized."[32] Barthes wrote those words after watching an injection moulding machine at a trade show spit out small plastic toys. While Barthes does not make clear whether he thinks the abolishment of the hierarchy of substances is a good or bad thing, it seems that he was incorrect in his conjecture: instead of abolishing the hierarchy of substances, plastics were taken up in capitalist economies at the bottom of the order.

The ways that the hierarchy of substances is taken up in capitalist versus socialist economies are the subject of a much later book called *Synthetic Socialism: Plastics and Dictatorship in the German Democratic Republic* by Eli Rubin. Rubin draws attention to the "Year of Consumption and Chemicals" (1958) in the German Democratic Republic (GDR) as a way of highlighting the ways that plastics played a role in selling socialism to a public who had long become weary of the austerity of the socialist experiment. Under the GDR, plastics were considered utopian materials regarded as an equalizing force: anything could be made from plastics, in quantity, even without an existing colonial base for natural resources, and therefore everyone could have everything they needed.[33] Whereas plastics were used to increase consumption under capitalism by creating and marketing new wants, plastics were used to address needs equitably under socialism, and it was therefore never devalued in the same way until far later when the cultural influences of the West became dominant. When the influence of the West became incontrovertible, plastics were then devalued as part of the socialist project.[34] While plastics became devalued in both the West and the East, it was therefore for very different reasons: one became a feminized and infantilized plastic in a patriarchal society, and the other became a socialized material in a society that now yearned for the class stratification of capitalism.

From the history of technology, there is an even smaller amount of plastics scholarship. There is Wiebe Bijker's account of Bakelite, in which he uses the idea of technological frames and inclusion to argue that Baekeland's invention of Bakelite required the inclusion of several different disciplines in which he had already had success. Bijker notes that Baekeland's dominance in the field of early plastics allowed him to "construct not only a new plastic but a specific historical account of that invention."[35] Baekeland's dominance in the thermoset field was central to the thermoset utopian vision of plastics during the interwar years, as I will show in chapter one below. Karl Mulder and Marjolein Knot similarly analyze polyvinyl chloride through Thomas Hughes's systems approach to map the various criticisms of polyvinyl chloride as health and environmental hazards.[36] Mulder and Knot seek to comprehend the ways in which polyvinyl chloride became entrenched in the plastics industry and to propose ways it may become de-entrenched. As polyvinyl chloride is the biggest "problem child" of the three plastics I examine, particularly with respect to the carcinogenic vinyl monomer and endocrine-disrupting plasticizers, Mulder and Knot's article is increasingly relevant and was ahead of its time.

In the past decade, there has been an eruption of critical plastics scholarship, particularly in the context of discard studies, a nascent field founded by Robin Nagle and driven online largely by Max Liboiron.[37] Liboiron is a dominant voice in discard studies, and their book *Pollution Is Colonialism* promises to be a foundational contribution to the conversation about the uneven harms that marine pollution, including plastic waste, exacts on Indigenous communities, especially those relying on fishing for their survival and livelihood. Otherwise, critical plastics scholarship has been in large part led by Gay Hawkins, an Australian scholar whose work with the new materialism of waste has translated into several monographs, including *Accumulation: The Material Politics of Plastic* [38] and *Plastic Water: The Social and Material Life of Bottled Water.*[39] She is currently working on a project called "The Skin of Commerce" that is "exploring the history and politics of the relationships between plastic and food post WW2."[40] This politically engaged, intersectional, and activist scholarship sits at the interstices of environmental science, new materialism, post-colonialism, and policy, and it is extremely important to addressing the ways in which plastic has become an enormous environmental and cross-species health problem, especially in marine environments. The dominant plastic waste discussions in environmental studies and in general, in contrast, have minimally intersected with the question of *how* the world came to regard the material as they do, focusing on an ahistorical account of current harms. My project is part of the scholarship to rectify that research gap through recognizing the ways that the feminization and infantilization of plastic contributed to its perceived disposability.

The study of plastic is integral to two trajectories in the fields of environmental studies and environmental health: first, the study of poisonous and/or endocrine-disrupting chemicals as a reproductive and environmental threat and, second, the study of plastic pollution and waste. It is worth emphasizing that both fields originated roughly in the period under investigation, so plastic must be analyzed at once as an object of and influential historical factor in these discourses. The first of those trajectories is environmental health, the study of which was inaugurated by Rachel Carson's *Silent Spring*.[41] *Silent Spring* was a devastating account of the harms that DDT has had on songbird populations (hence the "silent" spring), as well as its bio-accumulative effects on other species (including humans). Selling more than six million copies and translated into thirty languages, *Silent Spring* is credited with initiating the second wave "grassroots" environmental movement and inspiring the Environmental Protection Agency and the Clean Air and Water Acts of the 1970s. Carson, like Kaufman above, can be read as both a primary and a secondary source, as its publication in 1963 would have influenced the eldest postwar babies, then in their late teens.

While the environmental health movement started with a focus on either carcinogenic or mutagenic chemicals, often concentrating on dump or industrial sites (i.e., the "Love Canal" disaster and superfund site), the shift of concern to potential endocrine disruptors being leached from various plastics and other persistent organic pollutants (POPs) like poly-chlorinated biphenyls (PCBs, found in older generation transformers and via widespread contamination in industrial and natural environments) became far more prominent in the mid-nineties with the publication of the bestseller *Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story*.[42] In it, the authors forward and popularize the endocrine disruptor theory of environmental contamination, advancing the idea that exposure to certain plastics threatens not only the current generation but also all future generations of human and animal life. Here, the idea of the U-shaped dose-response curve is popularized, research that eventually led to the banning of polycarbonate baby bottles as a potential source of bisphenol-A in Canada in 2010.[43] Polyvinyl chloride toys (especially soft toys meant to be put in babies' mouths) are also a source of potentially endocrine-disrupting phthalates and have been the target of successful Greenpeace campaigns to ban their use, with George W. Bush signing it into law in 2008.[44]

The other trajectory in environmental studies is that of plastic pollution and waste being/generating an aesthetic blight. While these two trajectories are not mutually exclusive, as waterborne plastics will leach endocrine-disrupting and carcinogenic chemicals into the marine environment, they should not be conflated. Marine plastic was first observed by the Woods Hole Oceanographic Institute in 1963 and, since then, has ballooned into a massive problem for all levels of the marine biological food web.[45] Plastic on land, however, has had a more ambiguous determination, as it is enacted as primarily an aesthetic problem.[46] Terrestrial plastic pollution is the most visible type of pollution and is used repeatedly as a metonymic device to signify the anthropo-scenic impurities of the “natural environment.” The possibility of returning to a romantic, prefigurative nature-sans-humanity (or of the pure and unpolluted individual body that popular conceptions of “plastic-free” living have forwarded) has become a shorthand to deflect responsibility for our degraded present, as it individualizes rather than socializes the idea of a world without plastic. Nonetheless, waste material out of place has its own term – litter – and organizing strategies have been applied to it since it has existed as a material category.[47] The birth of the modern recycling and waste management movement, beginning from the first Earth Day in 1970, has had us picking up litter as a way of “helping” or “taking care” of our environment for the past fifty years, and it has effectively obscured larger issues of plastic pollution by focusing intensely on one less important, end-of-pipe, and individualized solution. A simple YouTube search on “plastic waste” will give literally thousands of hits of feel-good local and small-scale park or beach “cleanup days” with the obligatory smiling children "making a difference" and "taking care of mother earth." The way that terrestrial plastic pollution is also often used as a metonym for climate change, although the two have little to do with each other, means that recycling plastic, which is far more carbon intensive than burying it, gives people an excuse to feel as if they are, again, doing their part. [48]

However, as Samantha MacBride points out in *Recycling Reconsidered*, recyclability is a problematic paradigm, as its uneven and often market-driven development over the past fifty years has been largely due to an externalization of costs by corporations.[49] *Keep America Beautiful*, the purveyors of the (in)famous "Crying Indian" commercial launched the year after the first Earth Day, in 1971, was a lobby group composed of Phillip Morris and Anheuser-Busch, who wanted to fight against new reusable bottling laws being brought forward in Vermont's state legislature. Recycling individualizes responsibility for waste and obviates a sense of responsibility toward the more-than-human world, for as long as people are separating their paper from their plastic, they can consider themselves as being good environmental stewards.[50] Nonetheless, recycling is one of the most visible and successful triumphs of the modern environmental movement, having been adopted throughout much of the global north and acting as a metonym for environmental awareness.[51]

My attention to the problematic limitations of contemporary recycling movements is key to understanding the ways in which we relate to plastic more generally and toys in particular, as toys are rarely recyclable but often participate in second-hand economies, a waste paradigm that is largely privatized rather than state-run. Toys can therefore exist in a liminal state between recyclable and durable goods, and as such they can make visible the tensions and shortcomings of both state-run and privatized recycling paradigms. Toys, by dint of their target market, are afforded special status in campaigns against endocrine disruptors because key developmental vulnerabilities are experienced disproportionately by children. Plastic toys can therefore be used to draw together disparate threads of environmental studies in a way that considers the effects of plastics on the levels of both the individual and the population.

MacBride's book is part of a growing lineage of works that fall into the purview of discard studies. Discard studies, as a transdisciplinary and critical approach to the study of externalities (i.e., waste products) to consumption, allows the externalities to be re-internalized into the consumption cycle and addresses their use in late-stage capitalism. Discard studies can trace its genealogy to the mid-twentieth century, when Packard's *The Waste Makers* first popularized the concept of planned obsolescence.[52] However, the first book to address discard studies as such is Michael Thompson's *Rubbish Theory.*[53] Recently re-released in response to enormous demand, Thompson's work traces the journey of objects from new purchases into eventual transience and trash and examines the chaotic ways that a reversal of value might take place, through nostalgia and memory, back to collectible, vintage, or antique status. The theory of an intermediary third place between transience and durability accurately describes today's collectible market and is more precise than the single temporal trajectory of object-to-trash, as there is no "outside" of valuation. Understanding this transitional third place of nostalgia and its role in collectible markets is essential to any study that uses vintage toys as its interlocutor, since much of the literature about small, quasi-disposable five-and-dime toys is written by and for private collectors. Many of the most complete texts with respect to toys manufacture, origins, and materials, are collector price guides, which I have used throughout.

Rubbish Theory marks the beginning of a far more developed scholarship that regards trash as liminal, socially contingent, and dynamic rather than a fixed and reified object, thus filling in a glaring omission in the Marxist formulation of capital and making it more relevant for the twentieth century, as much of the life history of a contemporary object is spent as waste, rather than as objects with use-value. These ideas are developed in far more detail by Herod et al., who posit that waste under recycling is as much a capitalist process as anything else and that to look at recycling or waste from a performative or post-structuralist perspective erases much of the "congealed labour" (that is, the labour that is required to deal with recycling) that goes into global production chains.[54]

As plastic is often metonymic for waste, it holds a special place in the field of discard studies. In *Plastic Water*, Gay Hawkins argues that the same polyethylene terephthalate (PET) bottle of water "can exist as a product, as a personal health resource, as an object of boycotts, as a part of accumulating waste matter, and much more."[55] Her book is about the marketization and privatization of water under a neo-liberal economy, but it is also about entanglements with all the partial and unfinished meanings of this multiply enacted object. Central to her concern is "how the political is performed and enacted in specific instances – how different actors deploy particular political categories and analyses in order to make bottled water a matter of concern."[56] While Hawkins dominates the discussion, her use of new materialism as an analytical frame often lacks an understanding of the waste flows of late-stage capitalism.[57] The reader is instead expected to understand plastic as "vital, complex and ironic" after Jane Bennett's formulation of new materialism, an approach that has been criticized for its tendency to devolve into commodity fetishism.[58] I hope that by elaborating the social, material, and historical circumstances that created plastics as the materials we know today that I will counteract the commodity fetishistic qualities of current plastics scholarship within discard studies.

In tracing the ways that plastics' competing trajectories as either disposable or durable materials were elaborated through the rise of plastics in children's toys, I hope to historicize and ultimately correct the deterministic notion that plastics are a scourge on humanity that should be eliminated entirely. Eradication is an unrealistic, if not impossible, goal. Given my project's time span, STS Cold War scholarship is also relevant to its arguments. Meikle argues that Cold War anxieties about technologies of mass destruction find their expression in anxieties about plastics, and a popular thread in Cold War scholarship is the way in which the ideologies of the Cold War contributed to the development and proliferation of large-scale technologies like nuclear arsenals, computer networks, and national surveys.[59] While plastics certainly could be analyzed as a large-scale disruptive chemical technology, their role in elaborating the American consumer subject is probably more important to understanding their history, as the proliferation of plastics is undoubtedly key in the consumer subject's creation. The seminal historical text about postwar consumption is Lizabeth Cohen's *A Consumers' Republic: The Politics of Mass Consumption in Postwar America*, but her focus is largely on the policies and advertising copy that made target markets possible and on how those consumptive stratifications eventually translated into a body politic of "Soccer Moms and Nascar Dads."[60] The major historical trajectories of plastics, however, cannot be separated from the elaboration of the American consumer subject as both a political and economic entity. The combination of Cold War formations, economic stratifications, and new political frameworks allowed a new type of civil society to emerge, one that is heavily reliant on both a new type of consumer – children – and a new type of product – disposable and plastic. As Bijker demonstrates so well with his accounting of the popularization of the safety bicycle, a myriad of social, material, and economic factors goes into the development and proliferation of any technology.[61]

Finally, as my project's focus will be on children's toys, it is necessary to address the few Cold War texts that use toys as similar interlocutors. Anne Marie Kordas, in her book *The Politics of Childhood in Cold War America*, argues that the child was a prominent political vehicle to encourage cohesion in American patriotism and anti-communist sentiment.[62] This argument, particularly with respect to its assumption of overarching conformity, is in direct contrast to Amy Fumiko Ogata's argument in *Designing the Creative Child: Playthings and Places in Midcentury America* that the American postwar child was primarily constructed as a creative force to compete with the perception of a highly regimented and conformist communist state.[63] Both Kordas and Ogata use toys to make their arguments, but both use highly selective data sets: Kordas uses the militarization of toys to argue for highly regimented gender roles, whereas Ogata uses educational toys sold at museums, like the Museum of Modern Art, to argue for an encouragement of original thinking. Ogata's discussion of the greatly proliferating plastic in toys during this time is relegated to a paragraph about certain subsets of the adult population where the idea of the toy as "tabula rasa" became popular to encourage imagination, and she attributes the rejection of plastic toys amongst this subset as too realistic and therefore not creative enough. However, the average postwar toy box consisted neither entirely of military toys nor of creative toys; it instead contained a myriad of assorted toys, mostly small and from the five-and-dime stores and mostly made of plastic. The sheer proliferation of plastic children's toys has not been addressed, and neither has the changing perception of plastic's identity in the creation of the grassroots environmentalism of the late 1960s and early 1970s. The liminal status of toys between durable and disposable, as well as their poor recyclability, reflects some of the paradoxes of plastics themselves. Their association with children captures both the marketization of every aspect of North American life as well as the uneven effects of the "slow disaster" of environmental toxins found in endocrine-disrupting chemicals.[64] My focus on the Cold War years allows me to draw parallels between the nuclear anxieties of the Cold War era and the environmental anxieties of plastic pollution, as well as trace the specific development of a material so ubiquitous today as to be nearly invisible and everywhere at the same time.

Strategies: Trade Literature, Collectors, and Museums

The interdisciplinary and transecting threads of scholarship elaborated above have supported my object driven approach, as my focus is both on the thing itself and on how the object relates to the people and culture who make and use them.[65] Material culture's transdisciplinary engagement means that the "subjects of study are ceasing to be compartmentalized into exclusive categories[.] … [C]urrent approaches are characterized less by what is studied … and more by the kinds of questions that are posed."[66] An object-driven approach allowed for a depth of understanding that would have been otherwise difficult to access in a material that is often "all surface." To understand my objects as anything other than commodities, I needed to trace what routes they took along the way to their ultimate dissemination through the toy and department stores of North America. Through visiting two archives – the Strong Museum of Play in Rochester, NY, and the Science History Institute in

Philadelphia, PA – I began to understand and construct the ways in which the two industries – plastics and toys – were elaborated throughout the twentieth century. Further, I was able to see the ways in which the two industries were linked through the milieu of trade publications.

To be able to understand any industry that was dominant in the mid-twentieth century, we must look at the ways in which trade publications were used, as the writers of which were what Daniel Thomas Cook calls "cultural brokers: persons who occupy strategic, gatekeeping positions in organizations and industries and who thereby adjudicate cultural products and meanings."[67] Viewing trade publications as a form of knowledge-making in the mid-twentieth century supports Cook's notion that "'commodities' … consist not only of physical materials but also of discursive materials forged by producers, retailers, and press in and through time[.] … [C]ommodity production … is never exhausted with the making and selling of its good. Rather [it] always implicates the existence of social statuses, identities, and images, indeed their creation."[68] As I previously observed, these discursive nodes allow me to access some of the life history of the objects at the material level, instead of only in their commodity phase.

To trace the manufacture of plastics from crude oil to the fetishized finished product, I have turned primarily to the foremost toy and plastic trade publications of the twentieth century, though I also used several other trade, consumer, and archival sources to round out the narrative. *Modern Plastics* and *Playthings* were the pre-eminent trade publications of their respective industries and had integral roles in informing how those industries grew and developed postwar. The first issue of *Modern Plastics* was published in September 1925 and was the first trade publication dedicated to the plastics industry. It was launched by a chemical patent attorney named Carl Marx and christened as *Plastics* in its inaugural issue. It focused at first on supplying technical information to fabricators and moulders and was largely bankrolled by the materials suppliers that advertised within it. The publication's name changed twice in the following decade, as its focus shifted from fabricators to end users: first to *Plastics & Molded Products* in 1927 and then to *Plastic Products* in 1933. It also changed hands from Marx to William Haynes, a prominent chemical publisher, after the stock market crash in 1929, and Haynes soon thereafter announced the intention to shift its editorial policies toward the industry's economic renewal. This idea reached its "logical extreme in 1934 after it changed hands again[.] … [T]he new owner, Charles A. Breskin, already published *Modern Packaging*, a visually sophisticated magazine organized around the premise that new packaging techniques and materials could sway consumer choices in a depressed marketplace."[69] It was only then that a final moniker was settled, *Modern Plastics*. Its redesign under Breskin was modeled after *Fortune* magazine, as he explicitly wanted a journal that would appeal both to the burgeoning plastics industry and to the consuming public. Functioning as "more than a trade journal and less than a trade association … it offered a unified identity glowing with modernity with which to face the outside world … [and] enabled [the plastics industry] to establish plastic as a primary medium of the symbiotic relationship between manufacturer and consumer."[70]

Playthings has a slightly longer origin story than *Modern Plastics*, its first publication appearing in 1903 to coincide with the first American Toy Fair taking place in New York City. Founded by Robert McCready, who kept the title of editor-in-chief for over forty years afterwards, it was generally considered the pre-eminent trade magazine for the toy industry throughout the twentieth century. [71] The American toy industry had been slowly challenging the long dominance of the German toy industry from the middle of the 1800s onwards, but its ascendency became clear in the early twentieth century. The industry's own lobbying association, the Toy Manufacturers of the USA, was formed in 1916, first as a way of asserting the essential service of toys in the wartime "home-front morale" category, so that toy manufacturers would be able to continue to access restricted materials to make their toys.[72] Throughout its history, the role of *Playthings* magazine changed from a folksy publication that announced weddings and births of children to a behemoth periodical that published five to six hundred-page magazines monthly during the peak baby boom years of 1945–1964. If there was a toy in the twentieth century that was sold on American shelves, it was most likely covered in *Playthings*.

Given their scope, trade publications provide an accessible overview to understand both the toy and the plastics industries in the absence of other corporate archives – the toy industry is particularly secretive, and so is the competitive postwar environment of the plastics industry. The postwar issues of *Modern Plastics* and *Playthings* both gesture towards concerns of the manufacturing, marketing, and dissemination of the plastic objects that became synonymous with childhood. As the growth of the toy and plastics industries closely map onto the same timeline, using the leading trade publications of the era has provided insight into how toys were marketed to the plastics industry and vice versa.[73] They have also allowed me to identify key players that bridge both industries. As Cook observes in his history of the stratification and growth of the children's clothing industry over the twentieth century, trade publications represent "the backstage of social encounters – a space away from the scrutinizing gaze of the general public where the work of erecting the façade gets accomplished." He also points out that the most fruitful reading of trade publications is as an "entrée into a historically situated semantic domain."[74] It is in this light that I draw upon the trade publications to see how plastics were understood, integrated, and expanded into the toy industry pre- and postwar and to examine how the toy industry, in turn, provided the entry point for disposable uses of plastics that still affect our relationship to them today.

The size and scope of these journals are gargantuan. *Modern Plastics*, thankfully, had indices that compiled every dedicated article written about toys and plastics from 1937 to the late sixties, including all "backyard" applications like pools and inflatables, which was invaluable to my ability to trace differing attitudes towards the use of plastics for toys and the shifting consumer sentiments of the plastics industry. I further examined all instances of plastic objects that had primarily domestic uses, especially those that were marketed heavily towards women. *Playthings* magazine lacked a similar index and was of far greater volume, which meant that my approach to this periodical had to be more strategic; I therefore focused on the issues published from January to March and from 1939 to 1964. The January issues had the advantage of summarizing and analyzing the Christmas season of the previous year, and the March issues coincided with the annual Toy Fair.[75] The Toy Fair issue was the largest and most comprehensive production of the year, often more than 600–800 pages, and was distributed to the attendees along with maps and instructions for navigating the fair. The annual Toy Fair was often when new innovations or products were announced, which further made it a valuable resource in my examination of when certain plastic toys were introduced. The Toy Fair issues therefore provide an archival snapshot for the fiscal year that followed them. I ended my review of *Playthings* in 1964, as by that point most manufacturing had moved away from North

America and the format of the magazine changed significantly to include licensing agreements with television producers and other media.

Chapter Outline:

In telling the postwar history of plastics' childhood, children's toys, and their contributions to our current perception of the materials' disposability, I must set the stage. My first chapter, "Plastics' Infancy," does that. It traces the development of early plastics, including vulcanized rubber, Celluloid, and Bakelite, to show how different aspects of each of these discrete industries converged in the invention of fully synthetic thermoplastics during the interwar period. Celluloid's thermoplastic designation and the imitative qualities of the objects made from it were in direct contrast to the thermoset Bakelite's association with relatively high quality, frankly modernist uses in the American machine age from 1920 to 1940. Bakelite's requirement for compression moulding, like Vulcanized rubber, further meant that it was primed for use in the automotive industry, in a way that Celluloid's flammability precluded. The evolution of the generic singular "plastic" during the same period meant that the plastics that are the focus of my project – those fully synthetic thermoplastics coming into being in the late interwar period and experiencing significant scaling during World War II – were wholly captured by the nominalized adjective "plastic" while the earlier ones were not. Their thermoplastic designation meant that they were more easily slotted into uses like other thermoplastics and mass production using injection moulding techniques.

The second chapter, "Just Hear That Styrene Tinkling: A History of Polystyrene, from Crystal Balls to Christmas Gifts*,"* centres on polystyrene, the first of the plastics I take up in the postwar period. Taking a Pez dispenser as a first interlocutor, I show how polystyrene was used as a material in a hybrid form of packaging that encapsulated both toy and food packaging. Ideal Toy Company's use of thermoplastics during World War II was led by Dr. Islyn Thomas, the general director of the company from 1942 to 1944. While Ideal Toy Company used plastics to create flutter valves for gas masks and proximity switches for bombs, Thomas's use of the scrap offcuts to make plastic toys meant that Ideal Toy Company was able to continue to produce high-quality toys throughout a time when there were significant restrictions on those materials. Thomas would go on to found Thomas Toy Manufacturing postwar, which became one of the largest purveyors of five-and-dime toys in the postwar era. His sale of the company in 1958, when much of toy manufacturing was moving offshore to Hong Kong, meant that his moulds were auctioned off to companies in the vicinity; through the similarities in their material form, one can see the direct line from the five-and-dime boats he sold and the "banana boat" packaging for banana splits popular in the early 1960s. Through postwar applications of polystyrene to Christmas ornaments, which also held candy, the lines were initially blurred between the durable ornament and the disposable packaging. That blurring found its full expression in the banana boats and continues to this day to find its expression in Pez dispensers.

The third chapter, "How Hula Hoops Changed Hygiene: From Damp Cloth Utopianism to Chemical Cleaning," looks at the ways that low- and high-density polyethylene changed hygienic practices in the postwar years. It starts from Earl Tupper's wartime invention of Tupperware while working as a sample maker at DuPont. Tupperware has specific hygienic implications, as it was marketed via the Tupperware party as a way of creating a sanitary and modern kitchen via what Meikle calls a "damp cloth utopianism."[76] Plastic toys were marketed, particularly in the years immediately postwar, as “sanitary.” Domestic cleanliness was extremely important in the early postwar years (1946–1955), as there were several polio epidemics, and there were concomitant sanitation narratives in the toy industry. In 1956, as the polio vaccine was disseminated, sanitation narratives began to disappear from the toy industry, and the Ziegler process was invented in the plastics industry.

The Ziegler process makes possible the other form of polyethylene: high-density polyethylene (HDPE). HDPE’s first introduction to the plastics industry – and the way that most North American manufacturers came to know the material – was through the childhood craze of the hula hoop in 1958. Whereas the scaling of polystyrene, polyvinyl chloride, and low-density polyethylene (LDPE) were wartime efforts, HDPE scaled through a toy craze in 1958. Soon afterwards, HDPE became *the* material used for packaging household goods like shampoo, laundry detergent, and cleaning chemicals. This was important because many chemicals that became standard cleaning products in the home were able to be packaged in HDPE, where packaging them in cardboard or metal resulted in corrosion or leaking and shortened shelf life. By then, plastics had completed their journey from the heights of hope for an unbreakable, permanent modernity to the ultimately transient material as we know it today: the stuff of one-season toys, food wrappers, and landfills.

The fourth and final chapter, “Summertime, and the Living Is Plastic: Polyvinyl Chloride and the Creation of a Summer Toy Industry,” uses quasi-disposable summer inflatables such as beach balls and float toys to show how, first, their material form rose directly out of applications during World War II, such as inflatable rafts and solar stills and, second, how their proliferation postwar created a huge secondary market for the toy industry, which had historically experienced a significant downturn during the summer season. That summer spending was encouraged to its fullest by the creation of a “backyard beach” culture that found its expression in the wholesome “beach blanket bingo” and Mouseketeer culture of the late 1950s and early 1960s, where vinyl sheeting manufacture allowed for ever-larger backyard pools (at ever-greater cost) in the suburban milieu of postwar America. As those children grew into adults, their rebellion into the shortboard surfing revolution of California meant that they found a nascent environmental awareness that included a rejection of plastic as being inauthentic, and that mapped on to their rebellion against their parents’ generation.

I will end with a reiteration of plastics as dynamic and diachronic materials, rather than the static and reified material we have come to take for granted, and with a recognition that the danger from plastics results from its uses in proliferative late-stage capitalism, not from the material itself. Finally, I will ask the question: who cares for plastic? As part of the domestic labour of the home, it increasingly falls to women to decide what stays and what goes into recycling and second-hand donating paradigms. Plastic’s infantilization requires it to be continually disciplined, tamed, remoulded, reshaped, and picked up after.

Chapter 1: Plastics' Infancy

Figure 1-1: Plastics in 1940: An American Dream of Venus. Fortune *magazine. October 1940, 88-9*

Plastics: Before the Fall

In October of 1940, *Fortune* magazine ran an issue devoted in part to the extraordinary growth of the plastics industry in the interwar years. The article contained two incredibly striking images (Figure 1-1 above; Figure 1-3 below). Throughout the 1930s, the magazine had featured several missives about plastics – some laudatory, some critical – but the 1940 article signalled a new phase of maturity for the plastics industry in the minds and imaginations of the portrayers of industrial capital.

Growth and development were the themes of the caption that accompanied the first fantastical two-page spread (Figure 1-1: "Plastics in 1940"). The description used a new-born metaphor to portray the industry's development: "somewhere between the years 1935 and 1940 the infant U.S. plastics industry turned an epochal corner. Where there were only ten plastics, there are now suddenly twenty … the total value of finished products [is put at] some $500 million – which isn't exactly nursery blocks."[77] It continued with the childhood personification: "This new era in plastics might be described as a 'difficult age.' When *Fortune* last reported on plastics, in 1936, its plaint was that plastics seemed to be immured … in a childhood garden of gadgets." Figure 1-1 made this "garden of gadgets" visible with a striking collage of decontextualized images that float, swirl, and twist across the page. The timing of this layout, immediately preceding the American wartime mobilizations that would create the conditions to change the landscape of material goods forever, was captured in a moment of childish anthropomorphization. The "garden of gadgets" born(e) out of a material in its "infancy" prefigures a material-semiotic linkage now taken for granted – plastic as childish, plastic as playful, plastic as frivolous.

The caption for this "garden" was evocatively titled "Call It 'An American Dream of Venus'" and likely referred to the eponymous Salvador Dali exhibition that appeared at the 1939 New York World's Fair (Figure 1-2).[78] The description below pointed out some of the objects in the collage, shifting its metaphoric range from childhood to the ocean: "dentures, doorknobs, gears, goggles, juke-boxes, crystal chairs,[79] transparent shoes and ladies rise up from the plastic sea." The central figure on the page, a headless plastic torso named Venus, was foregrounded in both the image and the text. In an inversion of Dali's exhibit, where semi-nude women swam around in large fish tanks, here Venus instead *contained* the sea – or at least some fish, plants, and sand that stand in metonymically for it – in a clear, fish tank–like body. The image signaled both the internment of nature in plastic and the invisibilities of the female form, encapsulated in a single vessel. With leaves strategically covering Venus's front and back nether regions she evoked Eve before being thrown out of the Garden of Eden, the first (plastic) woman. Given that Eve was also moulded from Adam's rib, the multivalent meaning of the transparent female form becomes clear. At odds with the holy imagery, the torso was also being cut in half by a saw, evoking the dainty assistants in magic acts who submit their bodies to being cut apart and put back together again. The "magic act" imagery was reinforced with the Queen of Diamonds on her breast. *This is trickery*, the image seemed to whisper, a sleight of hand that replaces the once familiar with the utterly new. This waterlogged Venus foreshadowed the current intractable issues that exist with plastic in our oceans. The transparent female form conjures the invisible force that the feminization of plastic played in its devaluation.

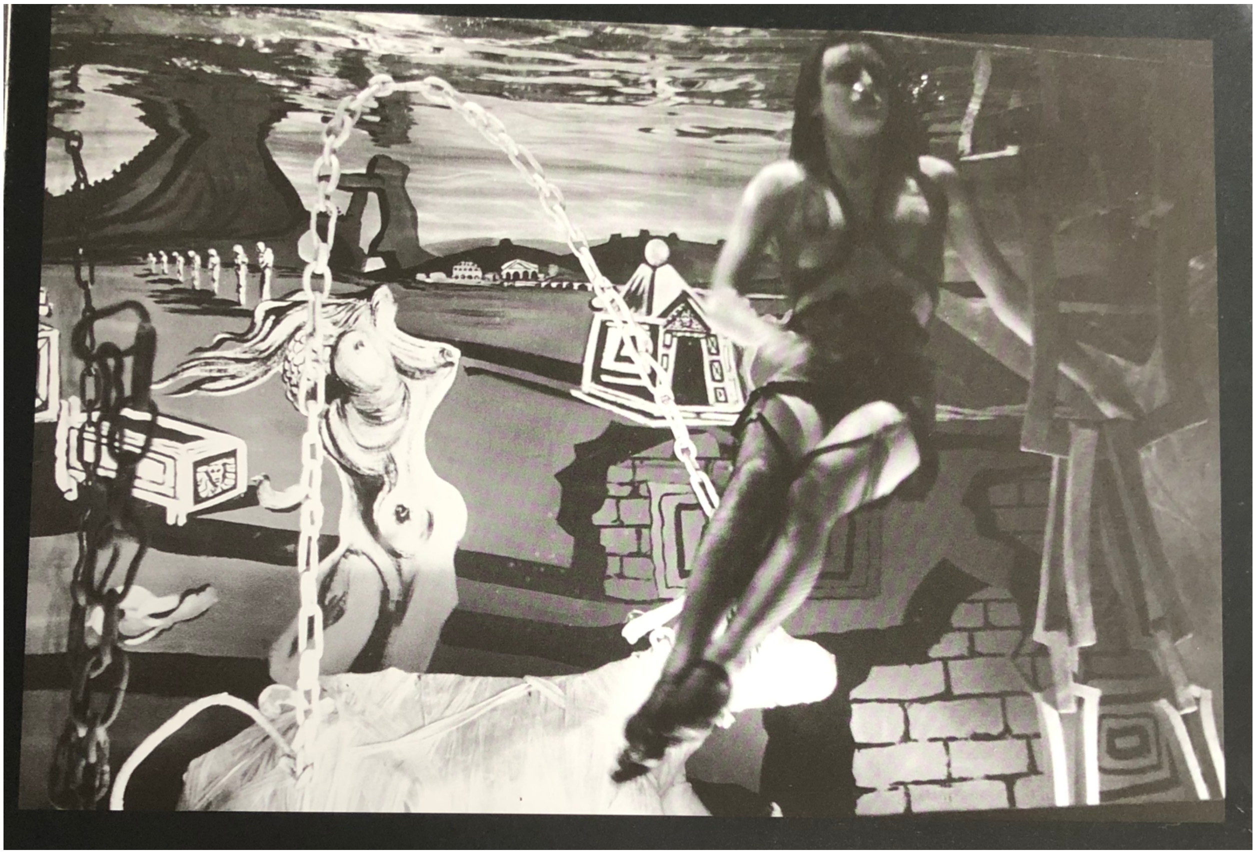


Figure 1-2: An image from Dali's World's Fair Exhibit. From Salvador Dali's Dream of Venus*, by Ingrid Schaffner, p. 77. Photograph by Eric Schaal.*

The caption continued, claiming that “only surrealism’s derangements can capture the limitless horizons, strange juxtapositions, endless products of this new world in process of becoming[.] … [For instance], tough cellulose plastic doorknobs … are readily translatable into gunstocks. Nylon hosiery … can turn into parachutes. The transparent lady also serves as the non-shatterable windshield on bombing planes.” Many of the products pictured above were the older and more established plastics: either hard plastics, invented in 1908 by Leo Baekeland (in the case of the steering wheel, phone, buttons, gears, make-up box, and chess pieces) or semi-synthetic plastics, invented in 1869 in North America by John Wesley Hyatt (doorknob, film, dentures, and hairbrush). Notably, the objects that were emphasized instead augured the tremendous growth spurt that the plastics industry was about to experience. They were made of the newer plastics – the polystyrene “Venus” fish tank or the nylons stepping into the top of the frame. These along with the doorknob are singled out in the copy as being transmutable from domestic or overtly feminized goods to military supplies: doorknobs into gunstocks, nylons into parachutes, disembodied torsos into airplane windows.

Plastic as a consumer good was coded as female, domestic, and childish in this spread. While there were a few examples of objects coded male (the saw cutting the torso in half, gears, steering wheel, and arguably dentures), the majority (sunglasses, umbrella, hairbrush, cosmetics container, high heel, necklace, stocking, buttons, utensils, curtain) were distinctly feminized. Further, there were a large variety of playful objects – the chess pieces, playing card, dice, piano keys, doll house furniture, jukebox, camera, and film – that added to the feeling of frivolity. The vertiginous imaginative potential of plastics in 1940 was clear, as were the gestures to a utopian, modernist future. Nowhere in the image did it even hint at what comes after the Garden of Eden, after the fall of the "garden of gadgets."

This single spread encapsulated many of the themes that follow: plastic's shifting form or formlessness, serious versus playful applications of plastic, and plastic's growth and proliferation into the lives of North American consumers. Plastic's unstable identity – or "difficult age," as the copy put it – in the interwar period was a product of the original proliferation of the newer plastics, among them polyvinyl chloride, polystyrene, and low-density polyethylene, that were being developed by major chemical companies such as Dow, DuPont, Imperial Chemical Industries, and BF Goodrich. Those plastics had just begun to find a clear market in 1940, and although the excitement that surrounded them was palpable, it would require massive wartime investment and mobilization to create the proliferative plastic reality of today. This stage of plastics history was a turning point for its mass devaluation in the second half of the century and its perceived disposability today.

My dissertation will trace plastic's fall from grace to understand how plastic became disinvested of positive potential at the same moment it became ubiquitous in our material world. The chapters that follow will document how the explosion of four common consumer plastics – polyvinyl chloride, polystyrene, and high- and low-density polyethylene – hinged on their use in children's toys and women's domestic objects from their respective inventions until 1970 in North America.[80] Between the interwar invention of these plastics and the first Earth Day in 1970, the transformation in children's toys was nearly complete: the contents of the average toy box went from being 75 percent wood and metal to being 90 percent plastic.[81] I refer to this postwar period as plastic's childhood: an age of unprecedented growth and development when plastic’s unstable identity contributed to its competing trajectories. As the plastics industry grew and developed, plastics themselves became more infantilized in their association with childish and domestic consumer goods. Juvenile plastics – cheap, cheerful, and low value – were entrenched in domesticity and required tending in the form of environmental and domestic guardianship.

Figure 1-3: "Synthetica: A New Continent of Plastics." Fortune *magazine. October 1940, 92-3.*

"*Synthetica*: A New Continent of Plastics," was the second full-colour, two-page image published October of 1940 in *Fortune* magazine, directly after "Plastics In 1940: An American Dream of Venus."[82] Much like the Venus image, it captured a moment in time right before World War II, before the rise of the thermoplastic giants, where thermoset plastics utopianism was at its apex. *Synthetica* conveyed an enormous amount of information about the early days of the plastics industry. As such, a close reading of *Synthetica* will serve as a map for this chapter. Because to understand the effects of polyvinyl chloride, polystyrene, and the high- and low-density polyethylenes, one must understand the material and social conditions of their invention, research, and development. To tell the story of postwar disposability in plastics requires an understanding of three aspects of its prewar development: first, its evolution out of the chemistry of synthetic dyes; second, the development of moulding technologies for an entirely new class of material; and third, the material pressures of industrialization and a rapidly shrinking world driven by the technologies of flight and electricity.

Mapping as Knowledge, Mapping as Power, Mapping as Conquest

A close reading of *Synthetica* requires first engaging with its specific modality. Maps are never neutral objects, regardless of their claims to accuracy, but an imaginary map occupies a special place in its ability to create worlds. As a spatial or geographical representation, the map of *Synthetica* made visible an industry that would otherwise be difficult to understand through chemical formulae alone. As James Corner writes, the "function of mapping is less to mirror reality than to engender the re-shaping of the worlds in which people live[.] … [T]he unfolding agency of mapping is most effective when its capacity for description also sets the conditions for new … physical worlds to emerge."[83] Corner's summation of the re-shaping of worlds is appropriate in this case, as the map of *Synthetica* indicated both the ground that the plastics industry had gained in the century leading up to this publication and, since maps have a long and storied history of being one of "the specialized intellectual weapons by which power could be gained, administered, given legitimacy, and codified," the material world it would yet colonize. [84] If, following Brian Harley, we accept the premise that maps are "a kind of language," then *Synthetica* told the story of the shifting and unstable meanings of plastics in their first century. A large part of the stories of Celluloid, Bakelite, vulcanized rubber, and other early plastics had to do with shifting language and genericization, defined here not in the traditional manner of a trademark becoming indelibly associated with an object and thus entering regular parlance (though this also occurred), but instead as a blanket terminology in which many different materials became one.[85] The queries of what did and did not count as a plastic, the fight to gain territory through trade name practices, the arguments for certain words' appropriateness over others to describe it, the grammatical conversion of *plastic* the adjective into *plastics* the noun, and the subsequent shift in the public vernacular of *plastics* the noun to the singular generic *plastic* – these are some of the issues that I will address in the pages that follow. While the amorphous terminology of the early plastics slowly solidified in the interwar years from 1919 to 1939, several new types of plastics simultaneously emerged under those hardening terms, which helped make these new plastics a reified material reality postwar. The early research and development of three of the four plastics I focus on – polystyrene, polyvinyl chloride, and low-density polyethylene – took place at a time when the borders around public discourses and understandings of plastics were becoming settled. As such, the materials that most people think of today when they hear the word *plastic* are the chemical colonizers that emerged from the continent of *Synthetica* during World War II to take over the rest of the world. Finally, mapping as a discipline grew along with industrialization enabled imperialism, as maps "fixed territorial relativities according to … the mechanisms of the world market" over the span of the twentieth century.[86] Maps' work in legitimizing conquest, empire, and the nation state has been established, and *Synthetica* suggested the ways in which corporate concerns became more powerful over time, resembling nation states of their own.

"*Synthetica*: A New Continent of Plastics" was a striking image, especially in comparison to the chaos of the *Venus* image above it. Coupled with its caption, it gave the reader an immediate visual aid to what was, at the time, an unstable industry. *Synthetica* was clearly designed to bring order to the terrain, establish boundaries, and give industry a steady footing. As John Pickles writes in his study of propaganda maps, the "message of the map is carried by two different structures, one of which is graphical, the other of which is linguistic[.] … [I]n the map they operate almost uniquely as inseparable from each other."[87] He argues that we cannot interpret propaganda maps in a traditional manner: their central purpose is, unlike most maps, a distortional or persuasive function. Therefore, this map of *Synthetica* must be interpreted intertextually – that is, within the context of every other social phenomenon at the time.

A close reading of the map shows us that plastics then are not as we understand them now, as the map starts with a material that most people today would not think of as a plastic: Glass. Rising from the Sea of Glass, one of "the oldest plastics known" according to the caption, the continent sprawled out from an isthmus of the natural resins, vulcanized rubber and shellac among them, surrounded by trees that looked like rubber plantations. From there, and using a similar base material, the country of Cellulose bulged to the left, with provinces representing different types of cellulose plastics: Nitrocellulose, Cellulose Acetate, Regenerated Cellulose, and Rayon Island. The capital cities were the trade names with the most market share at the time: Celluloid for Nitrocellulose, Tenite for Cellulose Acetate, and Cellophane for Regenerated Cellulose. There was Lake Acetic Acid in the middle of Cellulose Acetate, acetic acid being one of the precursor chemicals to its manufacture. To the right, the country of Phenolic protruded, dark and dim, much like its plastic namesake. There, the capital was Bakelite, on the banks of the river Formaldehyde. It was "ruled by Union Carbide & Carbon Corporation," and the caption read that Phenolic was "the greatest plastic country of all – a heavy region of coal tar chemicals fed by Formaldehyde River[;] … its hard-working plastics, in a sober Quaker dress of limited colours, [went] into most of industry."[88] Urea sat below phenolic, related but described as a "more frivolous and color-loving state. Its main industries [were] buttons, tableware, light-globes."[89] Between the two bulging countries of Cellulose and Phenolic, there were three long, narrow countries, two mountainous and the other low-lying: the Crystal Mountains of Acrylic, the Crystal Hills of Styrene, and the land of Vinyl. The grouping here of acrylic and styrene was the only place on the map where the material properties of the two plastics trumped their chemical similarities, as acrylic and styrene are not closely chemically related.[90] The caption stated that the "Crystal Mountains of Acrylic (price elevation: $2.50/pound) r[a]n down into the Crystal Hills of Styrene – both brilliant new plastics with glass like properties,"[91] although the Crystal Hills of Styrene were chemically more related to its neighbouring country, the low-lying Vinyl. Vinyl, "a fast-growing new country of safety glass fillers and rubbery plastics," was reckoned to "subdivide soon."[92] The Great Acetylene River runs through it, acetylene being the precursor chemical used to make polyvinyl chloride until the late 1950s. The final country, found at the bottom of the continent, Alkyd, was a "great swamp of bright, impervious plastic paints, varnishes, and lacquers." Its capital Dulux resided on the banks of Phthalic Anhydride Lake. From glass to paint, there were the inclusion of things into *Synthetica* that we do not today think of as plastics.

With striking visual similarities between these countries and the colonial strongholds of South America and Africa and with this image appearing at a time where the U.S. entry into World War II seemed inevitable, the message was clear: the importance of these countries was growing, and they were ignored at your peril. The detail of the map was stunning: from each country's size approximating their relative market share in 1940, through the rivers and lakes of precursor chemicals and the cardinal points of the compass being the elements Hydrogen, Oxygen, Nitrogen, and Carbon, to the placement of each country roughly charting a timeline of development and commercialization – the map was meant to educate and inform the readers of *Fortune* about the "lay of the land." In a nod to what was happening in geopolitics, as well as the ways that the exponential growth of the plastics industry made it difficult to predict, *Synthetica*'s "boundaries [were] as unsteady as the map of Europe."

The strategic importance of the pictorial map at this time and in this publication was profound. The maps published in *Fortune* in the 1930s and 1940s were extremely popular as visual aids to understanding world conflicts and became a high-water mark in popular conceptions of cartography and information. Susan Schulten, in her account of Richard Edes Harrison, a highly influential popular cartographer employed by *Fortune* throughout the 1930s and 1940s, notes that these maps were enormously fashionable during and after the war, with Harrison achieving the status of a "minor celebrity" because of them.[93] Eleven of Harrison's most influential maps were published as a special issue in *Fortune*, the month before *Synthetica*. His maps were so popular that they were compiled into a separate atlas in 1944 called *Look at the World*, which "sold nearly 25,000 first-edition copies before it even reached the stores."[94] Reflecting an increasing interest in the bird's eye view in the age of aviation, maps published in this period emphasized proximity and a world woven tightly together in both conflict and peace. Harrison's view on mapping was that "his maps showed the true nature of spatial relations in a world of air power, [but] he was equally explicit about their persuasive function; they were intended to explain the first truly global conflict to citizens in a modern democracy through graphically dramatic images published in mass-circulation photo-journals such as *Life* and *Fortune.*"[95] While *Synthetica* is a purely speculative endeavour rather than a "real-life" map, the relative importance of mapping as a persuasive and expository tool at the time it was published is key to understanding how influential the plastics industry was poised to become.

In an analogous way that Africa has often become singularized by the colonial West, thus erasing the enormous differences between both varied ethnicities and countries on that continent, the vast continent of *Synthetica* became singularized as *plastic* in the postwar years. It is therefore essential to re-insert difference in the histories of each country, acknowledging their specific topographies in relation to one another. While comprehensive histories of vulcanized rubber, Celluloid, and Bakelite have been covered elsewhere, a basic understanding of their development and shape is essential.[96] Many histories of plastics focus on the heroic and singular inventions of individuals like Charles Goodyear, John Wesley Hyatt, and Leo Baekeland without acknowledging the underlying material pressures wrought by industrialization, electrification, and increased population. Plastics became the dominant material that we know today in several discrete growth spurts, with each development I highlight below contributing to a specific part of its progress. The following vignettes tell the stories of the development of vulcanized rubber (conceived 1839) and its contribution to Bakelite (conceived 1908) through the similarities in moulding techniques for thermoset plastics; the development of Parkesine and Celluloid (conceived 1862 and 1869, respectively) and their contribution to early consumer culture; and the late interwar inventions of polyvinyl chloride (commercialized in 1926), polystyrene (commercialized in 1937), and low-density polyethylene (commercialized in 1939) in the labs of the chemical companies BF Goodrich, Dow, and Imperial Chemical Industries (ICI) in England, respectively. While there are as many stories that could be told about *Synthetica* as there are countries, provinces, and cities on the map, these are the most important to frame what came afterwards.

Classification and Aggregation: The Problem of "Plastic"

While STS has an abundant literature on classification, an analysis of the early days of the plastics industry ultimately concerns aggregation, not classification. It becomes difficult to engage with a literature that makes finer and finer delineations of organisms, disease, or microbes to describe twentieth-century science when I am dealing with quite the opposite – more than 10,000 different types of materials (dependent on precursors, manufacturers, manufacturing methods, plasticizers, co-polymers, reaction time, and so on) can now be classified as "plastic," a word whose etymology simply means that it is capable of being moulded. One of the great disservices of the twentieth century in understanding plastics is wrought in this aggregation, as we do not have a deep enough popular understanding of the materials we encounter daily to be able to engage with them in any but the most superficial ways. Meikle's explanation of this dilemma is a good starting point, worth quoting in its entirety:

> For several decades, confusion reigned over just what constituted a plastic. Among the inventors, chemists, and businessmen that promoted the new materials, the noun referred to the manufacturing process. A plastic, whether natural or synthetic, was something that could be molded or shaped when soft, then hardened. In 1903 the United States Patent Office created the classification "Plastics" out of the former "Caoutchouc and Minor Plastics." Although the new category explicitly excluded glass and butter, it admitted such oddities as "scraps of cork, leather, etc." compressed to make "articles of definite shape." Even Baekeland, later referred to as the father of plastic, bragged in 1909 that his Bakelite was "far superior to … all plastics." In fact it was "a *non-plastic*" because its chemical reaction rendered it permanently hard, infusible, and insoluble. Eventually a definition emerged that encompassed even Bakelite. The industry's first trade journal, *Plastics,* founded in 1925 by two partners who "didn't even know what plastics were," borrowed a definition from *The Century Dictionary Supplement* of 1910. "Plastics" – changed to plural form to suggest a variety of types – indicated a "commercial … class of substances … worked into shape for use by molding or pressing when in a plastic condition." As a category, plastics was more commercial than scientific, encompassing an array of materials united by similar manufacturing processes, shared markets, and a common name.[97]

What Meikle makes clear is that plastics were always and already embedded as materials in relation to their manufacturing process and industrial and capital relations; it was never a material purely wrought from the wonders of chemistry. Polymers were "technological items before they were objects of knowledge," as Celluloid and Bakelite existed from 1862 and 1907 onwards, respectively, but the structure of polymers was not elaborated until the work of Herman Staudinger showed them to be macromolecules in the early 1920s.[98] The fact that the distinction made between Bakelite and Celluloid is that of "thermoplastic" versus "thermoset plastics" rather than "addition" versus "condensation" polymerization shows the functionality of popular aggregations over chemical classification. Plastics, as I will show below, have always been defined by utility – whether that be their manufacturing method, result, or end-use –

rather than by classification. This property has prevented plastics from ever claiming technological neutrality, being first cast as a utopian and progressive material in the early part of the twentieth century and then, once their proliferative detrital forms became dominant, a dystopian and profligate material in the latter part.

Instead of *Synthetica*'s plastics utopia, then, I propose that Foucault's concept of a "heterotopia" serves the landscape of *Synthetica* better, as all classification of plastics is wrought with contradiction and unstable boundaries.[99] As opposed to the imagined utopia, the real plastic world is heterotopic. A heterotopia refers to a "real place"; it represents "places that do exist and are formed in the very founding of society[,] … a kind of effectively enacted utopia in which the real sites … are simultaneously represented, contested and inverted."[100] Foucault claims that "heterotopias are disturbing, because they secretly undermine language, because they make it impossible to name this *and* that, because they shatter or tangle common names."[101] Because the early plastics industry is so intertwined – in materials, in capital, in colonization, in consumption, in resource surplus and resource scarcity, in militarization, and so on – the singular noun *plastic* must be exploded into all its contradictory, unstable, and boundary-crossing parts. The stories that follow show how these unstable parts were ordered, whose good it served to do so, and what the ultimate result of simplified conceptions of complex and multi-faceted materials would be.

Vulcanized Rubber:

Figure 1-4: The Isthmus of Natural Resins, containing vulcanized rubber. Detail from "Synthetica: A New Continent of Plastics," Fortune *magazine, October 1940, 92.*

Figure 1-5: A Victorian mourning necklace made of Vulcanite. Image from "Goddess in LA" online store at rubylane.com. Used with permission.

Most socio-cultural histories of plastics do not start with vulcanized rubber, as it is not considered plastic (the noun) in today's understanding of the material. Jeffrey Meikle begins his account with Celluloid's invention in 1869; likewise, Morris Kaufman starts with the invention of Parkesine in 1862. Curatorial texts like Susan Mossman's edited volume *Early Plastics: Perspectives 1850–1950* and Penny Sparke's edited volume *The Plastics Age: From Modernity to Post Modernity*, both published within the purview of museums, are a little different, as they prefer to take a "long durée" approach to plastics, which includes the natural plastics such as "amber, horn, wax, bitumen, shellac, and gutta-percha," possibly because they have physical artifacts made of these materials to take into account. While there will always be debates regarding origin stories, vulcanized rubber is an often-missed contribution to the development of the plastics that came afterwards. Due to the neglect of public education efforts about plastics as materials, the tacit reclassification of vulcanized rubber as not existing within the purview and history of plastics has become a missing starting point that helped divorce the later fully synthetic materials from their semi-synthetic and natural origins. However, at least in 1940s vision of *Synthetica*, we see that vulcanized rubber's position as a thermoset semi-synthetic plastic was the isthmus on the map that opened to the horizons below it. Its decreasing land mass indicated the real and perceived scarcity of the resource, particularly important on the eve of U.S. involvement in World War II. Zooming in on the picture, we can see the trees that are responsible for latex, the base material for vulcanized rubber. Latex (also known as caoutchouc, India, or natural rubber) is the sap harvested from the rubber tree (*Hevea brasiliensis*), which is native to the Amazon basin. Because of greatly increased demand in the 1890s, first for tires for bicycles and then for automobiles, agents from the United

Kingdom smuggled *Hevea* seeds out of the Amazon and cultivated them extensively in south and southeast Asia. Cultivated rubber supply outstripped Brazilian rubber supply by 1914, rubber production quickly scaling from 94,000 tons in 1910 to more than a million tons by 1936. In October of 1940, that colonial supply was under imminent threat, as the Japanese, already active in the region since 1937 with the second Sino-Japanese war, had signed the Tripartite Act with Germany and Italy the month before, and imports from Germany of their synthetic rubber had already been cut off in September of 1939.

Referring to Meikle's explanation of how plastics were first classified in the patent office, we can see that "plastics" as its own category arises from the category of "caoutchouc and minor plastics." Chemically, the ways that cellulose is "nitrated" in order to create Celluloid and rubber "sulfurized" to create vulcanized rubber are similar, which would justify the grouping of caoutchouc and minor plastics (i.e., Celluloid) together. Unsulfurated latex has a very low level of heat and cold tolerance – it becomes gummy and sticky when too hot, and brittle and cracking when too cold. By adding sulfur in 1839, Charles Goodyear (and Thomas Hancock in the U.K.) changed its chemical composition, hardening it and making it into an infinitely more useful material that was able to withstand a far wider array of environmental conditions. While today we primarily associate vulcanized rubber with the manufacture of tires, "Vulcanite" or "Ebonite" was also used as a moulded material, as a replacement for onyx or jet in jewellery, or as a replacement for ebony wood in pianos, in very much the same way that Celluloid was used as a replacement ivory (as we will see below). Vulcanized rubber is an older and often forgotten sibling of plastic and has frequently been intertwined in its use.

One of the boundaries between rubber and plastics is blurred in the invention and scaling of synthetic rubbers. The material pressures of World War II came to a boil when the Dutch East Indies (present-day Indonesia) fell to Japan in 1942, and the allied forces were abruptly cut off from the cultivated supplies of latex. In response, the U.S. created and scaled the Rubber Reserve Company, a "mixed organization … composed of chemical industries and oil companies, to organize the production of synthetic rubber and protect the supply of all the basic products." The U.S. was initially playing a catch-up game with Germany, whose industrial chemists had conceived Buna – polymerized butadiene (Bu) catalyzed with sodium (Na) – in the interwar years. Spurred on considerably by a tax imposed on imports of natural rubber to fund synthetic rubber development, the U.S. quickly went from 41,000 tons of synthetic rubber at the point of their entry into the war to 700,000 tons in 1944. Government rubber styrene, known more commonly as GR-S, was substantively like Germany's Buna-S (Buna co-polymerized with styrene), but just different enough to be non-infringing on their patents – the "codename within Goodrich for its first successful rubber was 'nirub' for non-infringing rubber." I will cover the creation of GR-S in more detail in my polystyrene chapter, as it was one of the key reasons styrene (the monomer to polystyrene's polymerization) was scaled so significantly during World War II. Even in this simple vignette, we can see some of the ambiguities in our plastics heterotopia: synthetic rubbers are plastics (the noun), but natural rubbers are not (however, they are adjectivally plastic); slight changes in polymerization processes require different trade names of the same chemicals, and German versus U.S. development of the same material were subject to an enormous conglomerate of interests along both Allied and Axis lines.

Celluloid:

Figure 1-6: The Country of Cellulose. Detail from "Synthetica: A New Continent of Plastics," Fortune *magazine, October 1940, 92.*

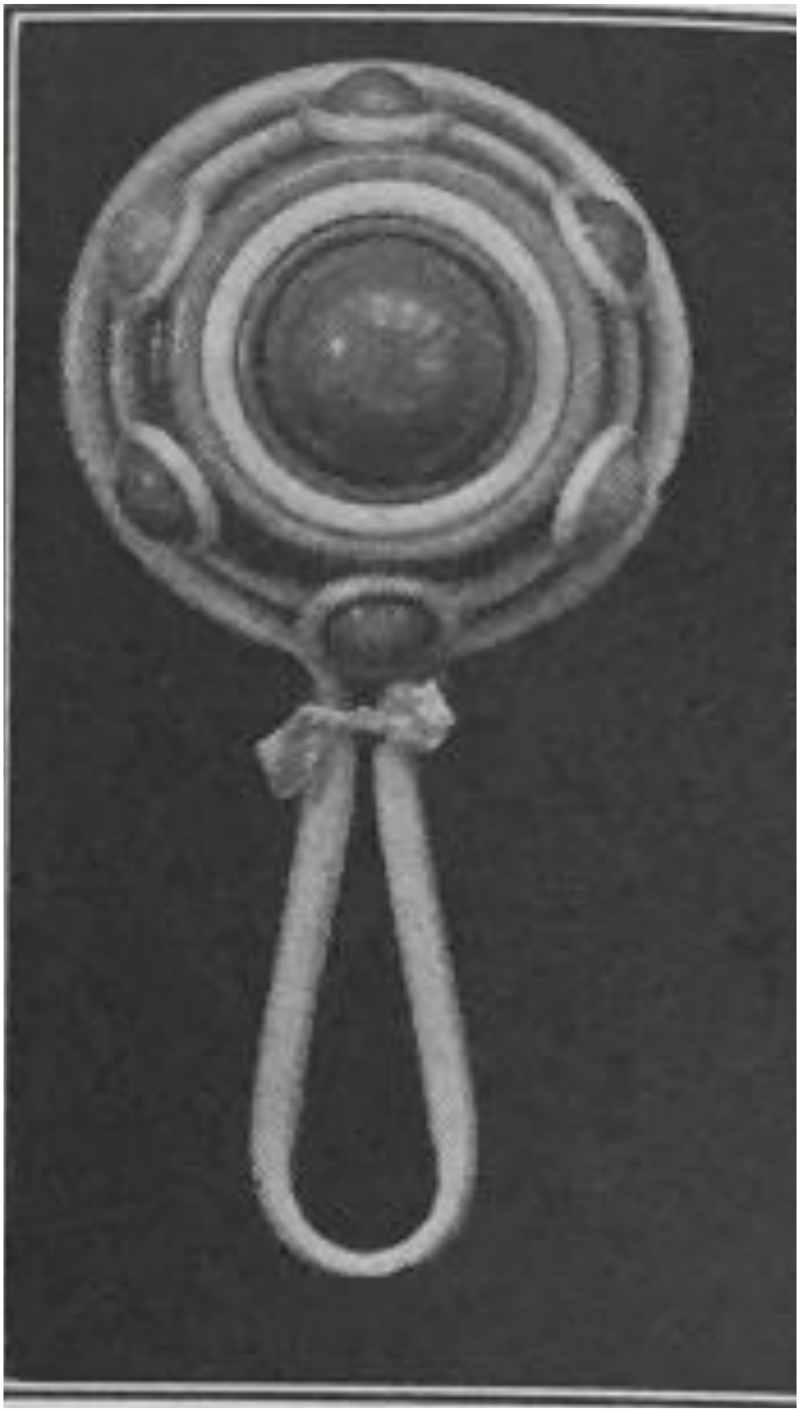


Figure 1-7: A celluloid baby rattle. From Playthings*, February 1931, 186.*

The utopian tale of the invention of Celluloid is well known and often repeated. It is a normative narrative that emphasizes both the singular genius inventor and the technological inevitability of the invention. In this story, John Wesley Hyatt worked in a back shed over the course of six years, as a response to a $10,000 reward for a substitute for ivory in billiard balls, to create the first Celluloid in 1869. While not strictly untrue, the singularized, U.S.-based, and temporally bounded story of Hyatt and his billiard balls has proven too compelling to be told with nuance and has been repeated in nearly every popular text about plastics (and quite a few academic ones) ever since. From the early popular text *Plastic Horizons*,[102] where "young Hyatt devoted evenings and Sundays to the task," to a more recent New York Times bestseller *Stuff Matters* by Mark Miodownik,[103,] and even in Harvard University Press's *History of Chemistry*,[104] Celluloid's invention continues to be associated with a parlour game and an enterprising young man playing with chemicals in a shed. The irony of this indelible association is that Celluloid was not, in fact, all that appropriate of a material for billiard balls, as its flammability and explosiveness meant that, when the billiard balls collided, it made a sound like a gun going off, which proved hazardous in western saloons.[105]

The actual story of Celluloid's conception was far more complex. Instead of the simple utopian tale of Hyatt's billiard balls, it was a heterotopic tale of tensions between scarcity and abundance, war and peacetime, financial backing, trade names, failure, and hazardous substances. Instead of being tightly temporally bounded by the six years that Hyatt spent in his shed, it starts with the invention of nitrocellulose in 1845 as a substitute for gunpowder. Nitrocellulose, also known as "guncotton" or "smokeless powder," was invented by Christian Schönbein, a Swiss-German chemist based out of Basel.[106] Guncotton has six times the gas generation power as black powder, and industrial production for arms purposes increased throughout the second half of the nineteenth century, particularly during the years of the American Civil War. Nitrocellulose was also dissolved in ether or alcohol – known in this form as "Collodion" – and used as a wound dressing, as the alcohol would evaporate and leave a film that would keep the wound shut, a process that, to this day, is found in "liquid Band-Aids." Finally, it was used in the "wet-plate" process of early photography, which, as opposed to its predecessor albumen (egg white), reduced the exposure time needed to make an image.[107] Note that while "Smokeless Powder" and "Collodion" are named places in the province of Nitrocellulose, the first actual plastic made from cellulose is not. Collodion and smokeless powder were the forms that nitrocellulose took until 1862, when Alexander Parkes added a solvent (alcohol) to a less nitrated form of nitrocellulose. With that addition, he created the first semi-synthetic thermoplastic, introduced at the Great Exhibition of London in 1862. Named "Parkesine" after himself, it won the bronze medal for "excellence of quality" in its section.[108] The leaflet that was displayed alongside the artifacts at the exhibit was instructive, as it prefigured later understandings of plastics. Parkes only defined his "new material" by what it might be used for – "such as medallions, salvers, hollow ware, tubes, buttons, combs, knife handles, pierced and fret work, inlaid work, bookbinding, card cases, boxes, pens, penholders" – and by its abilities to be made and worked in a variety of different states:

> it can be made hard as ivory, transparent or opaque, of any degree flexibility, and is also waterproof; may be of the most brilliant colours, *can be used in the solid, plastic, or fluid state*, may be worked in dies and pressure, as metals, may be cast or used as a coating to a great variety of substances; can be spread or worked in a similar manner to India Rubber, and has stood exposure to the atmosphere for years without change or decomposition.[109]

The suggestion that Parkesine could be used as a substitute for materials like tortoiseshell, ivory, and horn, similarly to vulcanite as a replacement for jet, shows that, from the very beginning, plastics were conceived as a way of providing affordable luxuries for those aspiring to increase their class standing, and in this way the material was perceived as a great class equalizer. However, rather than providing a classless plastic utopia, its heterotopic properties later reinscribed class between those who could afford "authentic" goods (where "authentic" simply means "not plastic") and those who could not.

Parkesine would, for all its fanfare, be short lived. The Parkesine Company was dissolved after only six years, in 1868, which was only two years after it opened its first factory. Parkes's obsession with keeping the price below that of gutta-percha (sap from another latex tree, *Palaquium gutta*, similar to *Hevea brasiliensis*) to guarantee his financial backers meant that he used the cheapest cellulose available, which in turn meant that his products would often be contaminated.[110] Because of the lack of camphor in his formula in comparison to the nitrocellulose that followed, it would also shrink, deform, and generally become unusable after a short period of time. After the Parkesine Company folded, its manager, Daniel Spill, founded another company, on much the same formulations and manufacturing processes and in the same location as the Parkesine Company, but under a different trade name: the Xylonite Company. Spill insisted that the only problem with Parkesine was that it was not white enough to be a convincing substitute for ivory. Though the Xylonite Company was abandoned in 1874, Spill was undeterred; he founded yet a third company, the Daniel Spill Company, and began to produce both Xylonite and another (chemically identical but whiter) material, Ivoride. The Daniel Spill Company found a small niche market for its Ivoride material in "knife handles, brooches, and decorative trinkets."[111] As we can see, even the very first plastic, with all its simplicity in use, also has multiple bifurcations and difficulties with boundary making, naming, and intelligibility.

This boundary making does not end with Hyatt's Celluloid, either. After Hyatt patented the process of creating Celluloid in 1870, Spill would spend the following seven years of his life, up until his death in 1877, suing Hyatt for patent infringement. Bijker details the patent infringement case between Hyatt and Spill as an example of "interpretive flexibility" as the two had a fundamental disagreement in what constituted the difference between two chemically identical materials. For Hyatt, the difference was in the fabrication process, where he used a solid solution of camphor and nitrocellulose. However, Spill saw it as the material itself being identical, regardless of whether the camphor and nitrocellulose was in solid or liquid form, and therefore Celluloid was covered by his original patents for Xylonite and Ivoride. When the suit was eventually settled in 1884, it was decided that neither Hyatt nor Spill owned the patent, because Parkes had already covered the combination of camphor and nitrocellulose in his patents (despite Parkesine not having used camphor in practice), and that decision meant Hyatt was awarded a victory, as the decision "denied Spill the novelty of using camphor and thus nullified his grounds for litigation against Hyatt."[112]

Here we see how Celluloid became Celluloid and not Parkesine, Xylonite, or Ivoride, through the actions of litigation. But it was not just the name that added to the complexity of the material; it was also its use. As Kaufman points out, there were worries about material shortages that went far beyond ivory for parlour games. The chair of the Royal Society of Arts, after a lecture by Parkes in 1865, stated: "We are exhausting the supplies of India rubber and gutta-percha, the demand for which is unlimited but the supply not so."[113] The development of Celluloid was therefore a response to the perceived scarcity of materials that were making possible other things like the transatlantic cable, laid only eight years prior with a coating of gutta-percha. The history of Celluloid then, even though it has similar drivers as other material technologies of the time, is understood differently compared to other materials, having been coded as more frivolous than gutta-percha and transatlantic cable. Even in 1962, Kaufman rails against the story of Hyatt and billiard balls, as "such thinking reduces the history of technology to a series of trivial events[;] … the main impulse in the development of celluloid … was the urge to find new ones to augment the supply of existing substances, which was proving inadequate to meet the demands of a fast-growing industry."[114] The material pressures of the Industrial Revolution were beginning to make themselves felt in the latter parts of the nineteenth century, and originally-thought-limitless natural resources were beginning to show their confines.

Although there were high hopes for Parkesine taking up serious applications, especially in an electrifying world, most of the uses of Celluloid ended up being for things more appropriate to commodity fetishes: the burgeoning middle class on both sides of the Atlantic had designs on luxury goods that were out of reach to all but the wealthiest of individuals, and the population explosion due to improved living standards, wages, and public health efforts (amongst other things) meant that people perceived scarcity in other ways as well. Into this consumer anxiety Celluloid stepped: Celluloid manufacturers produced "affordable luxuries" within reach of an emergent lower-middle class. Dress collars that did not need (expensive) laundering, imitation ivory vanity sets, and fancy combs were produced with Celluloid. Celluloid was therefore associated with the aspirational aims of the working class to rise above their station. Due to its later use in film for both photography and moving pictures, as well as innovations that begot Rayon and Cellophane, Celluloid's dominance in the plastics world continued until the emergence of a different beast, and the age of truly synthetic plastics began in earnest with the next iconic material on the list: Bakelite.

Bakelite

Figure 1-8: The Country of Phenolic. Detail of "Synthetica: A New Continent of Plastics." Fortune *magazine. October 1940, 92-3.*

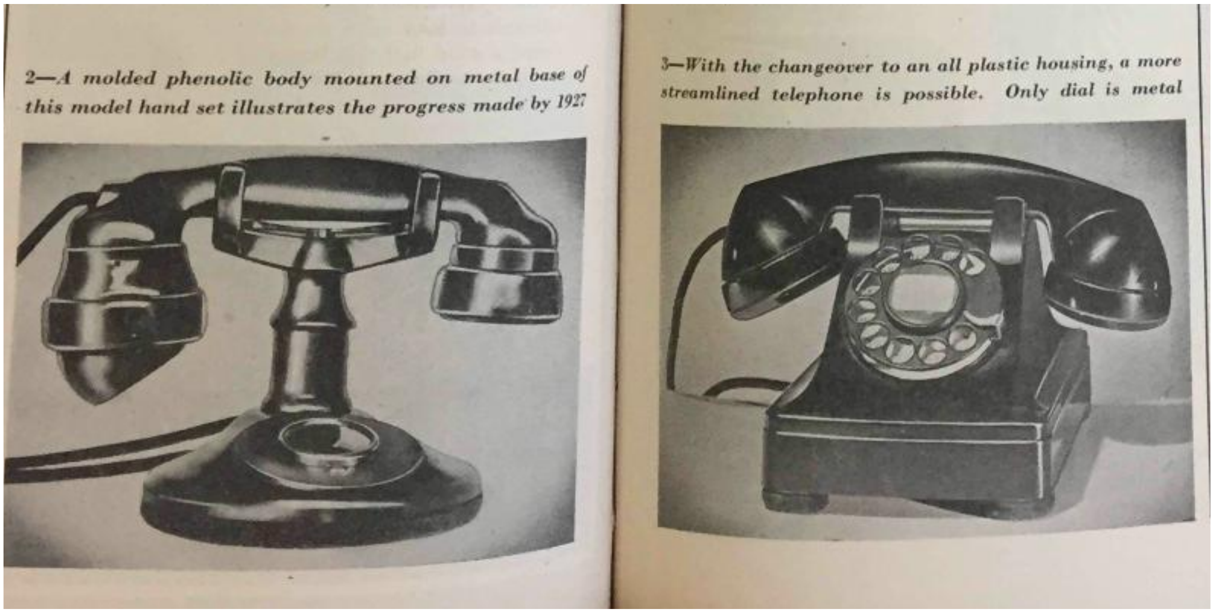


Figure 1-9: Examples of Bakelite telephones. From Modern Plastics*, December 1947, p. 182-3.*

The materials detailed up to this point have been semi-synthetic. Fully synthetic plastics, of which Bakelite is the first, comes instead from the mixture of two chemicals: phenol and formaldehyde. Its designation as "fully synthetic" comes from the fact that Bakelite does not resemble either of its base materials and its manufacture requires significant heat and pressure not found under normal atmospheric conditions. Bakelite can therefore only be created by the controlled reaction of these two substances, which are themselves synthetic, chemical distillates and not natural precursors. Bakelite was first conceived in 1872 by Adolf Baeyer, in Germany, as a side effect of studying condensation reactions between aldehydes and phenolics in the context of researching synthetic dyes. Rather than realizing what he had, however, Baeyer considered the resins that were formed this way a nuisance, "an annoying by-product that had to be thrown away."[115] It is only through what Bijker calls "retrospective distortion" that it is considered Bakelite today.

While one might assume that the cost of precursor chemicals might be the main explanation for why Bakelite was not developed at that point, that assumption would be misleading. In Germany, a catalytic process was developed in 1888 that allowed direct synthesis of formaldehyde, which caused the price of that precursor chemical to drop precipitously (coal tar was already abundant). While the availability of formaldehyde spurred several chemists to study the phenol-formaldehyde condensation reaction, it was almost always in the context of synthetic dye chemistry; for example, one chemist explained his failures because of "the sudden appearance of those 'unerquickliche Harze'" (which translates to "awful resins").[116] It would be another twenty years before Baekeland had his breakthrough in 1907 and quickly commercialized Bakelite as a mouldable material.

Bijker's analysis of why Baekeland was able to make the breakthrough technological frame shift that allowed Bakelite to be born is a fascinating account of insider/outsider knowledge-making practices and how Baekeland's "relatively low inclusion in the Celluloid frame" allowed him to see how heat and pressure, instead of solvents, became the primary determinant in Bakelite manufacturing.[117] Bijker argues that, after the patent suits between Hyatt and Spill over Celluloid, a substitute solvent became the primary way that most Celluloid chemists looked for a replacement. A substitute for Celluloid was sought because of Celluloid's flammability, which made it unsuitable for use in electrical applications, which were a growing market at the turn of the twentieth century. Baekeland, according to Bijker, was crucially included in a separate technological frame: that of electrochemical engineering. Bijker points out that "although the classic applications for plastics such as knobs, buttons, and knife handles do appear on the list of sample articles, Baekeland was primarily interested in developing his Bak[e]lite into a versatile and precise molding material for mass production under industrial conditions."[118] Baekeland himself stated that Bakelite's "use for such fancy articles has not much appealed to my efforts as long as there are so many more important applications for engineering purposes."[119] He therefore set Bakelite up in contradistinction to the uses of Celluloid: Bakelite was a "serious" material for industrial, automotive, and electrical applications. Its heavy and substantial nature, in contrast to Celluloid, meant that it was not primarily associated with consumer applications until later in its history; and when it did become associated with consumer applications, it was through totally new kinds that took advantage of a quickly electrifying world – amongst its most famous consumer uses was in the "machine age" designs of Bakelite radios, desk lamps, clocks, and telephones. Bakelite, and other thermoset plastics that followed it, therefore never had the association with the cheap and imitative baubles that Celluloid did, and it kicked off a phase of plastics development that Meikle calls the "thermoset phase of plastic[s] utopianism."[120] This era of plastics utopianism was characterized by the dominance of industrial applications and Bakelite's association with high-end consumer goods where the material was appreciated in its own right, rather than as an imitation of other materials. It lasted until the late 1920s, when Baekeland's patents expired, and the price of Bakelite dropped precipitously.

Bakelite is a great illustration of how the unstable language of "plastic" over the past 150 years complicates the utopian ideals that initially underpinned it, since Bakelite, iconic as it was as the first plastic (the noun), was not considered plastic (the adjective). Its designation as thermoset means that after heat and pressure are applied to it, it is "set" in place and becomes infusible – that is, not able to be re-melted, unlike Celluloid. This was a desirable characteristic, as Celluloid was too heat sensitive to be used in any electrical or automotive applications, two extremely fast-growing industries at the time. The fact that Bakelite was so hard and so different from Celluloid caused innumerable issues with existing manufacturers of Celluloid, as the former required an entirely new set of rules, techniques, and equipment to be successfully utilized; the processes related to vulcanized rubber were more appropriate to Bakelite's manufacture than those in the existing Celluloid industry. Baekeland himself had to travel around to the various manufacturing centres in the northeast U.S. teaching workers his tacit knowledge as the inventor of the material. The Celluloid engineers "were not able to handle a material that lost its malleability so completely."[121] Baekeland therefore sought out companies that had existing facilities for vulcanized rubber, and the "first precision-molded articles were made in collaboration with the Loando Hard Rubber Company of Boonton, New Jersey."[122] His close association with and use of vulcanized rubber companies would have allowed Baekeland to slot Bakelite more easily into the nascent auto manufacturing industry, further cementing its use in "serious" industrial applications. Baekeland was therefore able to pivot parts of industry and manufacturing toward the use of his fully synthetic, thermoset material, and although it used much of the same infrastructure as some of its semi-synthetic predecessors, its applications were not direct substitutes.

As the plastics industry grew, the conversation about what to name the increasingly unwieldy and disparate materials became more prominent. Shifts in terminology, process, and materiality between semi-synthetic and fully synthetic plastics, as well as between thermosets and thermoplastics, drove significant resistance to the nominalized adjective "plastic" by those influential in the industry, partly because Bakelite was a non-plastic in the adjectival sense and did not want to be associated with the older and more frivolous Celluloid. In a 1929 "round-robin" discussion on what the generic name should be, the plastics industry's trade journal, at that point only a few years old and not yet named *Modern Plastics*, asked for input about the Moulder's Association's assertion that the generic name should be "Synthoid."[123] In return, six prominent plastics company executives voiced opinions on the term, with Baekeland's being the longest and the one that was featured as the lead. Baekeland's contribution to the conversation is worth quoting at length:

> "Synthoid" has no meaning. It barely suggests that the material is made by synthesis. The termination "-oid," a suffix of Greek origin, has been used repeatedly in chemistry and other sciences, meaning "like"[;] ... on this account the suffix -oid looks rather incongruous in conjunction with synth- and would suggest a material which resembles a synthesis. The combination is obviously absurd[.] ... It is preferable to use a word of which the pronunciation in various languages differs as little as possible, which

> is not the case with synthoid, not even in American[.] … [I]n the East Side dialect where "toity-toid" means thirty-third, they may even come to write it "Saint-third"[.] ... On the other hand, there exists already a suitable word, the use of which is available to the trade, which has been used in chemical literature and even in newspapers and magazines, namely the word "Resinoid." ... "Resin" indicates its relation to resinous material while the termination -oid indicates that it looks like resin without being a natural resin[.] ... Celluloid was an excellent word, because this material was made from cellulose, and was a variety of cellulose without being cellulose.[124]

The rest of the conversation within the round-robin was equally as lively and appalled as Baekeland at the suggestion of "Synthoid." B.F. Connor, the manager of the plastics division of Colt's Patent Firearms Manufacturing Company, said that "'Synthoid' is a child of superficial thought and effort; a future incorrigible; bound far beyond our control. Will not "synthoid" cause more doubt, more fear and suspicion within the minds of the buyers than already exists?"[125] Charles Reeves, of the Celluloid Corporation, suggested instead that a "coined, generic name, such as "Korox" is one that is not suggestive of any material – it is easily pronounced and spelled – it is euphonious – and is easily remembered, and it could be made to made anything and everything the molding trade desired." Reeves in particular pointed to the idea that "'Synthoid' is too indicative of artificiality and that it might tend to place the materials or articles molded therefrom into a group classification of the 'oid' materials."[126] The idea that an "oid" material was limiting, even from the representative of the Celluloid Corporation, shows the language issue clearly: the industry wanted specificity, not genericization. It knew it struggled with intelligibility and suspicions toward their materials from consumers. Connor went on to say that if the industry "submerge[d] these specifics [with the generic name Synthoid it would] … help open the door for the substitute, the 'just as good' – those that would traffic on the goodwill of others. Surely, we should encourage all the new materials, new formulas, new methods, etc. but they should carry specific designation and stand or fall upon their individual merit."[127] One wonders if the word "Resinoid" had actually become the preferred nomenclature, as Baekeland wanted, or if the industry insisted on the specificity that was so arduously pushed for here, that there may be today a greater understanding of the material history of plastics, or at least the materials found in the natural world that plastics replaced.

Instead, the polymers were ultimately named after one of their states, not even their final state – only the intermediary state between the precursor chemical and the final form. The arguments about what to name plastics therefore function as a metaphor for the material itself: perpetually intermediary, always thus far unfinished. The ruminations over nomenclature reveal the difficulties in pinning down a material that could be anything and which eventually became identified not by its actual materiality or trade names, but by its end uses. Plastics were created as a newly abundant material, originally amidst a perceived and actual scarcity of resources. The naming, identity, materiality, and cultural impacts of plastics map, entangle, and are generative in the tensions between the endpoints of my story: from plastics' interwar development to the beginnings of the recycling movement, as the temporality of consumer goods collapse from infinite to instantaneous throughout the mid-twentieth century. This round-robin argument, vague and uncertain over what to call the stuff, is emblematic of what plastics are. The unstable naming practices of their beginnings mirror the indeterminacy of plastics as a substance and their ongoing unintelligibility, which contribute to the erasure of the material's varied identities and encourages the aggregation of disparate materials. This unintelligibility does us a great disservice, beyond making it difficult to sort recyclable plastic from non-recyclable. Unable to see the heterotopic nature of plastics being in the world, today we use plastics as cheap drivers of late-stage capitalism rather than lightweight, strong, dielectric, and insulating materials that could change the world for the better.

In April of 1930, under the "In Closing" section of the journal that was to become *Modern Plastics*, a small quip followed a response to a letter the journal received from *Chemical and Metallurgical Engineering* about "plastic" being the proper generic name. The editors wrote that "they view with alarm – but thoughtfully – the many suggested generic names; they even suggest that 'plastics' is the ideal one. Congratulate us! It's fine, but we … won't take the joy out of life. This very term was brought up a few months ago at a meeting in New York. Thanks to us, that was all that happened."[128] It's unclear from this tongue-in-cheek statement whether the editors themselves were against the word "plastic" or whether they were shut down by others in the room, but one interpretation is that the industry was well aware that the conversation about the generic noun was all but a moot point and that the round-robin was a largely academic exercise: the generic "plastics" was already well on its way to being established, as is evident in the name of the journal itself.

This debate occurred in 1929–1930, when the thermoplastic giants were coming into being in the laboratories of Dow, ICI, and BF Goodrich. While Bakelite largely escaped its own genericization[129] and was allowed to remain highly valued, the four fully synthetic thermoplastics that I focus on in the following chapters did not. In this section, I have shown the process by which "plastic" began to be stabilized as the material we recognize today. The dominance of Bakelite takes us up to the late interwar years and situates us squarely in the moment where the stories of polyvinyl chloride, polystyrene, and low-density (and later high-density) polyethylene begin.

In the next section, I will cover the stories of those plastics' interwar developments: polyvinyl chloride and polystyrene in the United States by BF Goodrich and Dow, respectively, and low-density polyethylene by ICI in England. When taken together, the brief histories of Celluloid and Bakelite above and the developments of polyvinyl chloride, polystyrene, and polyethylene below form an effective prelude to the proliferation of thermoplastics postwar through toys and domestic objects. From the relatively robust and stabilized countries of vulcanized rubber, Celluloid, and Bakelite, we now enter the new and uncharted territories of Vinyl and Styrene and investigate the future of *Synthetica* with the new continent of Polyethylene, whose borders were not yet drawn. The countries Vinyl and Styrene are close geographically, but distinct in their materiality – the crystal hills of Styrene are in sharp contrast to the Vinyl lowlands. They both look to be stretching onwards, outwards, ready to create continents of their own, which is exactly what they did. The difference between Bakelite and Celluloid is important because, as we will see in the next section, what moved us from a plastics utopia, where an indestructible, never-decaying material was imagined to provide for all, were the fully synthetic thermoplastics. Whereas a thermoset plastic can only be formed or moulded once, a thermoplastic can become "plastic," the adjective, upon heating or re-heating before losing plasticity when cool. Thermoplastics could, theoretically, be used again and again, but they were instead enrolled in the current state of hyper-consumption and imminent disposability.

Polystyrene, Polyvinyl Chloride, and Polyethylene:

Figure 1-10: The Countries of Acrylic, Styrene, Vinyl, and Petrolia. Detail of Synthetica: A New Continent of Plastics. Fortune *magazine. October 1940, 92-3.*

With the invention of Bakelite in 1908, one sees a remarkably different practice in plastics manufacture take hold, one that hearkens back to vulcanized rubber. The thermoset modality was not long for this world, however. The thermoplastics that came into being during the interwar period from 1919 to 1939 created the disposable world we have today, although it was far from their creators' original intentions. This section will therefore address the invention and commercialization of three thermoplastics that were the focus of the postwar boom in disposability. From their Victorian era conception to their interwar invention and commercialization, I will break down both the similarities and differences between the early days of polyvinyl chloride and polystyrene and show how they set the stage for the expansionist possibilities of a material so new in 1940 that it did not even merit a place on the Synthetica map: polyethylene.

Polyvinyl chloride and polystyrene have similar origin stories and a similar chemical makeup. Chemically, polystyrene and polyvinyl chloride are both considered vinyls, which can be derived from ethylene, but not to be confused with polyethylene in another example of where evolving lay-terms for plastics complicate the ability to speak about them. Since the ethylene molecule is so important to thermoplastic manufacture in the twentieth century, it deserves its own section, as the petrochemical process for ethylene production is integral to the plastics that came after it.

The importance of ethylene:

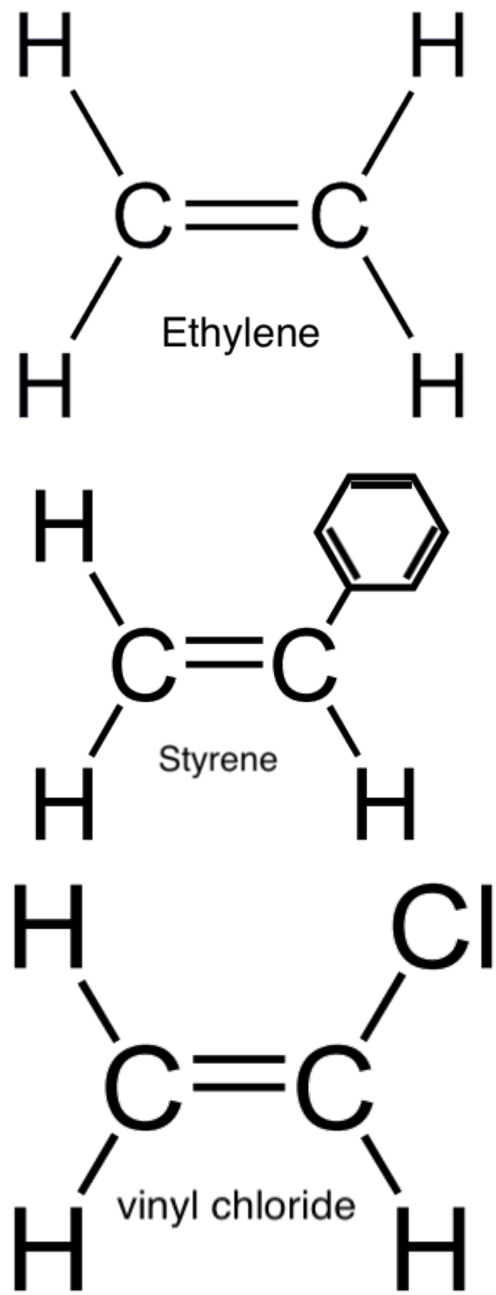


Figure 1-11: Structural formulas of the monomers ethylene, styrene, and vinyl chloride, drawn to emphasize their similarities.

A vinyl in chemical nomenclature is considered a functional group; therefore, all three of these molecules contain the vinyl group.[130] The simplest vinyl is ethylene, with hydrogen as the attached functional group. In polystyrene, the functional group is benzene (benzene is a six-side carbon ring). In polyvinyl chloride, the functional group is chlorine. Since the ethylene monomer is the base for both the vinyl chloride monomer and the styrene monomer, there are therefore similarities between the three thermoplastics I explore in the following vignettes. The double bond is the important chemical feature that allows polymerization as it can be broken by heat and pressure or by catalysts. When the double bond breaks, the polymerization reaction can go forward.

As a chemical precursor, ethylene is the ideal molecule for creating the monomers of polystyrene and polyvinyl chloride, but both of those plastics originally came from elsewhere. The wide-scale production of ethylene was therefore an essential moment for enacting the commercial production of fully synthetic plastics in North America. Dow surmised that ethylene production solved polystyrene's production problem, providing an easily produced base ingredient. According to Larry Amos, Dow was "the first chemical company in the world to make ethylene with crude oil."[131] Previously, ethylene had been manufactured by dehydrating ethyl alcohol, and it was mostly reacted with bromine to make a gasoline additive to eliminate lead deposits. As the popularity of automobiles grew, an increasing amount of ethylene dibromide was required, which spurred Dow to find a lower-cost production process. The resulting "pilot plant … led to the first commercial cracker to produce ethylene from crudes or heavy fuel oil."[132]

In the 1930s, crude oil was abundant. The famous photographs and cultural touchstones of the spurting oil geysers of the Texas oil patch during the Depression were a result of a massive shallow oilfield discovery in East Texas. *The Economist* reported in 1931 that, in a single month, that area went from the production of 55 thousand barrels a day to 253 thousand barrels a day.[133] This was disastrous for the stock market, already deeply depressed after the large declines of 1929 and 1930, as its discovery led to a massive oversupply of oil, crashing the price of its stock and leading to further deflation. Oil companies were desperate to find new uses for the glut so that the price of oil might recover. A spouting geyser in East Texas in 1931 is therefore another moment in plastics' material history where a surplus of natural resources drives the development of the world we have today. In contrast to the magical and alchemical utopian language that is often used to describe early plastics development, fully synthetic thermoplastics developed instead as a result of the rather more heterogenous reality of stock market speculation, oil speculation, land acquisition, drilling, and American oil and chemical companies attempting to recover their share prices during the Great Depression.

To produce ethylene, naphtha is the most important petrochemical. It becomes a gas at approximately 110°C and is collected underneath the lightest gasoline. Naphtha is then thermally dehydrogenated (a process known as "steam cracking") into various fuels, ethylene among them. The vernacular name for the process gives one a hint for what occurs: at temperatures between 750°C and 900°C and pressures up to 7600 psi, naphtha is "cracked" into more useable types of hydrocarbons.[134] The development of steam cracking, now ubiquitous in the gas and oil industry, led to its own set of innovations, as the high temperatures required for steam cracking required different alloys for the tubes. Those innovations were important to the later styrene plants, and Dow provided that information to other companies without any compensation as a part of the Rubber Reserve program.

The large-scale production of ethylene as an additive to fuel for automobiles, however, coincided with the severe economic downturn that characterized much of the 1930s, and the chemists at the Dow Chemical Physics Lab realized that there would soon be a glut of ethylene without a market, as people were no longer buying as many cars (or as much gasoline for their existing cars). Therefore Robert Dreisbach, who was "a very creative chemist,"[135] drew up two sides of a chart, with ethylene on the right and every chemical reactive with it on the left. In the middle, "he charted such comments as: 'would they react with ethylene? What might be formed? Could the product be sold?'"[136] By chance, he grouped benzene and ethylene, and then realized that "ethylbenzene could be hydrogenated to form the styrene monomer. If desired, styrene could be polymerized to form a thermoplastic that might have desirable properties."[137] Benzene, derived from coal tar and already used to make phenolic plastics like Bakelite, was already in plentiful supply at a low cost. The seemingly inconsequential chance grouping of ethylene and benzene would have vast positive consequences for Dow, and eventually, vast negative ones for the planet.

Polystyrene:

Even though polyvinyl chloride and polystyrene are both vinyls, only polyvinyl chloride has vinyl in the name. The styrene monomer takes its name instead from the storax pine (*Liquidambar orientalis*), named as such because the polymerization of styrene was first accomplished in 1839 by Eduard Simon, a German apothecary, who accidentally left oil from the resin in sunlight.[138] The storax pine is only found in the eastern Mediterranean, although there are other gumtrees that are grown in various countries around the world, of which the rubber tree (*Hevea brasiliensis*) and the gutta-percha (*Pallaquium gutta*) are two. Nonetheless, the commercial production of polystyrene needed to overcome two problems: first, the problem of premature polymerization, which prevented its transport; and second, the problem of scarce natural base materials, such as the storax pine. The first problem was solved by two French chemists, Charles Moureu and Charles Dufraisse. During their work developing acrolein for France's Committee for Gas Warfare, later published after World War I in 1922, they surmised that, with the addition of aromatic amines and phenols, spontaneous premature polymerization of liquid styrene monomer could be inhibited until the end-product material was required in an industrial process.[139]

The second problem relating to the lack of a scalable commercial process took longer to solve. While the first mention of polystyrene in *Modern Plastics* was in 1929, where the Naugatuck Chemical Company (a subsidiary of Goodyear) chemist Ivan Ostromislensky claimed that "Styrol Products [were] Now Suitable for Molding,"[140] the reality was that it would not be until 1937 that polystyrene would able to be produced in North America at a commercial scale.[141] This only happened because of the discovery of a more abundant, crude oil–derived precursor – ethylene – and the particular innovations of the Chemical Physics Lab at the Dow Chemical Company.[142]

The materiality of Styron is inseparable from the laboratory culture that it was created within, as its status as the "winner to market" was purely a function of how the Dow laboratories used both competition and cooperation in their research and development. In the Dow Chemical Physics Lab corporate history, the playful attitude toward the work of creating

new products is evident. John Grebe, the director of the lab, had “an unusual management style” that allowed an “expanding group of talented people [to] cultivate their ingenuity.”[143] Along with Ray Boundy, whom Grebe hired to be the lab’s first technical assistant, the Physics Lab went from a single room in the basement of the company’s main office to a large, purpose-built building located a half-mile from existing production facilities. It would soon be “surrounded by new plants developed and process-engineered in the Physics Lab.”[144]
From the successful production of ethylene, the synthesis of the styrene monomer from benzene and ethylene by dehydrogenation, and the subsequent commercial synthesis of polystyrene, began. The synthesis of polystyrene in 1931 was far from the black box of polymer production today, as the early lab-scale process is easily visualized, as opposed to the formidable industrial-scale processes that are currently in use. A description of the lab-scale process follows in chapter two and is largely due to the first female scientist ever to work at Dow Chemical Company, Dr. Sylvia Stoesser. Her meticulous research allowed for polystyrene’s commercialization.

However, the styrene monomer had other uses during the war, so the commercial production of polystyrene for consumers was quickly put on hold. As I previously mentioned in my section on vulcanized rubber, in 1942, Malaya and Indonesia fell under Japanese control. America’s supply of natural rubber was summarily cut off, and they had to scramble to find a substitute. The implementation of the production and scaling of synthetic rubber in the U.S. was headed by the Rubber Reserve program, as I will cover in the next chapter. Synthetic rubber consists of a co-polymer: butadiene and styrene. Dow had been producing the styrene monomer in commercial quantities since 1937; therefore, it was an easy process to scale for them. And scale it did: from an estimated 10,000 tons of all types of synthetic rubber in 1941 to 875,000 tons by the end of 1943. The federal rubber director, Bradley Dewey, commented in 1943 that "in a little over two years, an entirely new $750 million chemical industry which in peacetime would have been a miracle had it been achieved in 15 years."[145] The massive scaling of GR-S meant a surfeit of styrene monomer available at the end of World War II, which, like the glut of ethylene a decade before it, drove polystyrene development into the ubiquitous and proliferative consumer applications of the postwar era.

Polyvinyl Chloride

The vinyl chloride monomer, temporally like many of the resins that would become twentieth-century plastics, was first synthesized in 1835 by the chemist Henri Victor Regnault,[146] but was not polymerized until far later, via sunlight, in 1872 by Eugen Baumann.[147] The vinyl monomer was then treated as a "laboratory curiosity" and toyed with by various chemists for the next few decades. Although the styrene and vinyl chloride monomers were nearly contemporaneous in their synthesis, they have different origin stories: while the styrene monomer started off as a natural resin (much like vulcanized rubber), the vinyl monomer did not, being first described as a colourless liquid with a "gas that burned with a yellow frame with a green mantle."[148] The way that polyvinyl chloride became the plastic we know today is the next story in my vignettes about the interwar birth of the thermoplastics dominant postwar plastics industry.

Polyvinyl chloride in its sunlight (or low pressure) polymerized form proved too brittle to be mouldable at first, which meant that it was considered a useless material. That changed at the beginning of the twentieth century, however. Polyvinyl chloride research resulted from an overabundance of two chemicals: acetylene and chlorine. An electrothermal process was devised to create calcium carbide in the 1890s, which, when combined with water, produced acetylene gas. Acetylene gas was envisioned as a lighting solution but was outcompeted by coal gas and electric lighting.[149] Chloride, on the other hand, was a by-product of the production of sodium hydroxide from the decomposition of salt. Sodium hydroxide was used as bleaching powder in the pulp and paper industry, but there was little use for the excess of chlorine by-product, so there were many applied chemists who sought uses for chlorides. In 1912, the formulation for polyvinyl chloride was revived by Fritz Klatte, working for Chemische Fabrik Griesheim Elektron in Germany. A commercial process was developed at that point, but it was plagued with problems because of the difficulties in creating the polymer, as polyvinyl chloride was extremely difficult to process. Its softening point (160°C) is very close to its decomposition point (180°C), which means that it is "thermally unstable and degrades at the same temperature required for processing."[150] It wasn't until 1926 that Waldo Semon of the BF Goodrich Company discovered that if one dissolves the brittle compound in a solvent – known today as a "plasticizer" – that an elastic solid formed. As Kaufman described the process, "by intimately mixing a high-boiling point liquid, such as tritolyl phosphate, with the polymer, [Semon] obtained a rubber-like mass, not dissimilar from some of the co-polymers."[151] Here, we can see the beginnings of the shift away from the thermoset utopian moment that was Bakelite's dominance in the plastics industry toward the mass production of thermoplastics; the discovery that a relatively high temperature was required to process polyvinyl chloride was a decisive one, as it "marked a breakaway from rubber processing and clearly indicated the need for special plastics equipment."[152] This special equipment became available in the form of the first commercial injection moulders. Injection moulding, described in 1940 in the *Fortune* article accompanying "*Synthetica*," was the revolutionary weapon of the last revolutionary decade in plastics[;] … it came in with some pioneer machines from Germany about 1934. … A charge of molding powder is liquefied and stored in a heated cylinder, from which it is squirted in determined amounts, by plunger and pressure, into a closed, cold mold. As fast as the hot thermoplastic hits the cold metal, it hardens; the mold opens and ejects the finished articles. … The daily production average per cavity of the fastest compression mold is 480 pieces per eight-hour shift; the fastest injection molder shoots out 2880 in the same time. [153] Being able to produce plastic goods via injection moulding (as opposed to compression moulding) was crucial to using plastics in assembly-line production processes, with a six-fold increase in capacities for churning out commodities having changed the calculus of mass production entirely.

In another example of the heterotopic and transgressive boundaries of the early plastics industry, despite polyvinyl chloride needing specialized plastics equipment rather than the modified vulcanized rubber equipment that had been the staple of Bakelite production, early polyvinyl chloride was used as a replacement for rubber. Developed by a leading rubber manufacturing company, polyvinyl chloride became commercially available in 1930 by BF Goodrich as "Koroseal," and it was originally used as a replacement for rubber in shock absorbers. It became a largely invisible material, living inside the gears and parts of automobiles, in sharp contrast to the design-oriented Bakelite that spurred so much consumer spending during the 1930s. Bakelite and other thermoset plastics were used extensively during the Depression to spur domestic expenditures, particularly in the release of many consumer goods like radios, telephones, and irons in colour for the first time. Koroseal did not participate in this excess of redesign; instead, it continued to be mostly hidden inside other applications, partly because of difficulties in its production and problems with respect to plasticizers "sweating" out of the material, making the surface gummy or sticky. It was not until the Union Carbide Corporation developed Vinylite, a co-polymer of vinyl acetate and polyvinyl chloride, that polyvinyl chloride became more visible. Vinyl acetate lowered the softening point, much like a plasticizer, so that the liquid form of Vinylite flowed more easily.[154] Union Carbide, in contrast to BF Goodrich's interest in a synthetic rubber, was intent on finding a replacement for Tung oil, whose durability was superior to many other varnishes on the market at the time but which was subject to interrupted and irregular supply, as the raw material came from China.[155] Despite Vinylite being a far more stable and less temperamental material, it also struggled to find a consistent consumer market until the late 1930s, when its application extended to raincoats, insulation for wiring, and most prominently long-playing phonograph records (which carry the vernacular name "vinyl" to this day); these uses became its foothold in the market. This was despite Vinylite having been the subject of an extensive exhibit at the Chicago "Century of Progress" Exposition, featuring most prominently a house entirely made out of Vinylite, which *Scientific American* described as "the house that chemistry built."[156] The Vinylite house appeared a full quarter of a century before the far more famous "Monsanto House of the Future" was unveiled at the National Plastics Exposition in 1956, which later found its home at Disneyland for the following fifteen years. Here again the tensions between material scarcity and abundance made themselves clear. While polyvinyl chloride was birthed, and ultimately commercialized, due to an overproduction of acetylene and chlorine, ethylene was also important to polyvinyl chloride production as a way of cleaning up the polyvinyl chloride industry in the 1950s: production of polyvinyl chloride via the acetylene route required a mercury catalyst, and the subsequent production of the highly toxic methylmercury was the source of the Minamata Bay disaster.[157] The ethylene route to producing the vinyl chloride monomer requires no mercury, and it is the only way that the production of the vinyl monomer occurs today in North America (though the acetylene process is still used in some countries with more lax environmental regulations).

Polyethylene

Although first conceived by accident in 1898 by Hans von Pechmann during his experiments with diazomethane, polyethylene's commercial history began instead in England, at the Imperial Chemical Institute (ICI) in 1933. Its birth was originally the result of two chemists' basic research and development – Reginald Gibson and Eric Fawcett – and a fortuitous accident. When they subjected a mixture of ethylene and benzaldehyde to extremely high pressure, a residual oxygen contamination caused the precipitation of a white, waxy material. Because it was an accident, though, the initial product was not easily reproduced. It would be another two years before another chemist at ICI, Michael Perrin, developed a replicable process to create what is today known as low-density polyethylene. As it was the first polyethylene, however, it was only known as polyethylene, without any modifier. More commonly, it was called by its trade name Polythene.

The new plastic coincided with Great Britain's entry into World War II, and Polythene was extremely important in reducing weight for radar applications so that they could be placed in the nose of an aircraft. Polythene was an excellent electrical insulator, like other plastics, but weighed less and was more resilient to chemical and atmospheric assaults than other materials.

Under Allied collaboration agreements, ICI licensed the use of Polythene to DuPont in 1943, and as of 1944 DuPont was producing its own, with subsidies from the U.S. military. DuPont eventually devised a tubular process for its manufacture, and despite being rife with technical and manufacturing issues, that process allowed an enormous amount of wire casing to be produced.[158]

Polythene was a completely different class of plastic, one which would eventually be known as an olefin plastic, as I will show in my third chapter. At first, the classificatory schemes that the plastics industry had used were insufficient in describing it. In the first article about Polythene appearing in *Modern Plastics* in February 1944, the author explained that

because of its modulus of rigidity, [P]olythene occupies a peculiar place among the plastics. In thin sections it may be classified as nonrigid, yet it lacks the limp, rubbery quality that characterizes most nonrigid plastics. On the other hand, [P]olythene in thick specimens has enough stiffness to class it among the more rigid plastics. Incongruous results are often obtained, however, when rigidity, impact strength and related properties of the plastic are measured by standard methods.[159]

Its unusual properties along with its ability to insulate electrical wiring meant that "the material [was] available in production quantities only by specific authorization of the WPB under Conservation Order M-348."[160] The fact that industry was not able to obtain Polythene unless for military purposes did not stop them musing about its potential utility; for example, the photo accompanying the first article about Polythene had an ice cube tray and a bottle stopper amongst the more utilitarian tubing and grommets pictured. The author pointed out that the "toughness, flexibility, low water absorption and moisture impermeability will make it suitable, when available, for containers, including collapsible tubes for food, cosmetics and the like."[161] This was a prescient projection, which may have come from the fact that Earl Tupper was already experimenting with scrap Polythene at DuPont for exactly these purposes.[162]

Synthetica Redrawn

The increase in production for all three of the thermoplastics that became the generic "plastic" we speak of so pejoratively today were all borne of wartime necessities. Whether from the massive scaling of the styrene monomer as a precursor for synthetic rubber, the need for replacements for rubber coatings for fabrics through polyvinyl chloride, or the importance of polyethylene in coatings for wiring for high-frequency applications like radar, there was an enormous increase in production of fully synthetic thermoplastics that could not so easily be stamped down afterwards. The companies responsible for these products, on the precipice of the enormous changes that were wrought by the internationalisation of corporations and the explosion of psychological precepts in advertising, were obviously not going to shrink. Once wartime spending concluded it behooved them to find other places to sell their products. The next chapter will show how one company, Dow Chemical, used brand recognition and marketing of its plastic to good effect, at one point advertising its plastic, Styron, as a "super impact" plastic, tough enough for the roughest of children (see Figure 2-11 to 2-13 on pages 136-138 for examples of this marketing campaign). It is not an exaggeration to say that North American consumer culture was born out of this moment. As I will show in the next chapters, polystyrene, polyvinyl chloride, and polyethylene all entered disposable applications through the ensuing gauntlet of plastic toys and domestic objects that bombarded the American consumer.

Chapter 2: Just Hear That Styrene Tinkling

Figure 2-1: A Troll doll pez dispenser identical to the one described in text. From eBay.

Visions of Polystyrene, from Crystal Balls to Christmas Gifts

Christmas is a season of excess – excess food and drink, excess spending and credit, excess plastic and packaging. One of those excesses now sits on my desk, smiling its friendly little face at me – a Troll doll Pez dispenser. I bought the Pez dispenser on Christmas Eve, one of a bunch of small, fun objects to put into stockings, not really thinking about anything other than the laugh at its reveal. The Pez themselves were summarily consumed by my child with disappointing speed (I am a big fan of the chalky little candies). The Pez dispenser has sat, staring at me, ever since.

Pez dispensers have a distinctive sound when one pulls the head from the body. That high-pitched "tinkle" is a property of the material they are made from: polystyrene. The dispenser sitting on my desk is Made in China*, though the candy itself is still exclusively made in Orange, Connecticut. The factory produces 12 million Pez per day, consuming 12,500 pounds of sugar in the process. The U.S. alone consumes over 3 billion Pez candies per year, close to a roll of candy for each American. The company is still owned by the descendants of the original patent holder, Eduard Haas III, who invented Pez in Austria in 1927 for peppermint candies as an alternative to smoking.*[163] *The similarity in size to a lighter is intentional as is the "flick" to open.*

Pez dispensers are an iconic part of pop culture, with some of the rarest dispensers fetching as much as $13,000 at auction. eBay was started because of the founder's fiancée's Pez dispenser collection.[164] *The company that makes Pez, while still primarily a candy manufacturer, recognizes the importance of the dispenser to their brand and opened a museum of Pez dispensers in 2011.*

As iconic and collectible as they may be, Pez dispensers are also trash, with 70 million produced per year. Most of them end up in landfills, usually after some time lingering as a toy. Pez dispensers are single-use plastic sold at a small price, a hybrid of food, plastic, collectible, and garbage. These are the type of objects that give me pause before I think of them as unambiguously disposable. Indeed, it is why that little pink face is still smiling at me, whereas all the other packaging from Christmas is long since at a landfill. The polystyrene troll is not made up of the durable, eternal material of a utopian future. It represents the fleeting presence of momentary satiety in a world slowly filling with similarly discardable single-use plastic objects, masked in a veneer of false utility.

Plastic Packaging and Packaging Plastics

The introduction and chapter one covered the conception of plastics, described their birth as utopian materials of limitless possibilities, and provided enough fundamentals of their chemical makeup for the reader to understand some of the complexities and simplifications that make up the word *plastic*. The stories that follow in this and the next two chapters address how plastics contributed to the war effort, how the toy industry entered the picture, and what the chemical companies did with their enormous production capacities afterwards. In so doing, these chapters reveal how plastics became disposable, something to throw away rather than keep. The ramifications of these changes are felt to this day, with the proliferation of single use plastic packaging used for perishable food products. Polystyrene is the first of the plastics I cover, as polystyrene is most iconically associated with plastic waste in the form of a take-out container for fast food. My chapter will use the residues of different modes of polystyrene in the twentieth century, showing how a selection of consumer goods each embodied a different vision of polystyrene. This indeterminacy eventually settled into the one we can see now: the ubiquitous and problematic take out container. This history shows how the domestication of polystyrene was a historically contingent process, not a necessary or automatic function of its materiality.

Polystyrene was not always used for packaging. In their study of packaging in the twentieth century, Gary Cross and Robert Proctor argue that how foods were packaged brought about an enormous change in North American tastes as the twentieth century progressed. Their analysis focuses on the roles that cylindrical packaging played in delivering a concentrated jolt of sugar, nicotine, or opiate. Instead, my analysis concerns the ways that playful packaging created a hybrid between toy and trash. The Pez dispenser, and items like it, fall under the marketing category of *premium* objects: they are promotional items associated with the purchase of another. Premiums were a major aspect of Depression-era use of plastics. Government policy in 1930s America was heavily focused on measures to mitigate the worst effects of the Depression, and amongst those measures was government-mandated price fixing, where companies were unable to lower their prices below a floor set by the National Recovery Administration. The policy sought to inject stability into a deeply destabilized market and was in effect from 1933 to 1935. Companies were therefore unable to undercut their competition. To get around price restrictions, many companies found alternative incentives with premiums for which the consumer could mail in or were included with purchase. Marketers therefore popularized premium objects and were subsequently able to find ways into American households even when consumer spending was deeply depressed. Use of premiums therefore expanded in the American market concurrently with the development of polystyrene, as plastics were finding new markets in small free gifts with purchase. Premiums were also one of the most significant early markets for consumer plastics, which marked the beginning of an increasingly blurred boundary between food and toy, durability and transience.

Michael Thompson in *Rubbish Theory*, one of the seminal texts of discard studies, posits a dynamic system of use-value, where objects can shift back and forth based on context and culture, as opposed to the static use-value of the Marxist commodity. The dynamic system allows for a far deeper understanding of the proliferative and detrital aspects of twentieth-century capitalism. Thompson's two general starting categories are "durable" and "transient"; respectively, they denote objects with infinite lifespans and increasing value and objects with finite lifespans and decreasing value.[165] Premiums start in the 1930s in the category of durable, as they were heavily marketed based on their re-use, especially to women through domestic objects – from Ovaltine mugs to cereal box toys and Betty Crocker measuring cups. However, throughout the twentieth century, premiums, toys, and packaging moved towards an accelerated transiency, as I will demonstrate in objects that show how the temporalities of plastics as a consumer good shifted through the domestication of polystyrene.

What fascinates Thompson is not durability and transiency as categories, per se, but the radical discontinuity of an object switching from transient to durable in the form of becoming an antique or collectible.[166] Thompson's radical discontinuity informs my methodology, as the reversal from worthless to worthy gives me access to the residuals I used to tell the story of polystyrene. In the absence of archives of disposable packaging, the small toys and premiums contained herein are those very types of objects that have, at some point, experienced this inversion of their value, as their continued traces in the world are largely dependent on such transitions of value. These traces allowed me to study these objects, as one of my main sources of information (beyond the ubiquitous trade catalogues I rely on) were collector catalogues and museum collections.

Although I rely on these radical discontinuities for the material objects I use to tell my story, Thompson's binary of durable and transient to analyze the objects at the time of their manufacture is false -- or at least anachronistic. Through the objects contained herein, we recuperate a time when plastics have not been settled into one category or the other. As Bruno Latour points out, facts are a collective process, and the disposability of polystyrene was both temporally and materially situated within an unstable meaning.[167] My material interlocutors are hybrid objects: both durable and transient at the same time. The categories of durable and transient are a result of the historical moment I detail in the following sections, of the boundary work that was performed by toy manufacturers and chemical companies to sell their wares. Plastics were then, and are now, a "both/and" material. They will never be able to fully resolve due to this disjunct, but it is important to understand how this disjunct came to be. To be able to see the disjunct requires a refractory vision, as we will find in the invention of the polystyrene crystal ball.

In short a confluence of factors created the disposable reality we live with today. Starting with the crystal ball, the objects I follow in this chapter each address a different aspect of the invention of polystyrene and the popularization of premiums, along with the use of prewar plastics in toys and their convergence with Dr. Islyn Thomas and the Ideal Novelty & Toy Company. The first two objects after the crystal ball take us to the end of World War II and are comprised of a little Orphan Annie mug and a set of "Victory Fleet" toy boats made by the Ideal Toy Company. The continued and repeated emphasis on the quality of plastics continued postwar, even though polystyrene was being used in increasingly disposable applications; in the next two sections a novelty Christmas ornament from the E. Rosen Candy Company shows that increasing disposability, and the Dow "Styron 475" label shows how the Chemical companies fought against the transient designation. Dow attempted to set its plastic in toys apart from other, less reliable plastics. However, global manufacturing trends meant that toy manufacturing experienced a massive move offshore during the late 1950s and early 1960s, and many American toy manufacturers closed their doors. The final two objects, a toy boat from the Plastics Museum housed at Syracuse University, and an advertisement for banana boat sundae dishes, show that as the cast iron moulds were the expensive part of plastics manufacture, many of those moulds were sold off as a part of dismantling various toy manufacturing companies, and domestic uses in packaging for things like banana boat sundaes have remarkably similar forms to the previous toy boats that largely populated five-and-dime shops. The rise of a disposable society in North America is partly a story of the invention, marketing, and scaling of different iterations of polystyrene. It is also in part a story of how the mediation of domestic goods, a responsibility that falls almost entirely to women, changes in the shift from durable to disposable packaging. Within that shift, the ways in which playful applications of plastics contributed to a hybrid, liminal state of an object like the Pez dispenser will become (refractorily) clear.

Figure 2-2: Advertisement for Styrene by Dow Chemical Company. From Fortune *magazine, 1937.From the Dow Image Archive, Science History Institute.*

The advertisement above appeared in *Fortune* magazine in 1937 and was Dow's first advertisement for monomeric styrene. There are five geometric objects pictured: a cylinder, rectangular prism, cube, and two spheres. They are shapes that suggest symmetry and clarity, but not specific applications. Like the cubist movement with which they share an aesthetic, they are geometric representations of a reality: a world of infinite, malleable options and progress into which we can now glance. The foremost object is a perfectly round transparent sphere, a fortune teller's crystal ball made of polystyrene, evoking a futurity of limitless possibilities and trajectories. The text at the top stands at attention, casting its shadow on the scene and proclaiming, "STYRENE – A Triumph of Synthesis." A woman in the corner of the advertisement, hair swept back and in a white lab coat, sits, slightly hunched, staring out at the reader with an enigmatic expression on her face, regarding the reader through a prism. The advertising copy states that the monomer styrene and its polymeric form have "such a wide range of applications that its present uses represent only a meager measure of its potentialities." The objects cast shadows and light, their refractions interacting with each other to make complex patterns on the plain green surface below them. They allow a metaphorical glimpse into a utopian synthetic future.

I touched upon the conception of the styrene monomer and the birth of polystyrene in chapter one, as well as its subsequent scaling because of the Rubber Reserve Program during World War II. The image above, however, opens an entirely different conception of styrene that is often written out of its history. The crystal-clear form of polystyrene is presently a far less visible form of the plastic, as most people know polystyrene today as Styrofoam, the stuff of take-out food containers, insulation, and packing peanuts. Styrofoam, however, is only one form of polystyrene, one that exists as a genericized tradename of the material whose technical name is either expanded or extruded polystyrene foam (EPS). In order to understand polystyrene's refractory reality, the synthesis of the original crystal-clear material must be pulled apart from the birth of the foamed version, and how it played a crucial role in polystyrene's acceptance as a packaging material. The crystal ball formed a bridge between the earlier, utopian visions of plastic as a material with limitless potential, and its later use as a domesticated, and then transient, consumer good.

Figure 2-3: Sylvia Stoesser in 1935, Gazing through a Prism of Polystyrene. From "Saluting 50 years: Styron," Product 00502, Dow Historical Collection, Science History Institute.

The similarity between the woman depicted in the advertisement and the real life individual responsible for a successful polystyrene is striking. For the male-dominated world of Dow Chemical Company, the choice to depict a female scientist in the corner of the advertisement was likely intentional; the rhetorical significance of this choice will be addressed below. Dr. Sylvia Stoesser came to work at Dow Chemical in 1929 as a spousal hire, though between her and her husband, she was the one with the doctorate in chemistry. The lore of her hire was that Herbert Dow's wife intervened upon her husband's behalf, as Stoesser was unwilling to move from the Washington DC area (where she held a job at the National Bureau of Standards studying artificial sweeteners) or marry unless she was guaranteed employment. Herbert Dow therefore hired her himself, in lieu of Stoesser having to undergo the normal interview process.[168] She was the first female scientist to ever be employed by Dow Chemical Company.[169] Stoesser was integral in showing that "polystyrene could become a profitable plastic if volatile content could be kept below 1%."[170] Dow Chemical ran into initial problems with their styrene production for much the same reason that Alexander Parkes failed with his Parkesine, in that their drive for inexpensive base materials caused production problems. Larry Amos pointed out that while the "Midland ethylene plant was using the cheapest oil they could buy, [Stoesser] found that more expensive oils would be cheaper for Dow because they gave better yields."[171] Stoesser determined that the ethylene produced in Dow's steam cracking process had to be from higher-purity resources to create a commercial polystyrene. This was a key breakthrough, as at the time it was not economically viable to purify the post-synthesis styrene monomer to the point that it would not suffer the "monomer disease," where polystyrene made of styrene less than 99 percent purity broke down, crazed, and eventually shattered due to contaminants in the cheap feedstock – all attributes contrary to what we think of plastics today.

The role of stabilizing and scaling this network of material actors was women's work. Stoesser quickly "assumed responsibility for the analytical work [of producing polystyrene], the testing of many potential inhibitors and for the quality of the styrene in general as well as that of polymers."[172] She devised the original process for producing polystyrene to the level of purity required, as in her "laboratory-scale process she filled round glass bulbs, salvaged from burned sixty-watt electric lamps, with pure styrene and research additives.[173] She immersed the filled bulbs in a water bath for ten days at 95°C and then finished the polymerization in an oven at about 160°C for a few days. The glass was destroyed after cooling, and a round 250-gram ball of crystal-clear polystyrene was recovered."[174] Here we encounter our first refraction: contained within glass, still at this time one of "the oldest plastics known" in its adjectival form, a more durable substance is created, ostensibly to take its place. The process of using glass as an envelope to test the properties of different polystyrenes shifts polystyrene away from the fragile properties of glass found in the monomer disease. The glass is then sacrificed – made transient - in the process of making the material less like glass. It is the first of many reversals of meaning in the durability/transience nexus, and it comes from the notion of plastic being glass and glass being plastic.

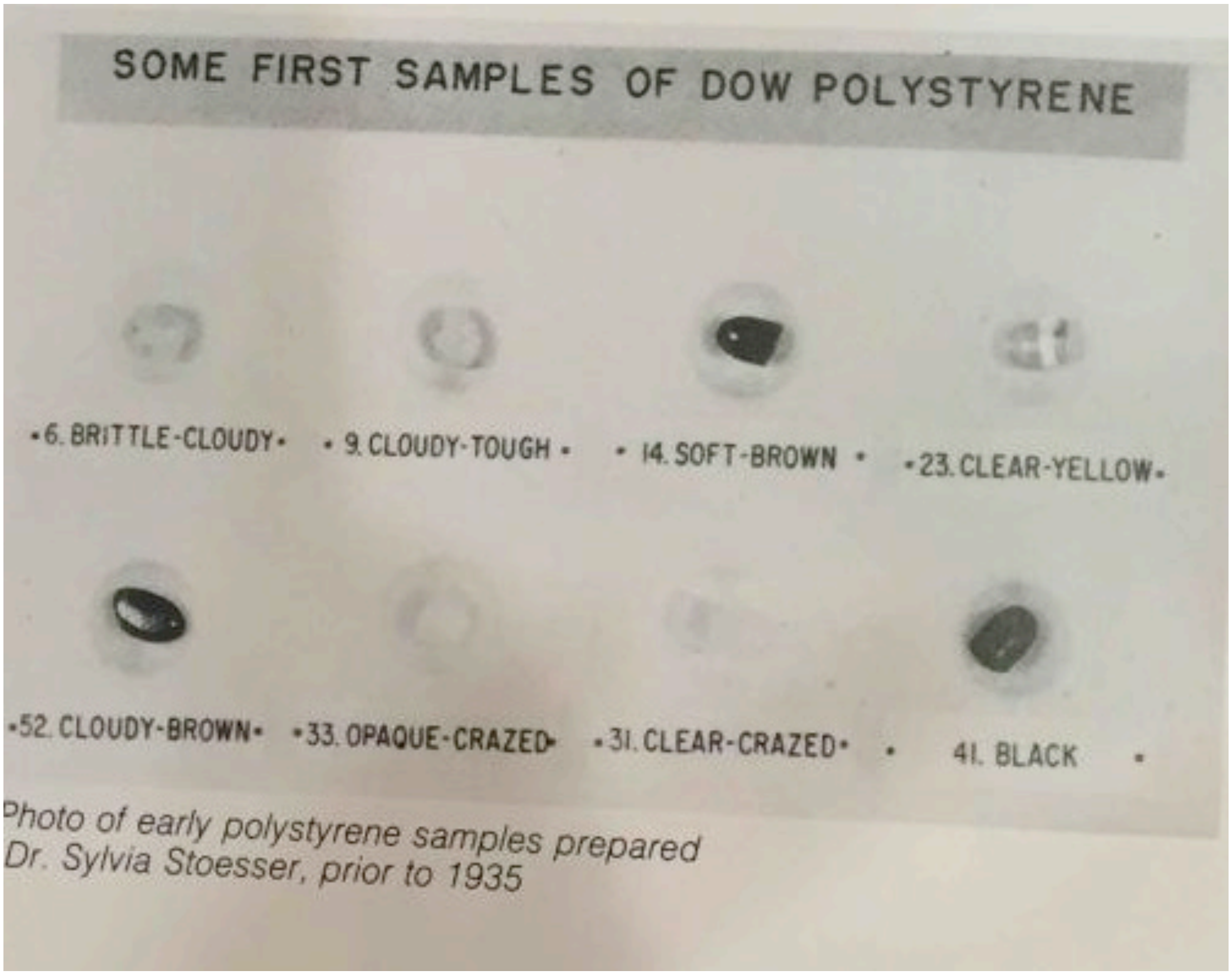
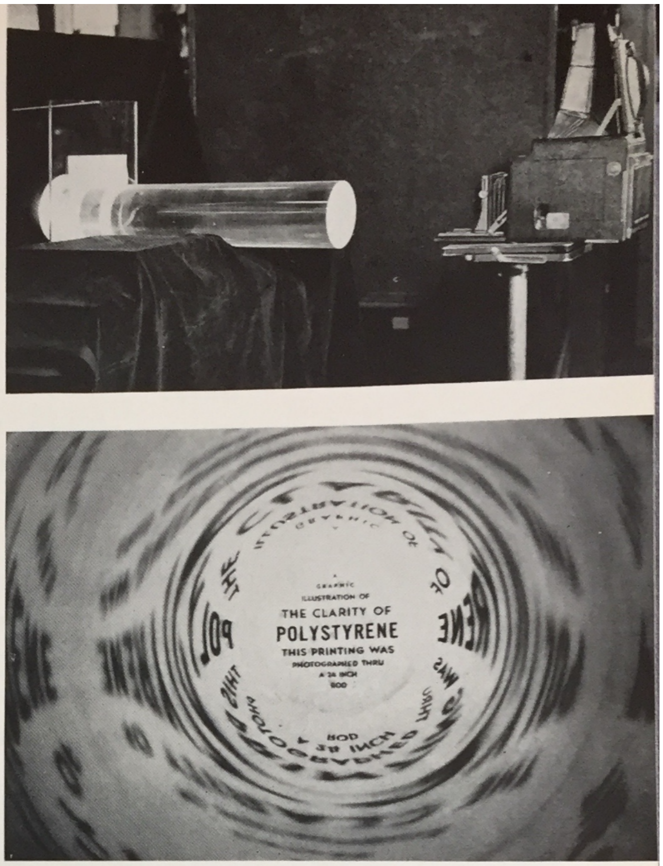
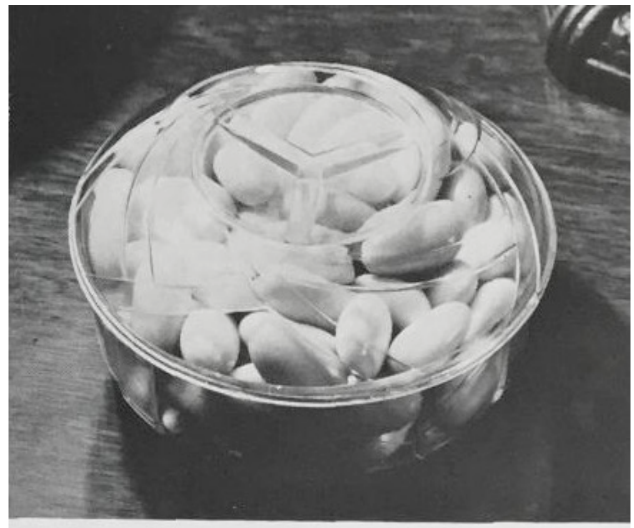


Figure 2-4: A Selection of Early Polystyrene Samples in "Crystal Balls." Prepared by Dr. Sylvia Stoesser. From "Saluting 50 years: Styron," Product 00502, Dow Historical Collection, Science History Institute.

Enter the crystal ball, potender of the future. The balls of polystyrene that Stoesser produced during her experimentation in the early 1930s were used as trade and industry giveaways and sent along with advertising for the yet unbuilt polystyrene plant, functioning as premiums for the mass production of polystyrene. They were crystal clear and made giftable paperweights since coins, magnesium crystals, and other ephemera could be suspended in them. The transparency was paramount to polystyrene's early marketing success, as I demonstrated in my introduction, because a lightweight transparent plastic to replace glass in aviation and building applications had been sought after for years. The pilot plant that opened in 1937 was simply a scaled-up version of the same process as Dr. Stoesser's lightbulbs, using 11-gallon tin drums as reaction vessels. After the polymerization process was complete, the tin drums were cut away and the resulting ingot was chopped up by hand with an axe and subsequently ground into granules for sale.[175] Stoesser's process only changed when wartime tin restrictions meant a continuous process had to be developed instead. This method worked to produce the first 200 million pounds of polystyrene, which, despite its potential as a replacement for glass, mostly found applications in the internal parts of the greatly expanding radio and telephone industries due to its dielectric strength. Here again we see the refraction between what polystyrene was envisioned to be and what it became: despite its beauty, it was relegated to interior components, which rendered it invisible rather than transparent.



The Dow Chemical Co. demonstrates the clarity of its polystyrene by casting a 24-inch rod, then photographing type through the end without distorting the letters. Both the process and result are shown above



Norton Laboratories, Inc., molded this candy box from polystyrene. It has the transparency of glass with less than half its weight and is far less fragile. Looks good for packaging things to sell

Figure 2-5: A polystyrene rod, showing its clarity, and a candy dish below. From Modern Plastics, *October 1938, 48-53.*

Polystyrene, first mentioned in *Modern Plastics* in 1929, was reintroduced to the industry in *Modern Plastics* in October of 1936 under the unassuming heading of "Vinyl Resins (Including Polystyrene)" in the "Product Directory" issue. There, the author acknowledged that "commercial development has necessarily been slow, due to the fact that until recently methods had not been developed for the production of the monomer on a commercial scale at a cost that would permit more than a few speciality (sic) uses for the polymer."[176] A year later, polystyrene appeared as the star of the show in a feature article in October of 1938. Written as an anthropomorphized bibliography, it went through polystyrene's history as the "oldest synthetic organic plastic," detailing every major advance from the early-nineteenth century onwards, finally culminating in "the advanced development of radio and television [that] began to demand an easily molded material of very low loss and power factors."[177] The astonishing photograph included from Dow Chemical Company in that article showed an undistorted and readable imprint on the bottom of a twenty four inch rod, which served as an example of the purity and crystal clarity that polystyrene possessed (Figure 2-5). Taken along with the *Fortune* magazine advertisement above, which stated that "there is every reason to believe that Styrene will mark a new era in the production of optical equipment," it becomes plain to see that Dow Chemical Company had high hopes for polystyrene as a future replacement for ocular lenses, planning to create a high-end market for polystyrene based on its beauty and unique properties. Dow's vision for polystyrene was clearly toward more durable uses, wanting to usher in a "new era in optical equipment" with a material that is touted to be "more brilliant… and transparent than glass." But the softness of the material clouded its future in the optical field, as it scratched too easily to be able to be anything but the most temporary of lenses. The durability of glass, despite its heavier weight and propensity to break, won out in optical applications. However, directly underneath the polystyrene rod, on the same page as that amazing photograph, there was a picture of what polystyrene would soon become synonymous with: a premium candy dish.

The significance of the imagery in the Dow advertisement thus becomes clear. Not only did the woman in the lab coat bear a striking resemblance to Stoesser herself but her inclusion was also a subliminal nod to the beauty and utopian aspirations of the material she had a hand in creating. Her gaze through the prism enigmatically looked toward the future. The initial promise of polystyrene was in the creation of a material, lightweight and unbreakable, to replace glass. Its delicacy and beauty meant that it was easy to see it as such, the brilliance and clarity reflecting a market for future luxury items. The material was emphasized for its novelty, newness, and progressive ideals, just like Stoesser's presence at Dow itself. Her crystal balls created the process by which Dow could move forward into the world of polystyrene. But that vision became refracted through a lens of Depression era economic recovery and government regulation that saw plastics being used for very different things. As we see in the next section, the coding of plastic became more overtly domestic and female. Through their use in marketing premiums, plastics became indelibly linked with ideas of domesticity and childhood.

Figure 2-6: Advertisement for "Beetleware," a Urea Formaldehyde Plastic, Emphasizing Its Use in Premiums. From Modern Plastics*, 1934.*

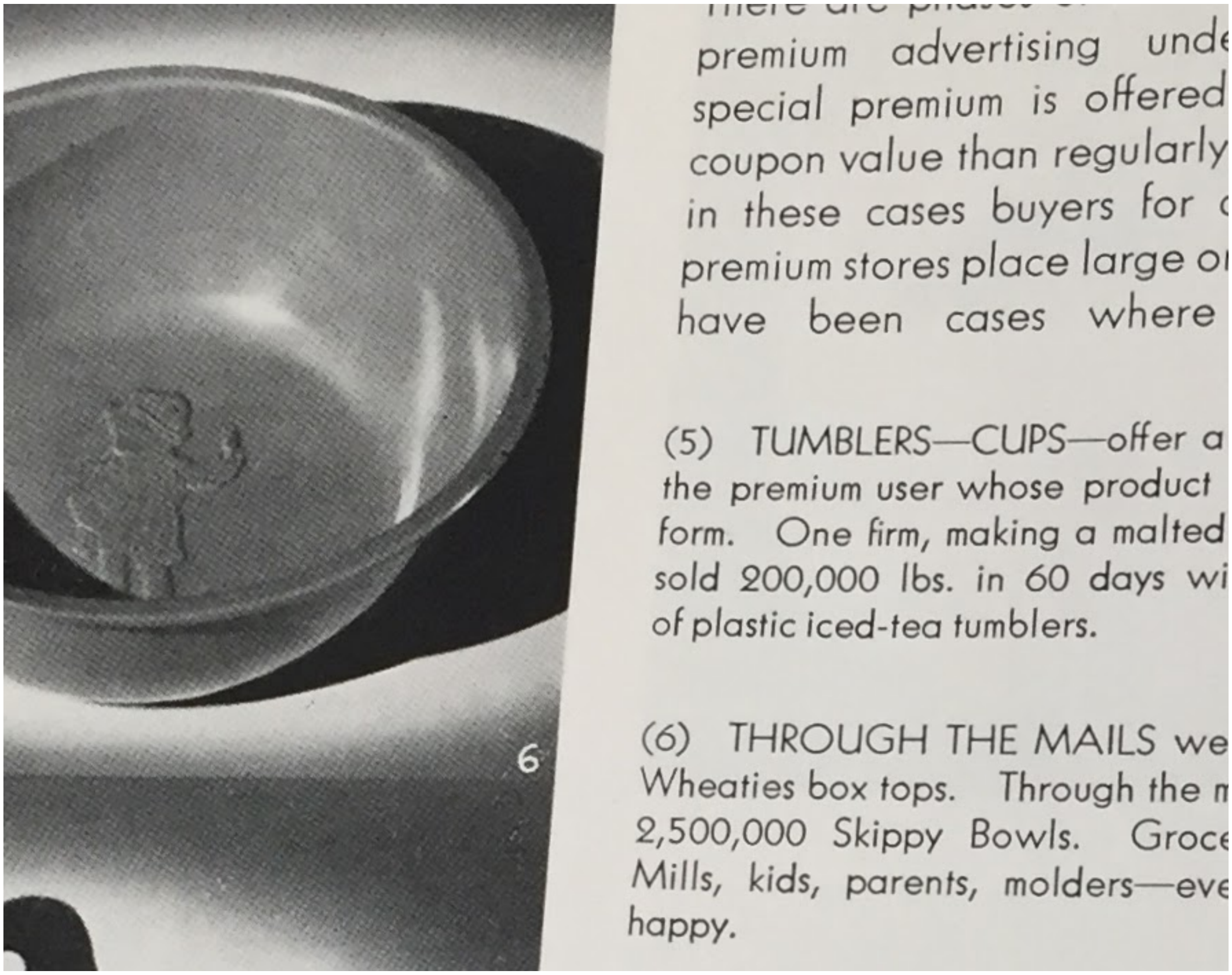
When a crystal refracts, a rainbow of colour is created. Likewise, colour has been crucially important to plastic's stabilization as a material not to be taken seriously. Chemical engineers had been searching for ways to add colour to plastics for many years before polystyrene was invented, and as it was being developed, in the laboratories of Dow Chemical, another revolution in plastics was taking place on the other side of the Atlantic Ocean, one that would be highly influential in the plastic's eventual development: Beetleware. The advertisement above is one of the few colour advertisements in an otherwise black and white magazine, showing how important the addition of colour was to the industry. The objects pictured were associated with domestic life – a cereal bowl, measuring cups and spoons, cookie cutters and a dry goods scoop surround the iconic little Orphan Annie shaker cup that took centre stage.

Beetleware, in the advertisement above, was the tradename for urea formaldehyde. Urea formaldehyde is a thermoset plastic originally produced by British Cyanides Company and started being marketed in the U.S. in 1934 by their American partners. It is a close chemical cousin to Bakelite, with one key difference. Urea formaldehyde was clear or milky white, and it therefore leant itself to the addition of colour – the first mouldable thermoset plastic to do so. Before Beetleware, fully synthetic mouldable thermoset plastics were black or dark brown. The addition of colour introduced a fundamental change in the way that plastics were regarded – instead of a serious material used for telephones and radio components, a bevy of colourful consumer goods appeared for the first time. A more colourful vision of plastics therefore emerged.

While the 1930s saw a boom in research and development for Dow Chemical Company, the rest of the U.S. economy and household consumption declined precipitously during the Great Depression. While black sufficed for the first telephones and coffeepot handles, during the Depression, many industrial designers sought to spur consumer spending with a redesign of household objects in colour for the first time.[178] The first solution to the lack of colour was found through the German innovation of cast phenolic, whose slightly different phenol-formaldehyde ratio allowed for a filler-free alternative, which could then be impregnated with colour. However, the addition of colour meant that the material could not be moulded easily, as any kind of filler (essential to the compression moulding process) would destroy the colour and clarity. It was instead "cast" into tubes, rods, slabs, and sheets, which were then machined into shape on modified woodworking equipment resembling lathes or presses, which added to the cost of the final consumer good.

The colour issue was finally resolved with the birth of urea formaldehyde in 1921 by an Austrian chemist, Fritz Pollak. Its "water white" formula meant that it could assume "any desired colour from light pastels to rich primary hues."[179] Although Pollak patented urea formaldehyde as "Pollopas" and intended it to make inroads in the "organic glass" market, much like the proposition for styrene above, it was the British Cyanides Company that managed to commercialize it.[180] It started to export urea formaldehyde in 1928 in the form of molded tableware, branded as either Bandalasta, Beatl, or, as above, Beetleware. The tableware was so successful that it pulled the company out of the brink of receivership and allowed the company to pivot successfully into plastics as its main product, becoming British Industrial Plastics Ltd. in 1936.[181] This represents a parallel stabilization of plastic, but with a contrasting appearance to the clear plastic invented by Stoessor. While Stoessor/Dow's clear plastic lent itself to luxury items, the coloured plastics gave rise to a different vision (and market): premiums.

The effect of adding colour to plastics was dramatic. Coincident with the expiration of patents held by Baekeland in 1926 and 1927, which reduced the artificially high prices for thermoset plastics, the ability to colour urea formaldehyde suddenly allowed thermoset molded goods to move away from industrial products and into colourful consumer commodities. At that point, the American public was still not very familiar with plastic as a consumer good in anything but the most utilitarian applications, despite Bakelite's claim to the "material of a thousand uses" most Americans had contact with plastics only as the handle of their coffee pot or their telephone. As a result of this unfamiliarity, American Cyanamid, collaborating with British Cyanides, was particularly interested in the premium market, which it hoped "would familiarize the public with Beetle and speed its acceptance."[182] The market for premiums was quite large in the 1920s, and as the U.S. moved into the depths of the Depression incentives and marketing to entice consumers to purchase goods became far more sophisticated.[183] Howard Dunk, a regular contributor to *Modern Plastics*, wrote in 1934 that the size of the market was enormous and growing, as "during the four years [before July 1933] there were over 800 million dollars of premiums sold" (i.e., 200 million dollars per annum), and that in the next year, the market had expanded to be worth around 300 million dollars – a 50 percent increase in a single year.[184] He also pointed to the "Executive Order … [that read] as follows: 'in view of the extent of the industry, the widespread use of premiums, and the fact that premiums at times lend flexibility to rigid prices, it appears there should not be a general prohibition against their use.'"[185] Selling the idea of premiums to the plastics industry was therefore quite overt. Gifts with purchase were common throughout the 1930s, with a Depression era emphasis on the addition of premiums to create a demand for certain brands of essentials. Premiums in the 1930s, before planned obsolescence became the driving ethos of twentieth century capitalism, were meant and designed to be durable objects. But their pairing with consumables – flour, Ovaltine, cereal – meant that the object you had to buy to receive the premium was summarily consumed, and had to be purchased again, thus giving you a duplicate premium object. In duplication, there is (eventually) devaluation. While the process was often mediated through the common practice of collecting a 'set' of similar objects, there was an inevitable point where duplication became unmanageable, the durable-transient continuum was disrupted, and the marketing campaign was a victim of its own success, as those premiums that were supplied became wasteful, clutter to be cleaned.



premium advertising unde
special premium is offered
coupon value than regularly
in these cases buyers for c
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(5) TUMBLERS—CUPS—offer a
the premium user whose product
form. One firm, making a malted
sold 200,000 lbs. in 60 days wi
of plastic iced-tea tumblers.

(6) THROUGH THE MAILS we
Wheaties box tops. Through the m
2,500,000 Skippy Bowls. Groce
Mills, kids, parents, molders—eve
happy.

Figure 2-7: Detail from "Premiums, Plastics, and Profits!" Showing the "Skippy" Bowl. The cereal bowl was the same one that appeared in the Beetleware advertisement above. Modern Plastics *magazine, October 1934, 40-48.*

Targeting housewives and children with premiums was intentional. In Dunk's next article for *Modern Plastics*, he argued that "there is no question that a premium plan is one of the most successful ways to enlisting children's interest in a manufacturer's products and service[;] … there are many articles of plastic that have an interesting child appeal."[186] The most popular premiums amongst children, due to its tie-in with the Little Orphan Annie radio broadcast serial, were those offered by the Wander Company for the purchase of their drink, Ovaltine.[187] Every week, children were instructed to "send in a dime 'wrapped in a metal foil seal from under the lid of a can of Ovaltine' so they could get the latest in a series of premiums."[188] These and premiums like them were explosively popular in the interwar period, with product runs in the tens of millions.

While the examples above were focused on children, marketing premiums to women was also overt. As early as 1930, the plastics industry was pitching the idea of moulded boxes being excellent re-use packages for women. Here, too, even before colour was on its way to being part of plastics vernacular, the boxes were praised for their "color and color effects, different and often expensive where the process of securing them is confined to printing."[189] One article pointed out that the advantages of plastic containers, "beyond the possible objection of greater cost, are many; probably the outstanding one being permanency, that is that the box may be used as a refill case or have a secondary use" and "having real beauty."[190] One of the products featured in this article was a precursor to the postwar polystyrene candy boxes, as the "Domart Sewing Box … when packed with Park & Tilford and other candy, is an excellent gift, one that is useful and permanent, for the permanent features are not effected [sic] by the temporary use of the box as one for candy." Note that the candy was present to sell the box for later re-use, and not to hold the candy, in a reversal of how we think of packaging today. The remainder of the quote illustrated best exactly how the plastics industry regarded women as the primary consumers of their products, as Dunk stated that "we believe that there are enough old-fashioned ladies that stick to candy and sewing, even in this day of cigarette ads and ready-to-wears, to provide a volume of sales worthwhile." [191]

The hybridity of the Domart sewing box shows how dramatically the packaging paradigm has shifted in less than a century. The candy is added to entice the consumer to purchase the *box*, rather than the *candy* being the commodity, which would be the case today. The reversal from the package being the durable object and the candy being sold as a bonus to the premium is a direct contradiction to the ways that we currently think of packaging, and a fascinating subversion of the durable/transient dichotomy. The later manifestations of this exact phenomenon follow, where the hybridity of the package, candy, and toy became increasingly blurred as to become one object. Premiums played a crucial role in associating plastic with objects for children and contributed to its feminization through its introduction into the kitchen and domestic life. Premiums also contributed to diminishing the value of plastic objects, as people tend to associate price with value – if one receives an object for free/near free, it is a simpler task to discard that object.

Figure 2-8: Advertisement from Ideal Toy Company's 1942 Product Catalogue Showing the "Victory Fleet." From US Dimestore*, Ideal Toy Catalogs, photograph by Bill Hanlon.*

Our next refraction of the vision of polystyrene becomes an explosion as the world, and the plastics industry, move into World War II. Clarity in urea formaldehyde brought colour to thermoset plastics, but the speed and cost of most compression-moulded plastics was still prohibitive to their use in anything but the most expensive toys. It was only after 1934, with the introduction of injection moulding, that it became feasible to create toys at a price point and in the quantity that made plastics an economically feasible material to use for the toy industry's bread and butter, mass produced small toys. With the development and export of the first successful injection moulding machine from Germany, cellulose acetate became the "injection material "maid-of-all-work" until polyethylene and polystyrene appeared after [World War II]."[192] But there was one company, Ideal Toy Company, and especially the general manager from 1942-1944, Dr. Islyn Thomas, who made it possible to produce high-quality plastic toys throughout the war, of polystyrene. As I will show, Thomas was also instrumental in associating polystyrene with toys after the war.

The "Victory Fleet" boats pictured above were around four inches in length and moulded from scrap polystyrene plastic, leftover from other manufacturing jobs and wartime materiel. The advertising copy from the 1942–1944 Ideal toy catalogues indicated that the boats were "safe, sanitary and educational toys that were practically unbreakable" and that they possessed "gorgeous, brilliant plastic colours." The photos of the models, however, taken more recently by prominent toy collector Bill Hanlon, show a mottled group of boats in grey and light blue with a hint of red and a bit of yellow in the middle boat. The charm of the "camouflage" was a product of the colours of the scrap materials used, not an intentional choice on the part of the toy manufacturers.

Figure 2-9: The Victory Fleet along with a Selection of Other Collectible Military Toys from 1944. From US Dimestore*, Thomas Manufacturing Corporation 1940-1947. Photograph by Bill Hanlon.*

With the outbreak of war in Europe and the resultant scarcity of materials dedicated to military applications, many materials, such as the metals that toys were commonly made from, were unable to be obtained for non-essential use. Therefore, between September 1939 and December 1941, when the U.S. joined the war, cellulose acetate plastic became a ubiquitous material in playthings. In July of 1941, a feature article in *Modern Plastics* pointed toward the lack of non-ferrous metals as a reason why there was an increased amount of plastics in toys.[193] The use of plastic as a replacement for other restricted materials lasted only two years, however, as plastics ultimately became restricted themselves. In August 1941, *Modern Plastics* published the U.S. government Office of Production Management's (OPM) order to restrict the "delivery of formaldehyde [to produce] resins and plastics that would be used in manufacturing various items[;] … the explicit intention of the order [was] to eliminate the utilization of plastics for novelties, gadgets, and decorative items."[194] With the United States' formal entry into the war, this order became law through the limitation order L-81, published in *Playthings* magazine in April 1942. To the toy industry's dismay, in addition to the expected metals restrictions, the order placed restrictions on almost all types of plastic, plasticizers, and dyes. [195] The order represented a recognition of the importance of the newer thermoplastics especially, as vinyls and styrenes were both on the list.

While most plastics were heavily restricted with America's entry into the war, there was one company able to circumvent the restrictions and continue to associate plastics with children's toys throughout the conflict. The Ideal Novelty & Toy Company, inventor of the "Teddy Bear" in 1903, and with a continuous hit list of toys that included the Shirley Temple doll, was the largest manufacturer of dolls and stuffed toys at the time, and Thomas, the general manager, was able to secure 800,000 pounds of styrene from Remington Rand, as rubber joined the restricted list.[196] Remington Rand was unable to manufacture its electric razors and had no further use for the Styron they had stockpiled to create their casings. As there had been a significant shift in the toy industry already toward cellulose acetate with injection moulding, polystyrene was able to be substituted into existing moulds. The stockpiled Styron was supplemented by scrap Lucite left over from Firestone's Chemical Warfare Department, from the offcuts of plastic lenses for gas masks. From this mixture of surplus Styron and Lucite, Ideal was able to produce three different models of boats (marketed as Victory Fleets) and a plastic tea set, at a time when most toy manufacturers had to opt for cardboard or balsa wood as the main materials for toys sold during the 1942–1944 seasons.[197]

This fortuitous turn of events meant that Ideal was able to meet a demand that nearly every other toy company was unable to fulfil. The polystyrene toys were seen as higher quality than those from other toy manufacturers, as they were less likely to fall apart or disintegrate than those made of balsa or cardboard. That meant that Ideal could charge a significant mark-up for the toys – whereas prewar similar toys would fall into the five- or ten-cent categories, during the war they commanded up to seven times that price. Here we see another refraction, as through the lens of wartime scarcity, small, inexpensive, and mass-produced toys are, for lack of a better alternative, held in higher regard than nearly every other toy in the market. They re-emphasized plastic as a durable object, rather than a transient one.

To illustrate how tightly coupled the two industries (plastics manufacture and toys) became postwar, one must look no further than Thomas himself. With a doctorate in Plastics Engineering from the University of Scranton, by 1938 he would oversee the entirety of operations at Consolidated Molded Products Corporation. Consolidated Molded Products had been incorporated in 1874 as the Scranton Button Company and was already a giant of plastics manufacturing in 1940. With "seven hundred and fifty employees operating on three floors, Consolidated was the largest plastics molding company in the world."[198] They offered a complete array of services, from product development to mould design and construction, as well as compression and injection moulding. There, in 1935, Thomas met Benjamin Shapiro when the former was assigned to head Shapiro's custom moulding design of a plastic toy filmstrip viewer made of a Bakelite clone called Arco-Lite. This experience started Thomas off on a lifetime of plastics toy manufacture.

In 1941, Consolidated Molded Parts Corporation and the Ideal Novelty & Toy Company both submitted bids to the Chemical Warfare Department for a contract to injection mould flutter valves for gas masks. Ideal had just bought twenty-four brand new injection moulding machines based on the successes of their Shirley Temple and "Magic Skin" dolls and were looking for ways to avoid a shutdown of operations. The Ideal Novelty & Toy Company submitted a successful bid against Consolidated Manufacturing and won the contract, "despite the fact that no one within the company had the expertise required to fulfill such a large order with strict requirements and deadlines."[199] As Thomas personally detailed to Hanlon, he was told to "get right over to Ideal and straighten things out and that [he] could go over either as a civilian or in uniform."[200] In the meantime, Thomas and Shapiro had remained colleagues. Based on the success of the film viewer, Shapiro had started his own toy company in 1940, called Acme Plastics. Acme Plastics had contracted the creation of three boat moulds through

Thomas at Consolidated in 1940, which Thomas then procured for Ideal after he left Consolidated. Those boat moulds became the "Victory Fleet" above.

The man who headed Ideal Novelty & Toy Company from July of 1942 to 1944 was the best of both worlds. He came into Ideal with a wealth of knowledge from Consolidated as well as a keen interest in plastics in toys because of his past experiences with Shapiro. He was the person in charge throughout Ideal's work in the development of the proximity fuse, which was "a plastic fuse with a tiny Radar [sic] set which would set the fuse off when it approached within 2000 feet of the target."[201] *Playthings* magazine ran a letter from the Office of Scientific Research and Development in December 1945, which singled out and thanked Ideal Novelty & Toy Company for their "splendid production record and for the development program that was undertaken, which was so vital to our production."[202] Like the expensive toy jeep for civilian use, the use of plastic to create the proximity fuse was a way that plastics won accolades and respect as a military technology.

Throughout Thomas's tenure at the company, only six of the twenty-four moulding machines were ever devoted to defense work, while the rest were focused on creating the toys that had become synonymous with Ideal.[203] A mere five years after its invention, and because of the scraps Thomas was able to secure from Remington Rand, Styron became the plastic most associated with toys, a distinction that would last for years afterwards. His contacts in the plastics industry were perfect for sourcing further scraps, and Ideal's defense contract produced even more leftover material for their toys.

Thomas went on to establish his own toy company in 1944 – Thomas Manufacturing Corporation. One of the foremost experts in the world in injection moulding by this point, because of his experiences at Ideal and Consolidated, Thomas also authored the first book ever published on injection moulding in 1947, considered the “Bible” of the plastics industry for many years to come.[204] In 1951, he served as President of the Society of Plastics Engineering (SPE).[205] For his work in the advancement of plastics, Thomas was knighted in 1975 and was inducted into the Plastics Hall of Fame in 1979 by President Gerald Ford.[206]

While Victory Fleets and proximity fuses were being manufactured at Ideal, Dow Chemical’s new processes for producing monomeric styrene were being used by the military. When Malaya and Indonesia were occupied by the Japanese in 1942, America’s natural rubber supply was cut off, leaving the country with only a year’s reserve of natural rubber for the military.[207] This triggered a massive war effort, second only to the Manhattan Project, under the Rubber Reserve Company, which had been set up in 1940 to stockpile natural rubber in case America were to get involved in the war, but instead moved into the production of synthetic rubber after Pearl Harbour. Through a pooling of resources of the large chemical companies, there began a coordinated expansion of the manufacture of both styrene and butadiene, the chemical components of government rubber-styrene (or GR-S, America’s synthetic rubber). Styrene was subject to a massive build-up, with plants financed by the government built in Velasco, Texas, Sarnia, Ontario, and Los Angeles by Dow Chemical Company alone, which provided more than half of the wartime styrene for GR-S. U.S. production of synthetic rubber of all kinds in 1941 was a mere 10,000 tons, which was expanded by 1943 to 875,000 tons. While the government retained control over the synthetic rubber program for the following fourteen years, the massive build-up of Dow’s production capacity for styrene found and created new markets postwar.[208]

Christmas Ornaments and Candy Trays: Just Hear That Styrene Ringing

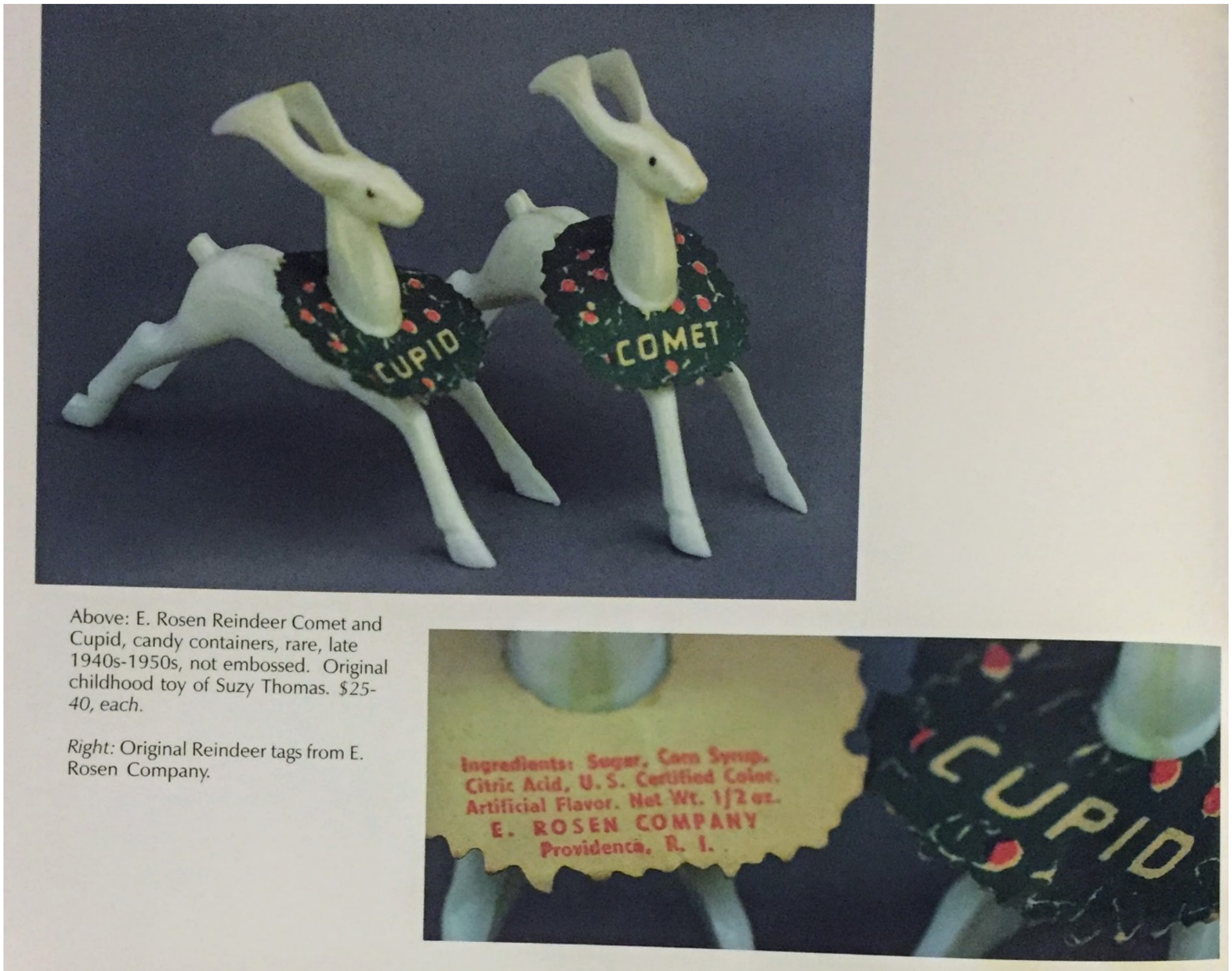


Figure 2-10: Collectible Reindeer Novelty Candy Packaging. From Holiday Plastic Novelties: The Styrene Toys *by Charlene Pinkerton. 44.*

Unmistakeably art-deco and streamlined in design, with swept back horns that evoked speed, the reindeers pictured above are today difficult to understand as packaging, as they were quite beautifully made. They came as a set, where the candy was packaged within the Santa's sleigh. Later editions had a Rudolph that one could purchase separately, but by that time the design language had changed, and Rudolph was far less stylized, far more realistic and toy-ish. The slight yellow discolouration along the neck was evidence of early polystyrene instability, as the oxidation of the impurities within the styrene were evident. The care in the design is apparent, right down to the detail of the candy ingredients being on the back panel of the wreaths around the necks of the reindeers, differently named though the moulds were identical. It is no wonder that these delicate polystyrene toys have become collectors' items, as most would have been discarded for much the same reasons that my Pez dispenser will eventually be. Make no mistake though, these ornaments were packaging. Rosbro toys was a plastics subsidiary of E. Rosen Company, a candy company based in Rhode Island who pioneered novelty packaging for Christmas confections.[209]

In the sections above, I addressed the invention of polystyrene by Dr. Sylvia Stoesser, the way that plastic premiums contributed to nascent notions of disposability, and how polystyrene became heavily associated with toys through the actions of the Ideal Novelty & Toy Company and Dr. Islyn Thomas during World War II. After the war, the threads of polystyrene, premiums, and toys became intertwined. The increased presence of plastics in the home, especially in the lives of children, along with their growing association with childhood, inevitably entangled the material with the growing narrative of profligate consumption of both consumer goods and sugar in postwar America. Christmas played a special role in the dissemination of plastic goods into the public. Polystyrene, after the massive manufacturing expansion of monomeric styrene during the war, found its place both under and on the tree, as well as everywhere else in the postwar home.

According to *Modern Plastics* magazine, the earliest use of plastics in Christmas decorations was in 1940. The sheer size of the Rockefeller Christmas tree in New York made it unfeasible for decoration with conventional (then almost entirely glass) ornaments. According to the first postwar Christmas article, "design [of] new decorations necessitated the choice of lightweight material not easily damaged by exposure to the elements. Plastic led the materials field and drawn acetate balls were decided upon."[210] After styrene came off restriction in 1945, the material used for Christmas decorations promptly shifts to polystyrene, as the illuminating "edge effects" were exploited along with the novelty of electric Christmas lights. Here, the changing geopolitical landscape had its effects, as "these new decorations [would] more than make up for the scarcity of finely blown glass decorations from Czechoslovakia … formerly depended [upon] for colour in … Christmas trees."[211] Likewise, the prediction that "next year, when materials are more available, the use of plastics in this decorating field [would], beyond a doubt, be at least quadrupled" showed how plastics filled commodity needs directly after the war, as materials became available in an uneven and unpredictable way.[212]

Christmas held special significance postwar not only for the glut of consumption that it came to mean but also for the particular ways in which that glut of consumption was packaged. It is during Christmas that we first saw the creation of a hybrid form of packaging-as-ornamentation, when the way that something was wrapped, boxed, or tinned held as special of a meaning as the object itself. The packaging in this section refers to packaging that functioned as both toy and receptacle. Made from polystyrene, the Santas, reindeers, and snowmen that hung on the tree or sat on the mantle served a dual purpose: they both served as a vehicle for a sugary Christmas treat and were used as a toy or Christmas ornament afterwards. While packaging designed for re-use was something that the plastics industry had been doing for some time with cosmetics and other premium packaging, Christmas was when durable re-use containers became heavily associated with children's frivolities, thus undermining their more adult applications. At the same time as the holiday plastic novelties were being introduced, the original heart-shaped candy box, also made of polystyrene, was being marketed for the first time.[213] We can imagine the grown-ups at Christmas, enjoying the sweet candy from the ornamental, toyish plastic packaging, beginning to associate plastics' identity with childish affectations.

Counterintuitively, these ornaments and candy boxes were extremely well made. At this point in the history of the plastics industry, there was still a concerted effort to sell plastics as a high-value material. There is today a significant collectibles market for the early polystyrene Christmas toys. Those collectibles form traces that make it possible to tell this story, as most packaging was thrown out without a second thought. As one of the collectible books suggested, the polystyrene toys gave "us beautifully coloured hard plastic novelties that would *outlast many other kinds of toys produced.*"[214] The organizing principles of durability and transience get confused here, as the reindeers' durability allowed their re-use, but the fact they were packaging allowed their accumulation. Therefore the very principle of re-use contributed to their disposal, as there are only a limited amount of reindeer ornaments one can have.[215] We can see how re-use containers for durable goods changed when the container became the purveyor of consumables, as for each purchase of a consumable, the collection of containers grew, thus undermining their use-value with their proliferation.

The first hints of what became an increasingly intractable problem in the twentieth century with re-use containers was addressed in *Household Hygiene* by Maria Elliott. Written in 1907, we can see the start of a struggle with the radical discontinuities of transience and durability at the beginning of the twentieth century, although in a reversal of the way that Thompson regards. She wrote that "although we are taught that everything in the world has some use, … at some time each article loses its usefulness."[216] The implication is that *everything* is thought of as durable in 1907, and that in household management, women have to make active decisions with respect to what becomes transient and can be thrown away. In Thompson's analysis, the trip from durable to transient is an entropic, passive process, and it's only the trip back from transient to durable that represents a radical discontinuity. But for those who make the decisions with respect to discard, the process is active, perhaps even more active than an object eventually gaining collectible or antique status. These hybrid objects, though quite charming and beautiful and created to be lasting and durable, set up conflict between these two categories – they attempt to fit the durable category, but end up ever more quickly into the transient category with their proliferation, particularly because they carry sweet, possibly sticky, and child-centred goods.

Cross and Proctor point out that candy had special significance to women and children. Often denied the masculine tastes of

> fermented beverages and tobacco, [candy] was associated with the cravings of women and children, with the added tint (or taint) of the frivolous or lavishly extravagant[.] …

> [I]t was not until the 19th century that sweets became an essential part of the celebratory rituals of Christmas, Valentine's Day[,] … Mother's day – all holidays built around women and/or children and the gifting of sweets.[217]

This hybrid form of packaging – toy and candy both – blurred the boundary between transience and durability, and eventually fed into increased notions of disposability, since we can only keep so many Christmas ornaments (or Pez dispensers). If the consumer wanted to keep consuming, the durable, re-usable package became plentiful to the point of excess in the household and inevitably necessitated its disposal. As women are traditionally the arbiters of what is trash, coding these objects as female or childlike meant they would have less hesitation in throwing them away, as they were considered within the domestic realm.

This active process of waste creation is utterly fundamental to how we understand plastics. Durability and transience as organizing principles became increasingly difficult to parse throughout the twentieth century, as plastics became ubiquitous. The lifecycle of a product made of polystyrene, particularly one associated with foodstuffs, is nearly negligible today, as my Pez dispenser can attest. That same Pez dispenser, however, has a near-infinite durability with respect to its afterlife as trash.

Dow's Styron and Styron 475 Labels

Figure 2-11: Advertisement for Dow Styron plastics, emphasizing their evaluation by Dow. From Playthings*, February 1950, 184.*

Figure 2-12: Advertisement for Dow Styron 475 plastic. From the Saturday Evening Post*, 1952. From the Dow Image Archive, Science History Institute.*

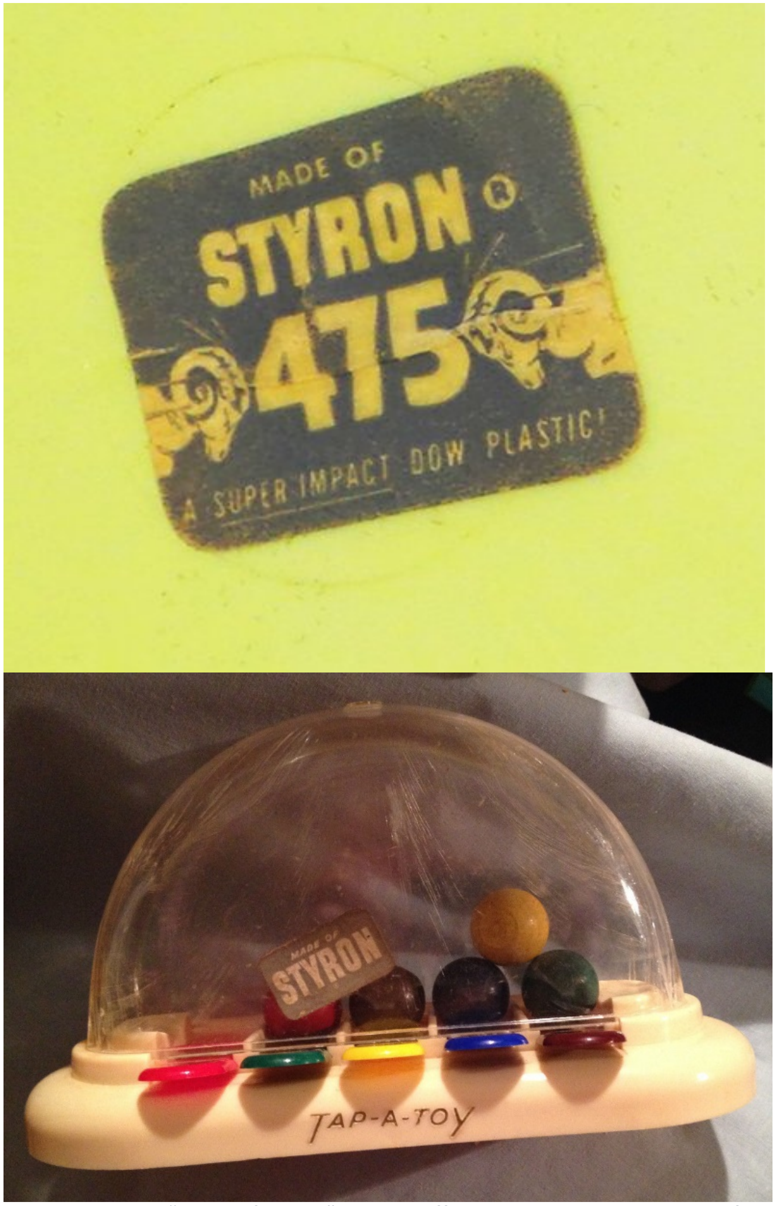


Figure 2-13: The "Made of Styron" Stickers affixed onto toys. Images taken from public listings on eBay.

The growth of plastics' use in toy manufacture is in part due to novel marketing approaches. The advertisements, at first glance, look as though they were selling toys, but in fact it is another refractory image – the advertisements are instead selling the plastic that the toy is made from. The first advertisement is from *Playthings,* wherein Dow is explicitly marketing its Styron 475 branded plastic to toy manufacturers, with the use of ram's horns to demonstrate durability. The second appears in *Life* Magazine's November 24, 1952, issue. Together, the advertisements show how the Styron brand became as important a marketing asset as the toys themselves. In an early example of brand identity strategy, the massive marketing efforts behind plastic toys were in many ways orchestrated and supported by Dow itself, through vetted partner and co-operative marketing campaigns.

In my journey toward polystyrene's ultimate transiency, with the radical discontinuities that provide the traces which allow me to tell the story, and the refractions that allow us to see the unstable ways in which the material was regarded, I have moved toward increasingly transient objects, without yet focusing on anything that is explicitly disposable. The Dow "Made of Styron" label, pictured above, comes close, but in another refractory, hybrid way, it is meant to reassure the consumer of the durability of the object, not its transiency. The label, pictured in the advertising copy as a tie-on tag, was a sticker affixed to the bottom or side of the object it was selling, or it was lithographed on cardboard packaging as part of the design. Because it was a sticker, surviving examples of it are exceedingly rare, as most people would think even less of ripping a sticker off than throwing away the packaging. However, this sticker represents a massive and aggressive marketing campaign by Dow Chemical Company to defend its product against its detractors. Over ten million labels were issued over the course of the campaign to convince consumers of polystyrene's durability, and attempt to set it apart from other, less stable forms of plastic, as we will see in my third and final chapter.

Postwar, plastics in children's toys ramped up quite quickly. The enormous manufacturing capacity built up during the war due to the Rubber Reserve Program made Dow's styrene monomer and Styron materials available in huge quantities. Partly because of individuals like Thomas, who already associated high quality (through price) toys with polystyrene during the war, and partly because the stage for small consumer goods was set through premiums, the production capacities of the factories making wartime materials switched quickly to consumer goods. In June 1946, *Modern Plastics* ran an article about how every fourth toy was made of plastic.[218] The toy industry was called out specifically and positively in terms of their use of plastics: "probably no other industry is as keen to find new and better materials and to improve its designs."[219] The lower-quality toys were made of "cellulosics" or, as we saw before, cellulose acetate, but the higher-quality toys were beginning to incorporate what became the biggest use of plastics in children's toys in the 1950s and 1960s: polystyrene.

Dow experienced a 31 percent growth in revenues between 1947 and 1948, as indicated in an annual report, which noted that products "springing from Styrene [were] steadily becoming more numerous."[220] Styrene was the only plastic specifically mentioned in that report, which also indicated that plastics, their only product line showing revenue growth, had come to account for 20 percent of their revenue. Starting that same year, in 1948, Dow invited manufacturers to submit toys moulded of Styron to Dow's main plant for evaluation. Products were "judged on basic design, molding techniques, comparison with other plastic and non-plastic materials, and their resistance to potential hazards."[221] The products that passed were awarded a "Made of Styron" label, which Dow then promoted through a large consumer and retailer advertising program. Its sheer size allowed it to get behind many of the smaller toy manufacturers to market the products made from the polystyrene raw material it sold them. As a co-operative, supplier-funded marketing program, it attempted to elevate the Styron brand, trying hard to associate it with quality and especially durability, as much as it promoted the toys themselves. The nationwide campaign provided banners, section cards, window backgrounds, and easel displays, and it sent checklists to toy buyers and department stores ensuring they knew which toys to stock. In addition to the normal ads, they put out four-page brochures through *Saturday Evening Post*, *Good Housekeeping*, and *Colliers* magazine.[222] This encompassed a major marketing campaign that lasted for years and went to thousands of households and retailers across the country. The campaign became one of the discursive practices through which plastics annexed the world.

The effect of this advertising campaign can be seen in the sales figures from the time. One example from the Dow Historical Collection showed a sales analysis chart with a category of "floral/novelty products" encompassing half of all of Dow's styrene business from 1949–1953.[223] Furthermore, Styron, Dow's second plastic product, was its top seller for half a century.[224] A chart published in *Modern Plastics* in 1953 showed that 17 percent of all styrene resin from all sources that was made that year went into toys.[225] This trend continued throughout the 1950s, and although toys' share of the total polystyrene market share decreased, it was only because of the concomitant increase in popularity of its uses for air conditioning and refrigeration. Nonetheless, due to the overall increase in polystyrene production, the total poundage of plastics used for toys increased throughout this time. By January 1959, 10 percent of all polystyrene use went into toys.[226] Given that there was an estimated 450 million pounds of styrene used that year, no less than 45 million pounds of styrene were used in toy manufacture in 1958 alone.

The point of this protracted campaign by Dow to associate its toys with quality and durability, was to continue to enjoy the positive war-time sheen that Thomas and Ideal had imbued plastic toys with. The massive postwar plastics expansion had negative effects, as the rush to take advantage of the baby boom attracted many unscrupulous and fly-by-night toy manufacturers. An op-ed titled "Toys Had Better Be Better," for example, written for *Modern Plastics* in 1955 immediately preceding the massive Annual Toy Fair that took place in New York City, exposed first the vast market, claiming the total toy retail income was "over a billion dollars in 1954" and that, "until 1953, plastics' share of this market constantly increased, and increased in greater proportion than the share of other materials."[227] However, the industry saw a 5 percent drop in volume in 1954, insisting that it was the result of "low-priced toys, from 19¢ to $1.98." The editor insisted that inexpensive infant toys must become better quality:

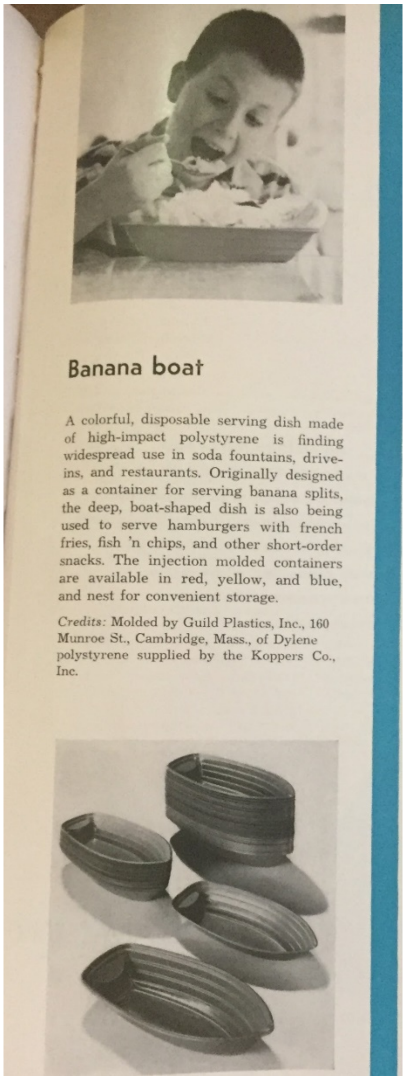
> sales of unsatisfactory plastics toys in this under five market establish in the minds of mothers a bad opinion about all plastics toys, which is bound to be reflected in future sales of higher quality, higher priced toys to the older age group[;] … these toys suffer because of damage done to mothers' [sic] opinions when the children were in the infant classification. … [T]he answer lies in a new ethical approach on the part of manufacturers of toys, new concepts in toy design, and certainly in careful consideration of materials and engineering factors[;] … furthermore, mothers' opinions on plastics toys effect mothers' opinions on plastics in housewares, furnishing, and other things. For the sake of the whole industry, plastics toys, particularly for children under five, had better be better this year.[228]

In only ten years, the narrative in the plastics industry had changed about toys, from fantastically optimistic and positive to critical – the editors realized the kind of reputational damage poor-quality objects made of plastic were doing to the overall plastics industry. They worried that the perceptions about toys were going to affect their profits and growth, which was why they continued to call for higher-quality items. Cheap children's toys would likely devalue the impression of higher-value commercial items containing plastics by association. Intelligibility and understanding at the consumer level continued to be important to the plastics industry, and they wanted the general public to understand that not all plastics were created equally, and that poorly made toys did not predict plastics as a whole.

Of course, the low quality of some toys (particularly five-and-dime toys, of which Thomas was a purveyor) was not the only reason that market share for plastic toys dropped in 1953. Thomas pointed out that the changing political landscape, with the cessation of conflict in Korea, meant that metal toys had been reintroduced. Writing in 1954, in a letter to his employees titled "The Importance of Cutting Costs," he argued that "generally, plastic toys have soured the public, since too many manufacturers took unconscionable advantage during the time when the metal industries were making defense orders. Since the curtailment of defense spending, the competition is extremely difficult. Of course, the manufacturers of cheap, thin-walled toys were the first to go. It is fortunate we have never sacrificed quality."[229] Considering Thomas Manufacturing closed a mere three years later, the memo to his employees can be seen as a harbinger of what was to come for the American toy industry.

From Victory Fleets to Banana Boats: The Final Refraction

Figure 2-14: Toy Plastic Boat. From the personal collection of Islyn Thomas, at the Syracuse Plastics Collection.



Banana boat

A colorful, disposable serving dish made of high-impact polystyrene is finding widespread use in soda fountains, drive-ins, and restaurants. Originally designed as a container for serving banana splits, the deep, boat-shaped dish is also being used to serve hamburgers with french fries, fish 'n chips, and other short-order snacks. The injection molded containers are available in red, yellow, and blue, and nest for convenient storage.

Credits: Molded by Guild Plastics, Inc., 160 Munroe St., Cambridge, Mass., of Dylene polystyrene supplied by the Koppers Co., Inc.

Figure 2-15: Advertisement for Banana boat sundae dish. Modern Plastics*, August 1958.*

The two photos above represent the end point of my argument and come full circle back to the deep ambiguities that form with plastics manufacturing and increasing notions of disposability. One is from a museum collection; one is from a trade magazine that was advertising new disposable trays shaped in a banana boat form. The boat, from Thomas's own toy collection, was donated to the Plastics Collection at Syracuse University by his late wife, after his death. The dramatic change in looks between the "camouflaged" Victory Fleet boats of 1944 discussed previously and the one shown here was largely due to an abundant supply of virgin polystyrene available in 1952; they did not require scrap plastic, and many of the dyes and colouring agents on restriction during the war were now readily available for consumer goods. The differences in solid versus hollow forms were due to the innovations that Thomas himself pioneered in injection moulding. However, it is in the form of the pan of the boat itself that we can see how durable and transient are inadequate descriptors when it comes to plastics manufacturing.

The second photo shows a boy of about eight years old, ears too big for his head, with a brush cut and a striped golf shirt. He is opening his mouth, about to shove a large spoonful of his banana split sundae into his mouth. The split looks massive, larger than the boy's head, either because of the perspective of the photo taken or because junk foods were more generous in a time before worries about childhood obesity. The photograph below the advertising copy, featuring the banana boats without food in them, show their shape clearly – they are slightly wider but highly reminiscent of the postwar boats put out by Thomas Manufacturing pictured above. The copy reads "a colourful, disposable serving dish made of high-impact polystyrene is finding widespread use in soda fountains, drive-ins, and restaurants.

Originally designed as a container for serving banana splits, the deep, boat-shaped dish is also being used to serve hamburgers with French fries … and other short-order snacks. The injection moulded containers are available in red, yellow and blue."[230]

In STS, there is a common form of analysis of early and novel types of technologies having the "ur-form" of those technologies which came before.[231] The argument states, simply, that one can see the "ghost" of the old technology in the novel form of technology that is disrupting it – early automobiles having spoked wheels is an example; as is computers having QWERTY keyboard inputs. While children's toys may not immediately spring to mind when one hears the word *technology*, the material of modernity should. Through the thirty years covered in this chapter, polystyrene transformed from a crystal ball of limitless potential, to ubiquitous domestic objects, and eventually to disposable food packaging like banana boats. It has travelled this journey refracted through premiums, then the military, and finally toys. Recurring themes arise of the eclipses of durability by disposability, quality by commerce, utopian futurism by cheap commodification, and the endless possibilities and utility of plastics by the constraints of a feminized and infantilized identity.

The form of the banana boat should be particularly striking, given the "Toy Cabin Cruiser" from Thomas Manufacturing above. The shape and depth of the mould used to create the toy boat from 1952 to 1955 was unmistakeably like the shape and depth of the mould used to create the banana boat in 1959. Given that, by 1959, most manufacturing of five-and-dime toys had moved offshore,[232] meaning that many of the original domestic moulds were sold off and given that the cost of the mould was the most expensive part of injection moulding, many moulds were re-used many times for different purposes, undergoing only slight modification.

The fact that it used the same plastic (high-impact polystyrene) by the same method (injection moulding) and was from the same area of the world (Pennsylvania/New Jersey) begs the question if there is not a far more direct linkage between the two (or two similar) products. What can be stated definitively, however, is that the gradual change from thermoset to thermoplastic materials, and the gradual change from durable to disposable uses of polystyrene, are both entangled with the growth of both the population of children in the U.S. postwar and the growth of the consumer society that surrounded them.

The sugar-cum-toy-cum-trash of a Pez dispenser becomes a sugar-cum-toy-cum-trash-cum-priceless-token of-mid-century-childhood. Priceless collections of small plastic dime-store toys are housed in museums while similar moulds gave the world disposable plastic trays for foodstuffs. There is no difference in the material form. The difference is solely in the way that we see it, the decisions we make to keep or discard, and the uses we have for it, as pairing plastics with consumable objects devalues the material to such an extent that it becomes disposable.

Chapter 3: How Hula Hoops changed Hygiene

Figure 3-1: Advertisement for Dorzar Toy Studios, from Playthings *magazine, 1945.*

From Damp Cloth Utopianism to Chemical Cleaning

Finishing this chapter currently, whilst the world shelters in place due to COVID19, has been strangely apropos. My chapters have vaguely mapped to specific times of the year – Christmas for polystyrene, and summer for polyvinyl chloride. This one I always intended to map to spring: a time for cleaning, and a time for Easter, which is the most vivid of my memories with respect to receiving hula hoops. During the annual Easter egg hunt when I was growing up, my parents would also hide a variety of inexpensive toys to find along with the chocolate and the eggs: amongst them was almost always a hula hoop.

I admit to hating hula hooping as a child. I was never able to get the rhythm so that it stayed aloft for more than a few rounds before it began its inexorable descent to the ground. My brother and I would invariably begin to use them for different types of games: they would be a safe spot on the floor which was otherwise lava, or a hole to jump through in the pool, or provided a 'harness' of sorts between horse and rider, where we would both be inside. These kinds of games nearly always pulled the hula hoop out of shape, bent it into an oval with dents and creases, sometimes made it entirely fold in half. I even remember taking the staples out that held the two ends of it together, unfolding the hoop into a C shape, and using it as a slide for marbles, which would come shooting out the other end.

The materiality of the hoop would never change, however: it would remain a tube of waxy plastic, brightly coloured and insubstantial, easily bent and misshapen but nearly impossible to break or permanently damage despite our best efforts. The waxy plastic would feel soft under my palm, interrupted only by the seam and two staples that held it together. The smoothness was always something I viscerally appreciated, sliding it through my hands, round and round, gently.

This Easter was different. My child, now being 15, is too old for an Easter egg hunt, but will still happily accept the chocolate if offered. Which is what I thought I would focus on when telling this story- sticky, sugary hands and the detergents that clean them. Instead, this Easter was the Easter that was not. Several days early due to rumours that they would close the 401, I rushed to my parents' place to see them. Arriving at dusk, I walked into the house, N95 mask donned, hand sanitizer at the door, and went immediately into the shower, where I bagged my clothing from Toronto and put on clothing from their house. I then proceeded to wear a cloth mask the entire time I was there, ensuring that I did not put my parents (65 and 69 respectively) and my grandmother (83) at risk of COVID.

Everything I touched in the house was promptly wiped with Clorox wipes, or immediately put in the dishwasher. When there were protestations that I was taking things too far, I replied with 'however small the risk, let us make it smaller, as the consequence is unimaginably large.' The HDPE was omnipresent: it housed the alcohol-based hand sanitizer, the shampoo and body wash, the dishwasher liquid, the Clorox wipes. Nearly without exception, if there is a caustic material, it is housed in HDPE. Toilet bowl cleaner. Bleach. Vim. Mr. Clean. Clorox. Lysol. Liquid *detergent for the washing machine. Liquid detergent for the dishwasher. Liquid detergent for the hand washing in the sink. Every shampoo, every conditioner, all the body-wash. The lotion applied to the cracked hands of skin washed too many times. An array of colours, shapes and designs, HDPE is amazingly versatile in this respect. Name brands, logos, and instructions printed directly onto the bottles or tubs, in every colour of the rainbow – meant to convey information about the content within – bright, cheerful, cheap, and above all else, clean.*

We did not always clean this way. Before the twentieth century there were few, if any, cleaning materials which fostered the 'schmear' paradigm of chemical cleaning,[233] *where the chemical is left on the surface of the thing being cleaned. As the convenience and popularity of this kind of cleaning has grown (Lysol was the first, but now we have wipes, mops, sprays, and foams that are all designed this way) so too have the indoor air quality problems associated with them.*[234] *The poem snippet from the advertisement I chose to start this chapter (Figure 4-1) shows how very different the paradigm of cleaning has become in a mere century. Written in 1919, and originally appearing in* Modern American Poetry: An Introduction*, it is, ironically, part of a hyperbolic missive* ***against*** *sterilizing childhood, a product of new standards for cleanliness that are imposed on the masses during the Spanish Flu outbreak of 1918, as it continues to explain what happens to the poor bunny:*

> They said it was a Microbe and a Hotbed of Disease;
> They steamed it in a vapor of a thousand-odd degrees;
> They froze it in a freezer that was cold as Banished Hope
> And washed it in permanganate with carbolated soap.
>
> In sulphurated hydrogen they steeped its wiggly ears;
> They trimmed its frisky whiskers with a pair of hard-boiled shears;
> They donned their rubber mittens, and they took it by the hand
> And elected it a member of the Fumigated Band.
>
> There's not a Micrococcus in the garden where they play;
> They bathe in pure iodoform a dozen times a day;
> And each imbibes his rations from a Hygienic Cup—
> The Bunny and the Baby and the Prophylactic Pup.

Note that while the poor bunny was subjected to rather extreme treatments, they still had primarily to do with temperature (steaming and freezing) and soap, which is washed off with water after lathering.[235] *This contrasts with many commercial products today that are designed to be left on the surface after wiping. The difference between them is their solubility in water – soap leaves a scum whereas synthetic detergents, being more soluble, do not. It is an innovation that has entirely changed the way we clean, but because of synthetic detergents' alkalinity, they initially posed a problem with respect to their packaging. This is partly the story of how that problem was solved.*

From Polythene to Packaging

Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE), while related, are not the same. The distinction lies in the amount of branching in the polymer, LDPE is more branched than HDPE, and hence less densely packed. HDPE sprang forth from LDPE, the first polyethylene, which was discovered in 1933 in England by Imperial Chemical Institute (ICI, see chapter one). Its tradename was "Polythene," though the tradename era was already past its peak.[236] I covered Polythene's conception and birth in chapter one, with its wartime scaling and use in radar equipment in World War II. HDPE, on the other hand, came along postwar, because of basic research at the Max Planck Institut für Kohlenforschung by Karl Ziegler. As I will show below, HDPE was scaled not due to wartime necessity, but instead due to the increasingly sophisticated consumer market of the long boom postwar.

LDPE and HDPE's combined effects on the postwar world of plastics and disposability was huge. As I will show in the pages that follow, their inventions had three main effects. First, LDPE and HDPE greatly contributed to the feminization, domestication and infantilization of plastics through Tupperware and the hula hoop. The story of Polythene was intertwined with Earl Tupper and his invention Tupperware, which was indelibly associated with domesticity and the highly feminized "Tupperware parties" of the 1950s. HDPE, on the other hand, was successfully scaled almost entirely due to a toy, with the hula hoop's invention in 1958. Next, LDPE and HDPE greatly accelerated the conversion of plastics from durable materials to disposable ones. Until HDPE's invention, the plastics industry was still very focused on using plastic for more durable uses, particularly in the building and automotive industries. Those plastics' proliferation provided huge leaps—after premiums and polystyrene, as I covered in chapter two—for plastics to become synonymous with packaging. Finally, HDPE and LDPE, because of their materiality as polyolefin plastics, ushered in a new paradigm of chemical cleaning, which undermined the damp cloth utopianism of earlier thermoset plastics. The waxy surfaces of the polyethylenes meant that the plastics continued to feel greasy if they were wiped with only water. Conversely, HDPE provided a way to contain the synthetic detergents that became popular during this time, as their inertness to caustic materials made them better candidates for packaging. Synthetic detergents' packaging in HDPE made them widely available, which in turn drove even more polyethylene production, as the synthetic detergents were effective in cleaning polyolefins where water was not.

As I covered in chapter one, thermoplastics, upon their birth, were very different from the dominant thermoset materials of the interwar years. They were not so much materials birthed to fulfill a specific need, but materials created to soak up the excess capacity of crude oil and ethylene during the Depression, then massively scaled during World War II. They were materials for which markets were later created, especially postwar. The birth of HDPE was the final death knell of plastics as durable materials. Unlike the high regard that polystyrene, polyvinyl chloride, and polyethylene held during the war, HDPE did not have a positive wartime utility to shed. As I will show, the hula hoop fad played a key role in the path that plastics took toward disposability, as their explosive proliferation scaled HDPE's production across North America. The type of hyper-consumption that hula hoops represented and the need for disposability were two sides of the same coin, as one cannot exist without the other. Hyper consumption in turn requires hyper-production, and hyper-production cannot exist without the unending extrusion of low-cost plastics. The fact that disposability was framed as hygienic meant that embedded within the new proliferative mindset of postwar consumer markets, it became a virtuous act to throw things away. But for polyethylene objects not explicitly disposable, synthetic detergents became the solution, displacing the earlier damp cloth cleaning of the hard thermosets. The entanglements between hygiene, disposability, the polyethylenes, and synthetic detergents, worked together to create the story that follows.

Figure 3-2: Advertisement for Tupperware from 1948, encouraging their use as premiums. From Modern Packaging*, September 1948, 14.*

When DuPont entered into licensing agreements with Imperial Chemical Industries to produce Polythene in 1943, Earl Tupper was well situated to take advantage of the material. Having previously worked as a sample maker for two years under contract to DuPont, Tupper had started his own company in 1939, The Earl S. Tupper Corporation. Based on the connections he had made while working at Doyle Works, his company received several lucrative commissions to manufacture war materiel, which gave him the access to Polythene before other custom moulders were able to get their hands on the coveted material. As a sample maker, Tupper created prototypes for the consumer market, which, if successful, were then manufactured by custom molders. Their role was to "field changes in consumer tastes and introduce unfamiliar articles to reticent retailers."[237] DuPont's ad hoc relationship with Tupper meant that he had unrestricted access to "machinery, methods and materials" for his experiments. This access was "reputedly the basis of his first polyethylene experiments."[238] Tupper was therefore able to invent the very first incarnation of what would become a defining feature of domesticity in postwar America: Tupperware.

Alison Clarke points to the crucial change and competing moral codes that Tupperware embodied. To understand Tupperware, it must be appreciated that "on the one hand, Tupperware taught thrift and containment; on the other, excess and abundance. These contradictions [represented] a historical shift from the Depression economy to a postwar boom."[239] Earl Tupper's status as a self-taught gentleman inventor meant that he imbued his product with all of the machine-age utopianism of the 1930s and believed whole-heartedly that plastics were the answer to a futurist land of plenty. Clarke writes that "Tupper envisioned a world utterly transformed through the appropriate application of polyethylene" and that he particularly wanted to transform the lives of women through his products, as his personal diaries were rife with inventions designed for them.[240]

But as Figure 3-2 shows above, Tupper's ability to understand, let alone market, to women left something to be desired. The title of the advertisement is taken from a Rudyard Kipling poem call *The Ladies*, a fairly risqué recounting of a British army man's sexual conquests around the world, which contained within such gems as:

> *Now I aren't no 'and with the ladies,*
> *For, takin' 'em all along,*
> *You never can say till you've tried 'em,*
> *An' then you are like to be wrong.*
> *There's times when you'll think that you mightn't,*
> *There's times when you'll know that you might;*
> *But the things you will learn from the Yellow an' Brown,*
> *They'll 'elp you a lot with the White!*

Tupper's regressive views on gender, despite him wanting to sell to women, meant that Tupperware suffered low sales and nearly went under. The advertisement above is a sales pitch to make Tupperware a premium gift, as it had suffered from poor sales in department stores. These poor sales continued until a woman named Brownie Wise stepped into the picture and changed the way that Tupperware was sold forever. Brownie Wise was a single mother from Detroit who piqued Tupper's interest by her astronomical sales figures. That interest translated into Tupper appointing her the vice-president of the Tupperware Home Parties division, based out of Orlando, Florida.[241] The "soaring increase in household expenditure, women doing their own housework, and… homebound mothers eager to earn extra income and thwart social isolation became enthusiastic organizers of the… Tupperware party" and spawned an entire generation of sales through conviviality, socializing, and the exploitation of women's friendships and networks.[242]

One would be hard pressed to find a postwar consumer object more thoroughly feminized than Tupperware. Since it was sold entirely through the Tupperware party, the wares allowed a generation of women who were otherwise cut off from the workplace to be able to earn a living in a way that remained socially acceptable in the conservative 1950s. Clarke writes that "women have stood at the forefront of changes in capitalist consumer society, [as] their social roles and cultural identities have been inscribed with the moral contentions and meanings of consumption."[243] Those changes reflected a fundamental shift in the competing moral values of thrift and hygiene. Gavin Lucas points out that "before disposability as a concept emerged, all waste was effectively regarded as inefficient and arising through improper management."[244] He argues that this idea fundamentally changed in the twentieth century, when the moral value of thrift is pushed out in favour of the moral value of hygiene. Tupperware was a microcosm of this shift, as it marketed effectively to both moral codes. It functioned to keep food fresher for longer, and save leftovers for later consumption, so it appealed to thrift. It was also marketed as a "sanitary, easy to clean" object that "protected pies and cakes against insects and dust," therefore it appealed to hygiene and as a safeguard against the threat of contamination.[245]

This shift had its roots in the rise of home economics in North America. As the germ theory of disease became widely accepted, cleanliness became not only an indication of moral goodness and class status, but also a bulwark against the spread of disease. As Elizabeth Shove points out, germ theory bore a new responsibility for homemakers: "if germs cause disease and if they can be killed by scrupulous hygiene, it is reasonable to interpret the visitation of illness not as an accident of fate but an indication of domestic failure and lax standards… [to this day] cleanliness is still used as an index of domestic responsibility and care."[246] Susan Strasser, in *Waste and Want: A Social History of Trash*, points out that germ theory was popularized not only in newspapers and magazines but also by "home economists in colleges, high schools, and settlement houses," and united "comfort and morality with science as the public learned that dirt and dust carried tiny creatures that caused illness."[247]

As the idea of hygiene became the norm, notions of disposability were increasingly tied to it. In this moral lens, we see the rise of throwaway packaging to both market and disseminate consumer goods. Well into mid-century, as I covered in my previous chapter, plastic containers were rarely seen as something that one could simply throwaway, as was evidenced by the explosive popularity of the comparatively expensive and decidedly not disposable Tupperware. But increasingly, disposability was specifically marketed as sanitary, as "every time a product was purchased off the shelf, the consumer was assured that the package was new and therefore clean, and this assurance was strengthened precisely because they threw away the package after using the product."[248] While Lucas primarily looks at the ways in which card and paper packaging played this role at the turn of the twentieth century, he also acknowledges the ways that plastics have become important mediators of disposable packages. However, he seems to assume that plastic, in packaging and otherwise, is *prima facie* disposable. As I will show, this was not necessarily the case. There is a specific and traceable history to plastic becoming associated with packaging, and plastic packaging becoming associated with disposability, which were both mediated through its domestication.

While Tupperware largely escaped this shift to disposability, many containers that were made of LDPE and HDPE did not. HDPE's birth and massive growth closed the door on many different paths plastics could have taken – from frankly plastic architecture to plastic's utility as a space-aged, easy-care material which required no more than a damp cloth to clean. Its trajectory—from its invention by Karl Ziegler in 1953, to its proliferation as packaging for synthetic detergents—follows.

Exotic Materials with no Industrial Significance Whatsoever: the Ziegler Process

While Tupperware was being disseminated via womens' networks into the homes of American housewives, a different, but related, plastic was beginning to take shape in Germany. Karl Ziegler, of the Max Planck Institut für Kohlenforschung (coal research) had been working on the effect that organometallic catalysts have on organic chemical reactions since the early 1940s, and in 1953 perfected the catalytic method for producing polyethylene at far lower pressures than the extant polyethylene on the market. By comparison, the original high-pressure polyethylene (or LDPE) required pressures exceeding three hundred atmospheres and temperatures exceeding three hundred degrees Celsius, whereas low pressure polyethylene (or HDPE) could be achieved at pressures as low as atmospheric pressure and temperatures no higher than ninety degrees Celsius.

Ziegler was one of the driving forces behind the dominance of the German chemical industry, before, during, and especially after World War II. He became the professor and director of the Chemical Institute at the University of Halle in 1936. In the same year, he lectured at the University of Chicago as a fellow, and therefore had long standing connections to the American chemical industry. For his work with the polymerization of butadiene, essential in Germany's lead in synthetic rubber manufacture (Buna Rubber, covered in chapter one), he was awarded the civilian "war merit cross" in 1940. In 1943 he became a chairman of the Kaiser Wilhelm Institut für Kohlenforschung, which was renamed the Max Planck Institut für Kohlenforschung postwar. As a condition of his appointment, he "insisted that [he] must be given complete freedom to pursue the entire field of compounds of carbon (organic chemistry) irrespective of whether a clear relationship could be recognized between [his] work and coal, or not."[249] Postwar, he was fundamental in rebuilding the chemical industry, from the point of a "shortage of chemicals, glassware, and equipment; recent foreign books and periodicals seldom available; and heat, water, and current often interrupted."[250] He re-established the German Chemical Society, and in 1954 "became president of the German Society for Petroleum and Coal Chemistry."[251] Because he was such an important figure in the German chemical industry, he was given freedom to do as he pleased.

The only time that Ziegler ever seemed to question himself with respect to the utility of his basic research was, ironically, in the year immediately preceding the discovery that would both win him the Nobel Prize in 1963 and change the face of the world as we knew it forever, asking himself in 1952 "whether, in the very difficult period after the war, one could really justify continuing investigations in a coal research institute into the properties of exotic materials with no industrial significance whatsoever—something that appeared to be the pursuit of private pleasure?"[252] Not knowing that his breakthrough would come in the months that followed, he continued his research despite his doubts, and in 1953 patented his method for using organometallic catalysts in polyethylene production.

Being able to use organometallic catalysts to create polymers shifted the plastics paradigm in a way not seen since Staudinger's discovery of their macromolecular structure.[253] While polymers were, after thirty years of refinement, able to be created in a relatively uniform manner by heat and pressure alone, catalysts meant the reaction could be made safer and more predictable by lowering the heat and pressure. The reaction could therefore be more precisely controlled, and polymer chain lengths could be customized to suit specific needs. The 1963 Nobel speech lauded the fact that "Ziegler catalysts, now widely used, have simplified and rationalized polymerization processes, and given us new and better synthetic materials."[254] Their elucidation made manufacturing easier, but it also moved their creation from the realm of manufacturers into the realm of organic chemists, which was reflected in the rhetorical shifts to come.

HDPE had a profound effect on the language by which different types of polyethylene, and eventually most plastics, were described. The dominance of using manufacturing processes began to wane (high-pressure versus low-pressure polyethylene) in favour of polymer chain composition (low-density versus high-density polyethylene). The polymer chain composition denoted the ability of the chains to compact together and create a tougher material. That unstable language was in full force in one of the early articles about HDPE in *Modern Plastics*. Some of the names bandied about at that time included "high-modulus, high-density, high molecular weight, linear, high heat-resistant, high temperature, and Ziegler and Phillips polyethylenes," each describing a different characteristic of the material or the person/corporate entity responsible for its development.[255] Regardless of what it was called, however, the plastics industry embraced the material excitedly, as it was the “next big thing” in plastics.

Polyethylene Grabs the Spotlight:

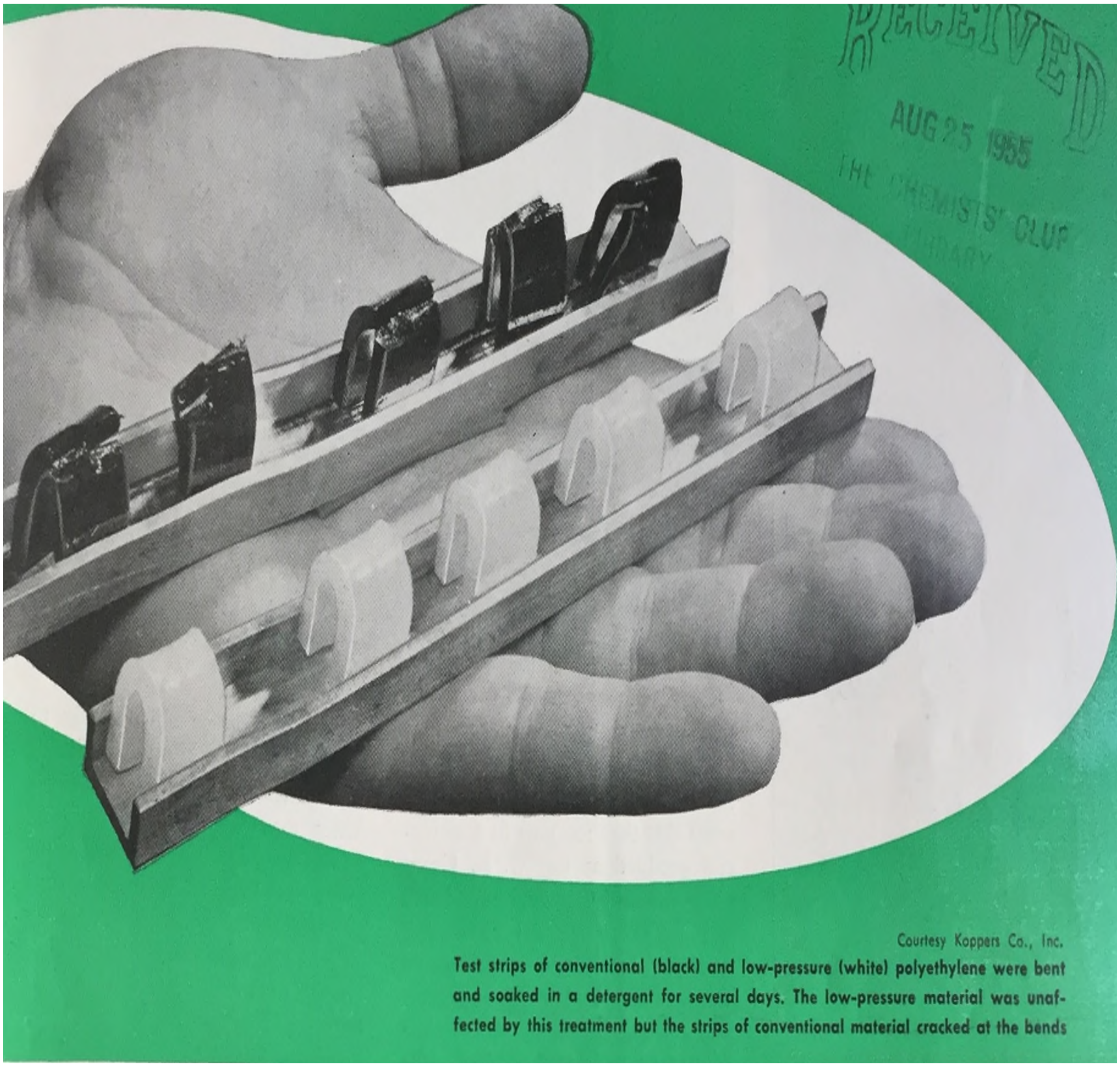


Figure 3-3: Lead image from "Polyethylene Grabs the Spotlight," Modern Plastics*, September 1955, 1. Image shows the effect of synthetic detergents on LDPE (in black, above) versus HDPE (in white, below).*

The plastics industry knew that HDPE was a remarkable material from the beginning. It was immediately recognized that HDPE was less susceptible to chemical degradation than any other plastic on the market to date. The potential for containers was realized immediately, as LDPE was already making significant inroads with Tupperware. In the first of two articles about the new polyethylenes run in *Modern Plastics* in September and October of 1955, the lead photograph showed how HDPE held up in comparison to LDPE when "bent and soaked in detergent for several days."[256] As it was the major chemical companies who were already dominant in the plastics industry, being able to sell yet more chemicals from vats that were unreactive to acids, bases, or other corrosion, was important to the industry itself. The further examples pictured on the following pages had a distinctly industrial bent to them, showing gloved hands pouring acidic liquids into oversized funnels or men in white lab coats and safety glasses submitting the new plastic to stress tests. Even when speaking of packaging, the emphasis here was on "bottles and carboys that will have chemical inertness, rigidity and impact strength… bottle molders are particularly smitten with the possibilities of low pressure polyethylenes."[257]

Figure 3-4: Photo of woman buying Tupperware from a housewares department in 1955. From "Polyethylene Grabs the Spotlight," Modern Plastics*, October 1955, 101.*

The second article, however, focused on LDPE instead of HDPE, and immediately acknowledged the material's domestication. Rather than leading with lab tests or industrial uses of LDPE, they instead chose a picture of a housewife buying domestic objects heavily reminiscent of Tupperware (figure 3-4). In its "Growth Measurements" section, the article points out that "the material has been scarce until the last ten or twelve months" so that growth forecasts could not be made, but that it was quickly becoming the most used plastic of all, even without additional HDPE plants coming online.[258] The use of LDPE in single-use grocery bags was here first proposed, which is one of the most common applications of the material today. They wrote that "odd uses in the packaging field crop up almost every week… A newspaper publisher delivered a special edition in re-usable waterproof polyethylene bags" and that both apple growers and potato growers have used polyethylene bags to sell their product, backing it with research from Cornell University that claimed, "plastics packaging caused a 100% increase in apple sales."[259] While these uses are quite normal today, that was not the case in 1955, emphasizing as they did the newspaper bag's re-usability. In a later section on the potential market for polyethylenes in blow molding bottles, it is assumed that any polyethylene that would replace glass soda or milk bottles would be sterilizable and last longer than the average glass bottle's six trips, which was a reason for using it despite its far higher cost in comparison to glass.[260]

Next, the "Molding Material" section made LDPE's domestication quite clear. The article stated that the moulding material's biggest use was "for housewares. That outlet has been so big that molders haven't taken much time to develop other markets… so far, molded polyethylene has been largely used for housewares and toys."[261] With hundreds of Tupperware parties taking place each week by 1955, Brownie Wise had turned the brand into a household name. She was featured in *McCall's* and *Business Week* magazines and newspapers at the time, with headers like "“Just a Housewife” Builds 30,000$ Business on Faith," "All-Girl Convention," and "The Soft Sell with the Social Service."[262] The relatively high price and prestige of Tupperware, though, meant that while LDPE was certainly feminized and domesticated at this time, it was still valued as a durable, beautiful, good.

The Seventh National Plastics Exposition: An Anticipated and Unanticipated Turning Point

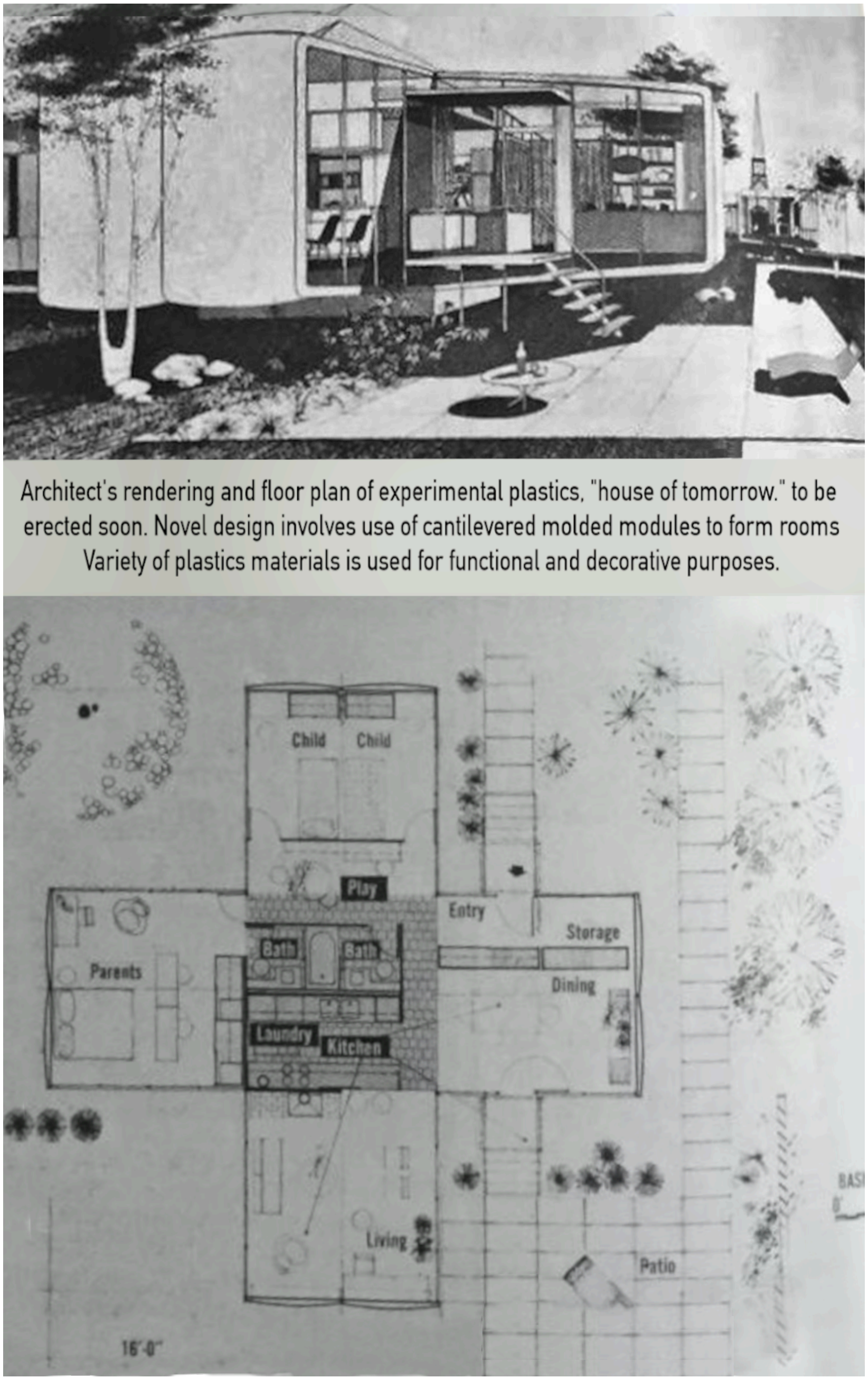


Figure 3-5: Architectural rendering of Monsanto House of the Future. from Modern Plastics*, December 1955, 188.*

The years leading up to the hula hoop's introduction in 1958 felt bizarrely disjunctive in retrospect. In 1954, the marquee exhibit at the Sixth National Plastics Exposition (NPE) was the Corvette, "North America's first all plastic bodied car."[263] The Corvette, while iconic, was never widely produced; production capacity at GM started at three and peaked at only thirty vehicles per day, compared to over 7500 cars/day being produced of steel. However, the market potential for an all plastics car paled in comparison to the building industry. Since 1933, when "the house that chemistry built" made of Vinylite was exhibited at the Century of Progress Exposition in Chicago, the plastics industry had been dreaming of breaking into the formidable building industry.

In 1956 the "Monsanto House of the Future" was revealed at the Seventh NPE. Like the body of the Corvette, it was built out of Fiberglas. Constructed at MIT with the purpose of "search[ing] for a way to use plastics to the fullest extent possible," and funded by Monsanto, the House of the Future was a "stressed skin" design.[264] Modularity was used to ensure that thermal expansion and contraction could occur without causing stress fractures. A central column with a base of concrete held all the functions of the house – plumbing, electrical and storage rose from there. The 'wings' of the house attached to the central structure and 'floated' five feet above the ground. Each wing was internally designed to serve a different function – bedrooms, kitchen, living area, or bathing area respectively. At a cost of 1M$ to create, it was not a low-cost alternative to conventional building, despite assurances that it could be scaled to a point where the cost could be brought down to approximately twenty thousand dollars.

The Monsanto house was the result of over twenty years of work that the plastics industry had been doing to align itself with the building industry. After the House that

Chemistry Built appeared in Chicago, celebrated modernist architect Ely Jacques Kahn was interviewed by *Modern Plastics* and admonished the industry to "Give [architects] Facts!" Kahn asserted that synthetic materials were not going to be used unless "the manufacturer has carried his own investigations of his goods far enough so that a designer can recommend a product to his client without fear of proposing too hazardous a choice." The problem remained for Kahn that "complete information is not submitted with the materials… [the designer] must work out systems of construction and watch out for practical objections."[265] But as I demonstrated in chapter one, the plastics industry struggled with the intelligibility of its materials to the building industry, because at that point the plastics industry still struggled with intelligibility to itself, with its constantly shifting materials and meanings being too unstable to define well.

Later that year a more positive interview with another celebrated modernist architect, Harvey Wiley Corbett, appeared. Corbett asserted in the interview that "social and scientific trends must logically arrive at the pre-fabricated house." His argument was that there was a "potential market of efficient housing for the masses comparable to that of supplying them with automobiles" and that "mass production of identical units… [can enable] housing for the masses to be made profitable by employing such a method and employing those materials which are most suitable for it."[266] He continued to argue that if the prefabricated house no longer suits ones needs, one can either "turn in the old model and get a new one; or [one] can alter the old one adding to it for additional members of the family or to indicate greater affluence."[267] It was these ideas, of a modular architecture, that informed the all-plastics house push for the next twenty years.

While design became more pragmatic than the high design ideals of those architects featured in *Modern Plastics* in the 1930s and 1940s, the plastics industry still had a difficult time cracking the building industry's code. Part of the problem was that architects and engineers continued to fundamentally not understand the material. The first editorial about better building codes appeared in 1954, admitting that "it is easy to understand why architects and builders are loathe to accept 'new' materials. First, a material must be tried and tested over a period of years before it may be recommended for a building application… second, the historic skills in the construction field do not lend themselves readily to the use of new materials."[268] Nonetheless, it ends on an optimistic note regarding "polyester-fibrous glass sheeting" (aka Fiberglas), knowing that the Monsanto house was already in development.

In the lead up to unveiling the Monsanto House of the Future at the seventh National NPE in 1956, the push to standardize and include structural plastics in building codes was increasingly fever pitched. Editorial after editorial throughout 1954 and 1955 covered progress in this realm. When the first sketches and floor plans of the Monsanto house were finally revealed in December of 1955 (figure 3-5), it was described as "flinging aside tradition-bound concepts of architectural engineering…an experimental 'house of tomorrow' takes full advantage of the inherent design potential of plastics as applied to the field of building and construction."[269] With the exposition featuring the Monsanto house, the Society of the Plastics Industry (SPI) sponsoring competitions for small homes design, "Building in Plastics" conferences occurring, as well as a concerted push by the plastics industry to get building codes changed, this moment seemed like the moment where the industry's move into structural building forms seemed inevitable, and that it was just a matter of time until it occurred.

But while the plastics industry continued to attempt to break into the building industry for the next several years, a letter to the editor in November 1957 points to some of the issues that would ultimately be insurmountable. The author, calling himself the president of "Architectural Plastics Corp," writes that "the plastics industry has created ample interest in its materials. It is now most appropriate for it to direct its attention to a comprehensive educational program. A major bottleneck is now the lack of educational opportunity for the building industry regarding plastic materials… I find only a small number of Schools of Architecture prepared to offer materials courses in plastics. I am aware of no reference materials or books prepared for architects."[270] Billie Faircloth makes a useful distinction in talking about plastics in architecture in that while plastics-in-building was made legible, all-plastics architecture was not, and claims that "its inability to define itself [was] because of its ceaseless redefinition, commoditization, branding, and its sources."[271] While the material object (doorknob, insulation, siding, piping) could be easily interpreted, stress tested, and perfected, all-plastics architecture was not. Sadly, The House of the Future never arrived. While no one can deny that there is currently a lot of plastic in construction, most of it is hidden within the walls as plumbing or electrical work, or as coatings on other materials, such as paint or laminate. This failed foray into an all-plastic architecture illustrates the crossroads that the plastics industry came to in the following two years, the divergent path that it took, and how quickly it happened.

Bonanza for Extruders:

PLASTICS FOR PROFITS

Bonanza for extruders

Hoop fad boomed use of high-density polyethylene, taught many processors how to use it

Hoops—the largest application for high-density polyethylene to date—could never have been foreseen in any market analysis. The hoop craze raced across America this summer and was expected to consume an estimated 10 million lb. or more of high-density polyethylene by the end of the year. The fad took a still-new plastic material which was undergoing careful and methodical sales development and overnight pushed it into big-volume extrusion. By the time the fever was at its height, scores of extruders had been educated in the use of high-density polyethylene and were running it on a routine basis. Thousands of laymen had been made aware of the new plastic. Hoops greatly speeded the wide-scale debut of high-density polyethylene, and most sales estimates for 1958 have had to be revised upward.

Photo, Hercules Powder Co.

The hoop fad was a great production challenge. Large extrusion capacity had to be marshalled overnight to meet the demand—and it was. High-density polyethylene is just right for hoops. It makes hoops that are not too flexible, not too rigid, and are safe for children. Because it floats, it is just right when hoops are used in water games.

Wham-O Manufacturing Co., San Gabriel, Calif., started the first hoops rolling. They were handsome, two-color products, made by feeding two extruders through the same die. Weight of the 3-ft.-diameter hoops (113-in. long extrusion) averaged 10 oz., with wall thickness of 0.068 inch. A tapered wooden dowel joins the ends of the extrusion, while staples fasten the polyethylene to the dowel.

As hoop fever spread eastward from California, new companies entered the field all the way along. Dozens of toy companies and extruders got into the picture, as well as every supplier of high-density polyethylene. Some hoop producers started shaving away at price (it started at $2), and quality. Some hoops produced weighed as little as 6 oz., and were made from scrap material and used straight wooden dowels, which created stress in the material and reduced the life of the toy. (See "The golden-egg goose," p. 5 of this issue.)

Even so, production could not keep pace, with children everywhere demanding hoops. In early September vendors expected to sell an estimated 20 million hoops worth $30 million retail by the end of the year.

The first hoops went on sale in New York early in August, and a week or two later extruders in the area were working three shifts a day to meet the demand. Some extruders paid triple time on Labor Day. In full swing, production in the New York area topped 600,000 hoops a week, and Wham-O alone had sold two million hoops. One supplier of high-density polyethylene had sold more than three million lb. to 50 companies by Sept. 10.

At this writing, there is still no end in sight for the hoop bonanza. But already hoops have brought scores of extruders an unlooked-for business boom, and helped launch a new material for the plastics industry.—END

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Figure 3-6: A Bonanza for Extruders. From Modern Plastics*, October 1958, 146.*

In the spring of 1958, a young upstart toy company called Wham-O released a simple toy. Based on a traditional toy that had existed for millennia in nearly every culture, and capitalizing on the mid-century craze for all things Hawaiian, the only difference between those hoops and the Hula-Hoop™ was that the partners from Wham-O decided to manufacture theirs from Marlex, the new high-density polyethylene from Phillips Petroleum. In contrast to the sixth and seventh NPE whose marquee exhibits were the Corvette and the Monsanto House of the Future respectively, the eighth NPE, taking place in 1958, featured the hula hoop as its main attraction. In 15 short months, an estimated 100 million hoops were sold worldwide, which would mean that a staggering 58% of the American population would each own one hoop, were they to be distributed equally amongst them.[272] Both the toy industry and the plastics industry were taken by complete surprise by the fad. It took

> "a still-new plastic material which was undergoing careful and methodical sales development and overnight pushed it into big-volume extrusion. By the time the fever was at its height, scores of extruders had been educated in the use of high-density polyethylene and were running it on a routine basis. Thousands of laymen had been made aware of the new plastic. Hoops greatly speeded the wide scale debut of high-density polyethylene, and most sales estimates for 1958 have had to be revised upwards (Figure 3-6)."

The original hoops used ten ounces of material and were "handsome, two-colour products, made by feeding two extruders through the same die."[273] There were also cut-rate or discount producers looking to capitalize on the fad, and as was common practice, much to the chagrin of an industry that still worried greatly about its image, "some hoop producers started shaving away at price and quality. Some hoops produced weighed as little as 6 oz… which reduced the life of the toy."[274]

The complaints that the plastics industry had about skimping in the toy industry were not new. Articles about the use of plastics in toys were nearly always accompanied by the reminder that the moulds had to be appropriately engineered, particularly with sufficient wall strength. As early as 1941, the industry's focus on toys' wall strength was evident. The manufacturer of the winning toy in the "Toy and Games" category of the sixth annual *Modern Plastics* competition emphasized in the write up that "careful attention must be given to the molding job… it is dangerous to be economical. If the parts are produced with thin walls, they will break under the hard use to which children subject them."[275] In 1954, coinciding with the annual Toy Fair in New York City, an editorial came out that pointedly targeted poorly made toys as being bad for the sale of other plastics, particularly "toys for children under 5… here were offered most of the poor-quality, badly engineered, thin-walled, weak toys." The editorial continues to warn that "mothers' opinions on plastics toys effect [sic] mothers' opinions on plastics in housewares, furnishings, and other things. For the sake of the plastics industry, plastics toys… had better be better this year."[276]

As I covered in my previous chapter, when that editorial was written, polystyrene was the most used plastic in toys. In 1953, 17% of all polystyrene manufactured went into "toys and games." Although Dow Chemical had released an improved formulation with its "super-impact" Styron 475, most toys in 1954 were still made with the lower cost original Styron. Styron was brittle, and therefore subject to breakage, hence the emphasis on wall strength. With high density polyethylene, however, wall strength became a drastically different concept. The materiality of HDPE, with its greater flexibility and strength, meant that it could be moulded far more thinly than polystyrene and did not suffer the same problem with respect to breakage than Styron did. Although Dow continued to market high impact Styron 475 for use in toys (see figure 2-11, 2-12, 2-13), polyethylene enabled plastics toy manufacturers to cut wall strength considerably and still not suffer breakage. While there were still complaints about skimping on hula hoops, they did not break, but bent instead. The hoop became misshapen but did not become “broken” in the traditional sense of the word, and therefore began to occupy the now familiar liminal space between trash and not trash. It is in this strange liminality that most plastic objects now sit. While the hoop can no longer hula, it is still defined as a hula hoop, not a broken toy. Because of the odd space it occupied, it created a continuity that we think should be a binary: trash/not-trash, disposable/durable. It is into that continuity’s forced fissure that we now step.

Disposables and Expendables:

MODERN PLASTICS

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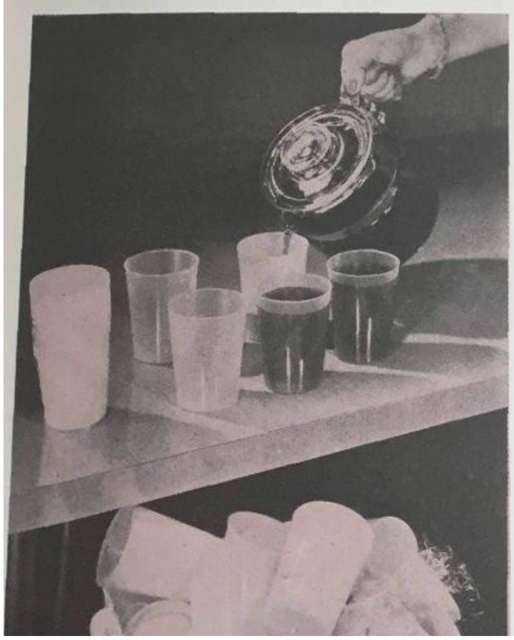
Plastics in disposables and expendables

Lower-cost materials, improved materials, and automation in processing are keys to a vast new market



A major problem in the marketing of disposable and expendable merchandise made of plastics, according to sales managers of companies concerned, is the disinclination of consumers to accept the fact that such merchandise has been designed to be, and therefore should be, discardable and destroyable.

A decade ago, when thermoplastics materials were more expensive, when plastics processing methods were slow, when materials for thin-section products were few and weak, the plastics industries were at some pains to stress durability and re-use value of plastics products, including packaging, and to educate consumers in the proper care of plastics merchandise. Since plastics products, disposable or not, are pleasant to the eye and to the touch, and inevitably have some durability, consumer habits of saving plastics items for re-use, developed at that time, hang on.

The earliest development of disposable plastics merchandise came in the packaging field, first through films and later through molded and formed containers. With increases in costs of non-plastics materials, with the development of higher-strength thermoplastic resins at lower cost, and with automation in molding and thermoforming, plastics began to compete with glass, metal, and paper in the packaging field. Even then there was much emphasis on plastics containers re-use, particularly for the refrigeration of leftovers. This situation is rapidly changing, as pointed up in an address before the 1956 National S.P.I. Conference given by Lloyd Stouffer, editor of *Modern Packaging Magazine*. Said Mr. Stouffer, "your developments should be aimed at low cost, big volume, practicability, and *expendability*. Your future (in this field) is in the garbage wagon!"

From molded cream cheese or ice cream packages to drinking cups for automatic vending machines serving hot and cold beverages was a short step. From packaging films to disposable temporary storm windows was not far. Particularly when polyethylene became more available and when the higher-strength sty-

Figure 3-7: Plastics in Disposables and Expendables. From Modern Plastics*, April 1957, 93.*

Hula Hoops were introduced on the tail end of a decade that had profoundly changed American toy manufacturing and were part of a death knell for domestically made toys. The early 1950s were mired in the Korean War, and steel availability again came under threat. The Korean War sped the (already fast) shift from metal to plastic toys, as previous experience in die-cast toys translated easily into injection moulding. If toy moulders could afford the cost of an injection moulding machine, they could use the thermoplastics that were a glut on the market. Then, in the mid 1950s, television advertising came into its own. The toy companies that jumped on the television bandwagon were those that survived. Licensing agreements became emphasized in the American toy industry, and because those licensing agreements were expensive, the larger toy companies sought less expensive manufacturing. Throughout the late 1950s, an enormous amount of toy manufacturing moved offshore. Domestic moulders therefore had a problem. Toys in the baby boom era had been big business, trebling to a $1.5B per annum market in the decade from 1947-1957.[277] Their exit to offshore manufacturing meant that moulders were left looking for new markets.

They found them in plastic packaging. While in 1956, the initial reaction to Lloyd Stouffer saying to an SPI conference that the future of plastics was "in the trash can" was dismay, a mere seven years later, he states that "it is a measure of progress in packaging… that this remark will no longer raise any eyebrows."[278] The rest of the paragraph, read from 2020's perspective of horrifying ocean pollution and mountains of plastic waste, is chilling:

> you are filling the trash cans, the rubbish dumps and the incinerators with literally billions of plastic bottles, plastics jugs, plastics tubes, blisters, and skin packs, plastics bags and films and sheet packages—and now, even plastics cans. The happy day has arrived when nobody any longer considers the plastics package too good to throw away" [279].

The “happy day” Stouffer references was surprisingly hard fought. The industry had to pivot its understanding of its own materials almost entirely in less than 10 years. In 1951, for example, when discussing the potential for attractive packaging on television, the main point was that the packaging would be able to be re-used—in that “no other materials known to man offer such fabulous combinations of beauty, durability, and cleanability.” In colour television as well, it was extremely important to ensure that “sleazy film, thin sections of molded parts, poor assembly, bad finishing, misapplication of materials” would not exist, as it “will show up over colour television… it is only an opportunity for the finest plastic products.”[280] These themes repeated themselves over and over during the 1950s, trying to emphasize that plastic needed to be held in higher regard.

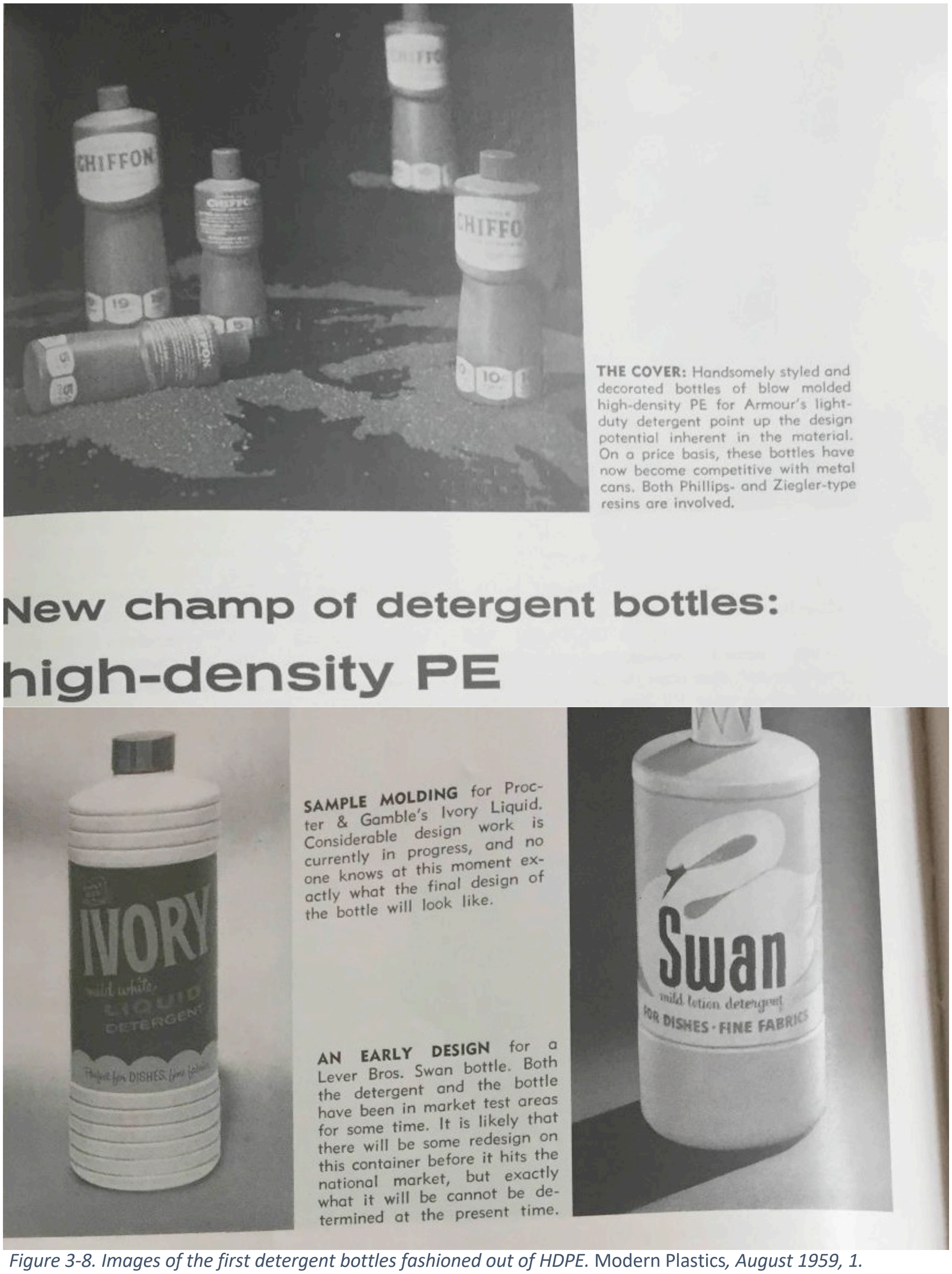
But even as these admonishments continued, disposability began to creep into the narrative. In April of 1956, just a few months before the Monsanto House of the Future is debuted at the seventh NPE, the first editorial about plastics for disposables was published. The idea of disposables was uncommon enough that the editor felt it necessary to define what disposables even were: “the tin can, the non-return bottle, the paper package, the cellophane wrapper are examples.” He continued that “most of our disposables are paper, largely because of cost but also because of the ease with which they may be made to disappear after use.”[281] Here he also pointed out that “not long ago, plastics were so expensive that deliberate expendability, except for specialty packaging… was not to be considered.”[282] While the initial focus was on polystyrene, as it had become the “workhorse plastic of the packaging field,” and here the emphasis continued to be on re-use, the industry was well into the realization of the pull that plastic had on consumers.[283] One case study had paper packages of ice cream removed from 16 Los Angeles area grocery stores and replaced with "I-C paks" made of transparent moulded polystyrene. They pointed out that "even with an increase of 5c per pint retail to defray the increased cost of the plastic package, sales in all test stores increased from 200 to 400%, with one recording an *800% increase* during the one-month test period."[284]

One year later, in April of 1957, not even a year after the Monsanto House of the Future made its debut, the industry came to grips with the full potential that the packaging industry seemed to offer. The article began by admitting that

> "a major problem with the marketing of disposable and expendable merchandise made of plastics… is the disinclination of consumers to accept the fact that such merchandise has been designed to be, and therefore should be, discardable and destroyable. A decade ago, when thermoplastics materials were more expensive, when plastics processing methods were slow, when materials for thin section products were few and weak, the plastics industries were at some pains to stress durability and re-use value of plastics products, including packaging, and to educate consumers in the proper care of plastics merchandise. Since plastics products, disposable or not, are pleasant to the eye and touch, and inevitably have some durability, consumer habits of saving plastics items for re-use, developed at that time, hang on."[285]

Thin-walled sections were as important to *produce* in packaging as they were important to *avoid* in toys. The same property that toys were admonished for repeatedly – sufficient wall strength—was seen as a positive in packaging. HDPE's materiality solved a problem not by sturdy design, but by its status as a polyolefin. It bent, but it did not break.

New Champ of Detergent Bottles: HDPE



THE COVER: Handsomely styled and decorated bottles of blow molded high-density PE for Armour's light-duty detergent point up the design potential inherent in the material. On a price basis, these bottles have now become competitive with metal cans. Both Phillips- and Ziegler-type resins are involved.

New champ of detergent bottles: high-density PE

SAMPLE MOLDING for Procter & Gamble's Ivory Liquid. Considerable design work is currently in progress, and no one knows at this moment exactly what the final design of the bottle will look like.

AN EARLY DESIGN for a Lever Bros. Swan bottle. Both the detergent and the bottle have been in market test areas for some time. It is likely that there will be some redesign on this container before it hits the national market, but exactly what it will be cannot be determined at the present time.

Figure 3-8. Images of the first detergent bottles fashioned out of HDPE. Modern Plastics*, August 1959, 1.*

Once disposable polyethylenes were scaled via hula hoops, they found an immediate market in packaging for synthetic detergents. Plastics development and chemical cleaning development closely paralleled each other, as they are both the product of research and development corporate cultures in the interwar period amongst the major chemical companies. After World War I, there was a concerted push for the American chemical companies to first catch up to, and eventually wrest domination away from, the German firms.[286] Many of the household cleaning products that are synonymous with hygiene today were developed during this period, with the first synthetic detergent developed in 1916 in Germany, lacking as they were in a natural source for tallow. For example, the development of *Tide* at Proctor and Gamble commenced in 1931, after their chemists made a visit to Germany's IG Farben Research Laboratories, though the laundry detergent itself was not introduced until 1946. The same research and development cultures that created many of the thermoplastics the 1930s were also used to develop a whole host of synthetics: from dyes to pharmaceuticals to pesticides to explosives, chemists used base materials – first coal tar, and then petroleum - and created new domestic products that promised to make life easier. When high density polyethylene was so quickly scaled due to the hula hoop, it seemed natural to immediately use it for the synthetic detergents which were very quickly becoming dominant on the market. Chemists already knew Polythene as a sort of wunderkind, as it is the only material that made hydrofluoric acid easily transportable due to its non-reactivity to strong acids and bases.[287] Detergent is harsh, and difficult to package, as one must account for its ability to dissolve both hydrophobic and hydrophilic agents. In August 1959, a mere six months after the hula hoop craze, HDPE is lauded as the "new champ of detergent bottles." At the time, "the material against which PE is competing here, is principally, steel. Almost all light-duty liquid detergents today are packaged in coated steel cans."[288]

One of the major players in this early adoption of HDPE for detergent is Hercules Powder Co. Under the subheading "Who is in the picture?" Hercules was stated as the main company to take initiative along with three bottle blowers, based on the "Ziegler type Hi-fax 1600-E" which, they state, "proved to be the first material with enough stress crack resistance for the job."[289] Here, you see the other side of the "material undergoing careful development" statement in the hula hoop article, where "market testing was a long drawn-out affair because the market loomed so large that no one could afford to take any chances on failure. Containers were redesigned time and again, molds were built and rebuilt, blowing techniques were revised, cartoning had to be re-engineered, filling equipment had to be developed and built."[290] Three months later, a two page 'info-tisement' run by Hercules titled "The hoops have had it… now what?" specifically points toward the "Hi-Fax" bottles as where the next boom is, however, they take care to emphasize "housewares, appliances, sporting goods and toys are among the many fields where product planners are now finding ways to whet customer buying appetites with these new plastics."[291]

Hercules Powder Company was formed in 1912 as a result of an anti-trust ruling against DuPont and mostly dealt with 'smokeless powder' – ie. Nitrocellulose or guncotton, and other ordinance, particularly through World War I. As it grew and diversified, it began to incorporate various other facets of chemical manufacturing throughout the interwar period. One of those facets was its 1920 acquisition of a company from Brunswick, Georgia which had developed a method to extract wood rosin from pine stumps. The best known (and most notorious) product that Hercules created from that rosin was a pesticide called Toxaphene, the subject of continuing superfund sites in Brunswick. However, another product which gained considerable consumer traction was pine oil, especially with the postwar ascendance of the popular floor cleaner, Pine-Sol. While Hercules did not make Pine-Sol, they made a competitor called Yarmor Pine Oil, which they heavily advertised in trade magazines such as “Soap,” “Soap & Sanitary Chemicals,” “Starchroom Laundry Journal,” and “Rayon.”[292]

Figure 3-9: An advertisement for Hercules Powder Company's Yarmor Pine Oil. From Soap*, May 1930. Part of the Records of Hercules Incorporated, Volume 1930, Science History Institute.*

Hercules is the perfect example of why it no longer makes sense to talk about production and consumption as discreet entities, one that follows another in an orderly form. It instead makes the most sense to talk about the chemical conglomerates that create most consumables postwar as an entangled process of becoming – where the production of one thing begets a waste product that becomes another product through chemistry; where the vertical integration from crude oil to finished object is specifically designed to induce demand. It's considered a triumph that the "younger managers and researchers displayed ingenuity and resourcefulness… competing in strange circumstances characterized by the presence of many rivals from previously distinct industries, such as chemicals, oil, rubber and metals; extreme difficulty in sustaining proprietary process advantages because of liberal licensing policies and easy diffusion of technical information across the industry; the necessity of building and operating large plants to capture economies of scale; rapid growth of demand, but even faster growth of capacity additions, and severe troubles in maintaining price levels."[293]

While there are three petrochemical areas that Hercules scaled in the years 1955-1961, "crystalline (ie. high-density) polyethylene… was the most complex of Hercules' initial efforts and the last to come to fruition."[294] But by the end of 1957, a mere three years after obtaining the license from Ziegler, Hercules began to commercially produce high density polyethylene. It was marketed "initially as a substitute for [LDPE] in many existing applications, such as housewares, coated wire, detergent dispensers, fibres, bottles, toys and chemical-ware. In 1958, the product received significant boost from the craze for Hula-Hoops, which consumed 2.5 million pounds of polymer." But "investing heavily in development work and manipulating the characteristics of the polymer… helped it gain a secure foothold in the market for blow-molded bottles such as those used to contain liquid detergents and bleach."[295] But the problems that Hercules encountered with respect to obtaining the chemical feedstock ethylene to produce HDPE pushed it to the point where they temporarily converted the plant over to making polypropylene by analogous process, as the plant designed for HDPE sat idle while Hercules waited on delayed shipments of ethylene from Enjay Company (a predecessor of Exxon Chemicals). The delay showed the need for Hercules to secure its own supply of raw feedstock, which in turn allowed "new raw materials base to supplement what appeared to be limited opportunities for growth in the company's existing business."[296]

Figure 3-10: A collection of snapshots from Playthings *magazine, emphasizing the "sanitary" aspects of toys. Compiled by the author.*

While chemical cleaning became ascendant starting in the 1930s with pine oil, for the largest population of people – children - who were affected by the polio outbreaks, it was only of limited efficacy, as it was too harsh to be able to be used for children's toys. The much-loved children's book, *The Velveteen Rabbit*, written in 1922, and chronicling the life, death, and rebirth of a cherished toy rabbit after his owner is stricken by scarlet fever, illustrates the issue with most toys prewar, in that most of the child's toys had to be burned to prevent contagion.[297] Metal toys are not easily washed without causing rust, and difficult to ensure complete sterilization because of joints and rolls to prevent sharp corners; stuffed toys were nearly impossible to clean without (as yet non-existent) high-heat dryers, wood is naturally porous and would not be easily sterilized without boiling and possibly ruining any adhesives used in its assembly. In those postwar years, where polio was a greatly feared and severe virus without a cure, only plastic was easily cleaned, with the 'damp cloth' of damp cloth utopianism. Advertisement after advertisement in *Playthings* magazine shows plastic toys being broadcast as "Safe! Sanitary! Washable!" and every other combination of those words, as the reader can see in the collage above.

As Emily Martin writes in *Flexible Bodies: Tracking immunity in American Culture from the days of polio to the age of AIDS*, the polio outbreak during the damp-cloth utopian era represented the last major outbreak before changing ideas around the body's natural and internal immunity became the dominant medical paradigm. Advertisements at the time for cleaning compounds "stressed the presence of deadly disease germs by the millions that may lurk unseen in ordinary house-dust."[298] She writes of being tripped up more than once in her own assumptions when reading about various measures that were taken; assuming, for example, that the suggestion that children not get teeth or tonsils removed during summer polio months was to prevent a hit to the immune system; until reading, chagrined, that it was instead reasoned that the open wound would be considered an entry point for the polio. She writes that the "external threat" rhetoric surrounding disease narratives bore remarkable similarities to the threats of cold war annihilation, where keeping one's own house in order (through domestic or political hygiene) was essential to keep the threat at bay.[299] While pine-oil was wonderful for floors and furniture, things that would go into children's mouths, such as toys, required less harsh treatments, which is why plastic was the ideal candidate for them. Throughout the 1950s, however, more and more products came onto the market that were based in synthetic detergents, with the introduction of now common cleaning products such as Mr. Clean.[300]

But the damp cloth utopianism that existed with thermoset materials like Bakelite or melamine was also undermined by the material composition of the new polyethylenes. Unlike the smooth and hard surfaces of many of the older thermoset plastics like Bakelite and urea formaldehyde, polyethylene has a 'waxy' or 'oily' surface feel to it. The technical term for polyethylenes is "polyolefins" – olefin being derived from the mid nineteenth century French descriptor of ethylene dichloride "oléfiant" or, chemically, the 'oil-forming' tendency of alkenes in reaction with chlorine gas. The damp cloth is no longer sufficient to feel as if a polyethylene surface is clean, as a result, because the surface remains greasy feeling (as anyone who has washed a Tupperware container more than once to ensure its cleanliness knows). Polyethylenes therefore undermined the idea that one can simply wipe the material with a damp cloth for cleanliness, at the same time as providing a reliable container for what would indeed get it clean – the liquid soap detergent. But at the same time as the rise of the polyethylenes, the sanitary aspects of toys were becoming less important, due to the invention of the polio vaccine by Dr. Salk in 1955.

As the reader can see, the way that we arrive at a packaged-in-plastic planet comes from a constellation of circumstances. Far from the common-sense story of plastic being used in packaging due to its cheapness, I have shown the many twists and turns that have occurred in the final stages of the devaluation of plastics. Instead of it being a matter of course, there are competing trajectories that plastics were approached with in the 1950s, and a child's toy – the hula hoop – tipped the balance in giving one of the plastics that are now synonymous with packaging a huge boost in the late 1950s. The 1950s plastics industry had, for the most part, been moving its 'marquee' type projects into more durable, permanent applications. 1954's Corvette and 1956's Monsanto House of the Future were the apex of a thirty-year push by the plastics industry to create both an 'all plastics' car and an 'all-plastics' house, ensuring their dominance over two of the largest industries in postwar America. But while this was the focus in much of the plastics industry nearly from the moment of its birth, it is not its current reality. Instead, their dominance in packaging became something that would define its use over the subsequent time period all the way to the present.

That boost, which contributed to cheap plastic's increasing ubiquity, as well as the "greasy" visceral properties of that plastic, and the proliferation of Wham-O's remarkable toy's imitators cheapening both product and material, all facilitated the changing perception of plastics from those of utopian usefulness and durability to a paradigm of a more quickly discardable material. Hyper-consumption and disposability are intimately entwined, and as a material's value decreases, so too do notions of its durability. This process culminates in HDPE's evolution into consumer packaging, to contain the synthetic products that the same industrial concerns that made the plastic itself were bringing to market. The intelligibility of plastic was undermined repeatedly by its ever-changing formulations, compositions, and branding which ultimately required the building industry to be far nimbler than it could be to adopt the new materials. However, consumers were much easier to educate and take from the practice of re-using packaging to throwing it away after a single use, a process that was facilitated by the proliferation of plastic toys. The 1950s are where the realm of plastic pollution we today see in every environment - from the Mariana's Trench to the tip of Mount Everest - began its inexorable growth.

Chapter 4: Summertime… and the living is plastic

Figure 4-1: The author's child, enjoying the sunset on the inflatable unicorn. Photo by the author.

Polyvinyl Chloride and the inflatable toy industry

In the summer of 2017, when I started writing this dissertation, I purchased a ten-foot long inflatable unicorn for my child to lounge on at the cottage. Its friendly white face, rainbow mane and tail, slowly inflated with a hairdryer set on cold, as the traditional method of blowing up vinyl inflatables by mouth was rendered impossible by its sheer size. As it inflated, the sharp and somehow clean smell of vinyl plasticizers permeated the air, wafting through and making people around it breathe its aroma in deeply. That unmistakeable odour is often likened to "new car smell." I thought about endocrine disruptors, phthalates, and BPA whilst simultaneously enjoying the familiar, comforting fumes. The smell is childhood, summer, and road trips to me, while at the same time it is also precocious puberty, decreased sperm counts, and fertility issues to me. It is difficult to hold both things in my mind simultaneously, to "stay with the trouble" as Donna Haraway admonishes us to.[301]

The unicorn was Made in China*. It arrived on the doorstep after I clicked a few links on Amazon, entered a credit card number and pressed "Order Now." The money I used to buy it will never exist in anything but digital space, as the directly deposited paycheque goes via electronic banking to the credit card company. These days putting a purchase on "plastic" is primarily an exercise in metaphor, as the increasing ephemeralization of consumption reaches its nadir. Numbers on a screen magically produced this mythical creature which comes to life via forced air before my eyes.*

The unicorn was a hit that first summer with all the children up at the cottage, who threw themselves bodily onto and over it, lounged on it, pushed each other around on it, rescued it from the slight current of the lake, fought over it, and ultimately dragged it out of the lake after the day was done. It had not popped and it was only very minimally dirty, having picked up far less lake detritus than the children in question. A couple of the children had red marks on their arms and legs from the seams on the unicorn where the head is fused to the body and the two parts of the body are fused together. Those seams – called flash lines – were the only physical evidence of the vast infrastructure that brought my mythical beast to life. Today, that infrastructure is even more hidden than the period of time that I will examine in detail, as it is thoroughly globalized. But through the flash lines – the seams – the joining points – we might get a tiny hint of what came before.

This summer, while I engaged in a final push to finish this dissertation, I spent very little time up at the cottage. The unicorn had again been inflated this summer, though my child is now too old and too in the throes of adolescent coolness to enjoy it very much. My parents are entertained by it however, as it attracts the waterfowl on the lake as some sort of vinyl demi-god. They kept it in the lake all summer, tethered to a rock that acted as an anchor. It had sprung a leak somewhere in its top portion, so the head that was previously held high by a tight inflation now drooped into the water, sad and forlorn, slowly dying. It was probably the last summer that the unicorn would add its cheerful face to the inlet in front of my parents' cottage. By next summer it will surely be adding its cheerful face to the dump, having lasted longer than most of its kin.

Polyvinyl Chloride: A black box domesticated

Polyvinyl chloride's story follows a familiar arc by now. The first part of this chapter covers its interwar invention, wartime scaling, and postwar domestication; and is similar to the trajectories that I covered in both the polystyrene and the low- and high-density polyethylene chapters. But polyvinyl chloride represents, in many ways, the apex of the story of the domestication of plastic and its subsequent spectacular fall. In Polyvinyl chloride, the ambiguity between plastic as surface and plastic as structure is strongest, and where plastic is at its most insubstantial. Early polystyrene is hard, but brittle. Low- and high-density polyethylenes are flexible, but still rigid enough to hold shape. With polyvinyl chloride, and in particular vinyl inflatables, we begin to enter the uncanny, as an inflatables' form is brought about by air, and its ability to maintain form is destroyed by its own chemical instability. The story of polyvinyl chloride shows how plastic's durability vanished and tells us about the utopian ambitions that vanished with it. To understand the identity of plastics in postwar North America, the discursive and political shifts that polyvinyl chloride experienced must be exposed. It then becomes clear how plastic fell from grace in the minds of the average consumer, whilst simultaneously and paradoxically being purchased in ever greater quantities.

Toys like vinyl inflatables have never been the primary focus in previous cultural histories about plastics in twentieth century North America, which I believe was a major oversight. Meikle wrote that "as surface rather than structure, the inflatable suggested a more fundamental substitution of the artificial for the natural than any prior use of plastic."[302] But by focusing on highbrow subjects like Italian designed inflatable furniture and Buckminster Fuller's geodesic dome and the process of ephemeralization he promoted, Meikle missed an opportunity to talk about the far more ubiquitous and mundane objects that surrounded many children in postwar America. Meikle astutely deciphered plastic's inchoate nature, but chose to focus on living/working structures, which never became widely accepted. The real embrace of the artificial occurred elsewhere, in the mundane domestic objects of child- and motherhood. Whereas the inflatable furniture and architecture that Meikle focused on remained boutique items accessible to only a few, vinyl inflatables as children's toys were sold in the millions and, through their material instability, taught a young population to both *mistrust* and *discard* the material of modernity.

The second part of this chapter is about what happened to plastic when those children grew up surrounded by a material that merged surface and structure and was utterly insubstantial. It covers the ways in which the suburban phenomenon of the 'backyard beach' was promoted and sold to an entire generation of children growing up in the suburbs. As those children grew into adolescence and attempted to 'find themselves,' the low-cost play pools, which turned into above-ground and in-ground pools as vinyl sheet manufacturing improved and grew, provided a poor substitute for what became one of the key countercultural movements of the 1960s: a massive teenaged surf culture that rejected the artificial and embraced the authenticity of the ocean, even though that surf culture still depended on the industrial production of plastic boards.

Polyvinyl chloride became what we know it as today because of its many different iterations in twentieth century North America. At its most basic, it is a polymer of the vinyl chloride monomer, which was manufactured in two different ways – one more harmful than the other. Its invention and commercialization saw several different trials and co-polymers, three of which I focus on below. It was first polymerized via sunlight in 1872, but was rejected as a useless material, as it was too brittle and unstable to be commercially viable.[303] As Meikle notes, it wasn't until the 1920s that its makeup became the subject of study, and it developed the protean character we now generally associate with the word plastic. Manufacturers learned that polyvinyl chloride can "assume a range of textures and densities, from soft and flexible to hard and resilient, depending on the plasticizers used."[304]

Polyvinyl chloride is today the third largest produced thermoplastic by volume, with a worldwide production volume of 60 billion pounds annually, accounting for 17% of the world plastic market.[305] In order to synthesize polyvinyl chloride, there are just two ingredients needed: crude oil and salt. Polyvinyl chloride is the least expensive of the three most common plastics today, primarily because one of its ingredients is not a petroleum. Its manufacture is largely done in huge industrial vats at temperatures and pressures that preclude any handling by humans, instead they are largely reduced to monitoring the process via instrumentation. Plastics manufacturing therefore represents what Bruno Latour calls a "black box" that is not easily opened, as its mechanics are not readily made tangible. As Latour puts it, a black box is "the way scientific and technical work is made invisible by its own success. When a machine runs efficiently… one need focus only on its inputs and outputs and not on its internal complexity."[306] The internal complexity of polyvinyl chloride manufacture needs to be made visible here so that we can move more completely into an understanding of the material and its effects on the world.

To make polyvinyl chloride in the United States in the 1920s, crude oil was transported via a six-inch cast iron pipeline from a well—most likely in Texas—to an oil distillery. The petroleum distillation process divided crude oil into its various component parts, including the one most important to ethylene production, naphtha. Naphtha was then thermally dehydrogenated into various fuels, including ethylene. To make the vinyl monomer, ethylene must be further treated. According to the dull description of a contemporary plastics technology textbook, until the 1950s, the vinyl chloride monomer was produced via the acetylene route. In short, "calcium carbide [was] manufactured by heating calcium carbonate (chalk) and carbon in an arc furnace. Acetylene [was] generated by adding water to calcium carbide, both reacting spontaneously. Acetylene [was] then reacted with anhydrous hydrochloric acid to yield the vinyl chloride monomer. The reaction usually [took] place over a fixed bed of catalyst. The catalyst [was] made of mercury chloride on activated carbon." [307] This dry description masks the reasons why the direct chlorination route was favoured postwar, as the methyl mercury produced as a by-product to the acetylene route was highly poisonous. Methyl mercury was the culprit in the Minamata Bay disaster, where an entire village of subsistence fishers in rural Japan began to experience severe birth defects and cancers starting in 1958 due to the vinyl chloride manufacturing plant that was dumping into the bay. The Minamata Bay disaster was one of the first visceral and terrifying evidences of plastic's harms, when it became known through a series of photographs published in *Life* magazine in 1972. Today, the acetylene route is still used in many global manufacturing centres such as China and Russia due to abundant coal supplies and lax environmental regulation, an aspect of polyvinyl chloride manufacture that is far beyond the scope of this chapter but nonetheless bears briefly acknowledging. The Minamata bay disaster was a consequence of vinyl chloride being produced via the acetylene route, not the direct chlorination route, but the chemical that caused the harm—vinyl chloride—would be forever seared into the minds of the public via the famous photographs.[308]

Since the 1950s, The direct chlorination method is used to create ethylene dichloride. Ethylene dichloride is then pyrolyzed (separated via heating) and the vinyl chloride monomer is created. A gas at room temperature, the vinyl monomer must be subjected to extreme pressure to become a volatile liquid capable of being polymerized. The vinyl monomer liquid is then dispersed into water, and vigorously stirred while heat is removed. Small, clear crystals begin to form in the gas, which is polyvinyl chloride in its initial form. Plasticizers and other additives are then combined with those small, clear crystals depending on the desired properties of the end product, whether it be rigid tubing for sewage applications or soft "pleather" for the chair that I am currently sitting on. While the direct chlorination route to make vinyl chloride does not produce methyl mercury, all soft polyvinyl chloride plastics have harms associated with them, as the phthalates added to them as plasticizers to make it pliable are implicated as endocrine disrupting chemicals.

In these explanations, one can begin to see why plastics may well be the ultimate materials for the fetishization of commodities. Though I have a science degree that included three years of study in chemistry, biochemistry and physics, the process is buried in the language of its constituent parts, and extraordinarily separate from the drama of environmental disasters or the mundanity of the chair that I sit on. Karl Marx encouraged those who would want to understand capital to glean the social conditions behind which the commodity is created, so as to avoid a fetishization of the finished product. But what if the process seems largely devoid of human workers? What if the creation of the product requires temperatures and pressures that preclude human intervention, and proceeds at an unimaginable industrial scale? To disrupt polyvinyl chloride's commodity fetishism requires a degree in chemical engineering. This, I think, is why plastic represents a problem for analysis and disruption of capitalist commodification, and perhaps why capitalism today—largely manufactured of plastic—is apparently hard to disrupt. The sole functional method by which the production of plastics can be discerned by the layperson—via a careful account of chemical reactions—obscures the actual process. This ignorance of the material has a material and social history. As plastic's ubiquity increased in consumer applications, an understanding of the substances decreased.[309] These twin characteristics of ubiquity and ignorance of plastics today provide both a protective function for the industry's ills, and allow for unnecessary fear-mongering amongst the pseudo-scientific natural health industry. This perceptual gap of contact *with* the material versus knowledge *of* the material highlights a fundamental disconnect between industry scientists and engineers and the consuming public. While scientists and engineers assumed that more knowledge was going to help the consuming public accept plastics, a bewildering array of chemical compositions instead aroused suspicions and distrust. As I demonstrated in my polystyrene chapter, there were large campaigns to delineate certain plastics as high-quality plastics in contradistinction to others. Polyvinyl chloride, due to its chemical instability, difficulty in manufacture, and propensity to become garbage, was often the 'other' plastic in question.

Vinyl inflatables were some of the most ephemeral toys, being both seasonal in nature and easily destroyed. Inflatable toys, particularly those that were designed for outdoor use, were easily popped, split, scraped or otherwise compromised. Even if they were not physically compromised, the outgassing of the plasticizers used in their manufacture, accelerated under the summer sun, made them susceptible to increasing brittleness, fading and cracking. While these issues have been improved over the years by better formulations and manufacturing processes, those produced in the generation after World War II made a notoriously unstable vinyl material, as evidenced by early Barbie legs which became 'gummy' and discoloured due to plasticizers leaching out of them.[310] Early polyvinyl chloride also had the dubious distinction of destroying other types of plastic, if it was in contact with them – it is for that reason many collectors of hard plastic toys will remove the harnesses and accessories of toys made of vinyl so that they do not leave discolouration and what can only be described as 'burns' on the other types of harder plastic. Polyvinyl chloride is therefore a recalcitrant plastic: a plastic that burns, sweats, crackles and discolours all on its own. Polyvinyl chloride's recalcitrance contributes in a myriad of ways to the fall of plastics from a utopian to a dystopian material, as its uncanny nature disturbs the separation between surface and structure, synthetic and organic, real and false.

Before the Flash: Early uses of polyvinyl chloride in toys

After the histories of other plastics, it should be no surprise to see some the familiar aspects of the evolution of vinyl: its interwar invention, wartime scaling, and postwar conversion to consumer objects. Koroseal and Vinylite were the earliest polyvinyl chlorides, patented at virtually the same time, with Saran (polyvinylidene chloride) following closely on its heels. Koroseal was BF Goodrich's invention.[311] Koroseal was originally conceived as a substitute for rubber, its uses being largely confined to seals for shock absorbers. Union

Carbide, on the other hand, was interested in a replacement for tung oil. Their research and development efforts produced Vinylite, a copolymer of vinyl acetate and vinyl chloride.[312]

Koroseal and Vinylite were not as successful as Bakelite in their initial forays into the consumer market. Koroseal only found success in the replacement of oil cloths for rainwear in the late 1930s. Vinylite's relevant consumer success, in contrast, was in "skin" for dolls. The earliest reference to "Magic Skin" in *Playthings* magazine was in October of 1940, where it was touted as "a promising innovation" which was "said to be the first all plastic doll ever to be developed in America, as well as the first attempt to stuff soft plastic, as has been the custom with cloth and kid in the past."[313]

Figure 4-2: Ideal's Plastic Dolls. From Playthings*, July 1941, 3.*

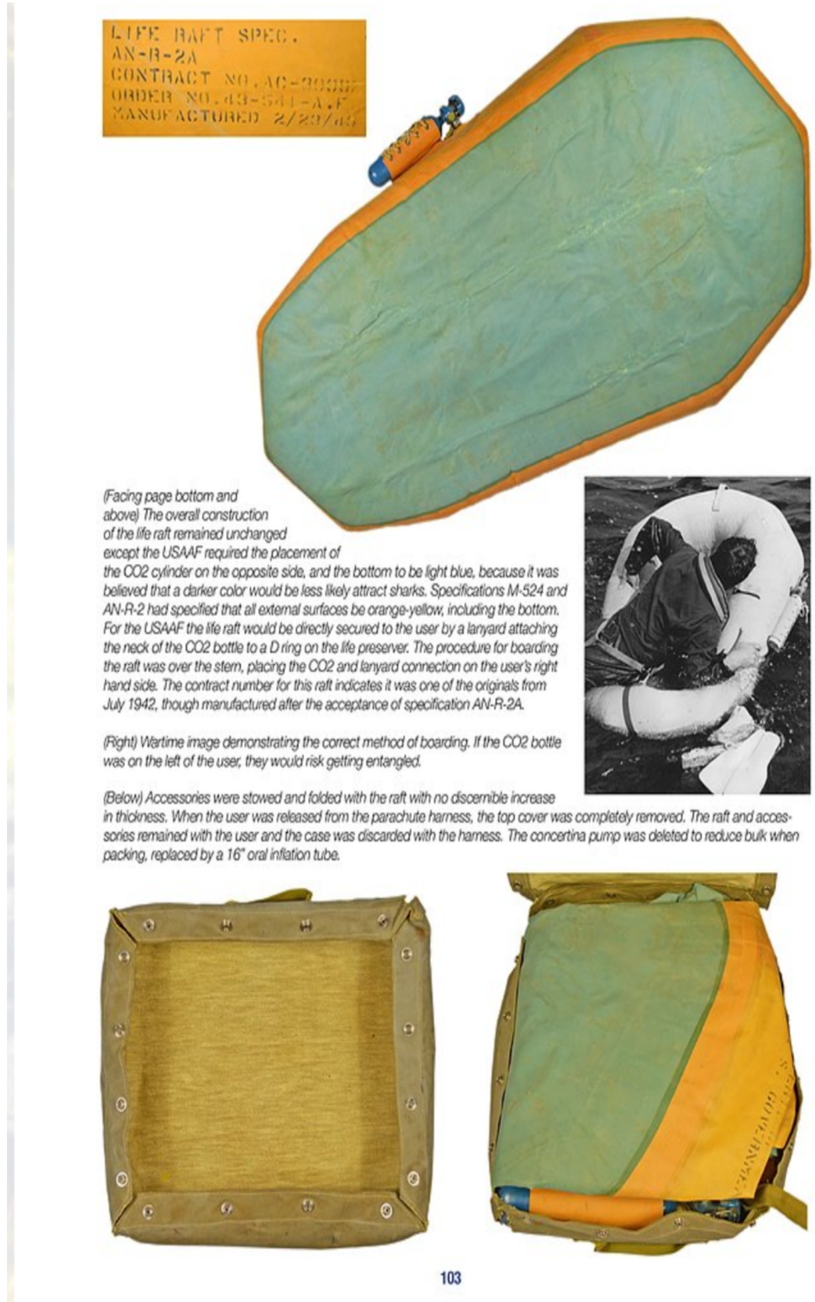
In a feature article about the history of doll manufacture, prominent toy buyer and frequent contributor to *Playthings* Magazine Eleanor N. Knowles, pointed out that "realism is the cry of the current crop of "little mothers" … the drinking doll vogue created the desire for endlessly dressing and undressing the baby… [the doll] was expected to be attractive dressed or undressed, as well as capable of being dunked."[314] The Magic Skin dolls, much like the other toy vinyl products of the time, were filled with a material called kapok, a natural fibre from the kapok tree (*Ceiba pentandra*). Notably, the vinyl sheet material was then *stitched*, rather than bar or heat sealed, as the technology to seal polyvinyl chloride had not yet been invented. While an inflatable doll was never popularized postwar, at least one precursor to the inflatable beachball was manufactured with stuffing and stitching. [315]

Before Pearl Harbour brought them into World War II, the US was enjoying a relatively robust economic upturn due to wartime manufacturing but was suffering from a relative lack of material goods to spend that money on, due to preliminary materials restrictions. While there were many restrictions on metals, the West's latex supply – almost entirely from British Malaya (present day Indonesia) – had not yet come under threat. Plastic was therefore one of the toy components not yet restricted, unlike many of the metals used in them at the time. Plastic in toys therefore acquired a relatively large market share in two short years. Following the enormous success of their composite Shirley Temple doll the 1930s, The Ideal Toy company's launch of the "Magic Skin" doll in 1940 is a prime example of prewar polyvinyl chloride in toys.[316] Enjoying incredible success, the doll "surpassed the record made by the Shirley Temple doll" during Christmas sales.[317] One of the key differences between the Magic Skin doll and the Shirley Temple doll was that the vinyl materials used were water safe, and therefore the doll was able to be "bathed like a live baby" (Figure 4-2). This material was so remarkable to the consuming public that *Playthings* magazine saw it fit to publish a selection of letters received by the Ideal Toy Company inquiring about what the material was, so that it may be used as "an artificial hand for a man whose hand has been amputated just above the wrist," a "foot and leg to wear over [an atrophied limb]" and finally a plastic surgeon from Connecticut wishing to "use the plastic for some experimental work."[318]

Vinyl's use in toys prewar was relatively short lived, however. After Pearl Harbour, the War Production Board's limitation order L-81, published in the April 1942 issue of *Playthings*, restricted materials on the "Prohibited" list to none, and those on the "Critical" list to 7%.[319] Vinyl chloride, along with urea formaldehyde, acetate and acrylic plastics were all on the former list, as well as many plasticizers. Therefore, as of June 30, 1942, the use of the great majority of plastics in playthings were prohibited entirely. As a result, most producers of plastic and metal playthings switched their factories to war production.[320] For the following two years, when made at all, toys were only made from non-critical materials, despite long and repeated arguments for the "morale requirements" of the home front, and toys' unique position to fulfil that requirement.[321] Soft woods like pine and balsa, as well as cardboard, were the materials of toy-making for everything from bicycles to fibreboard pails for the beach.

Figure 4-3: Fibreboard pail. From Playthings*, 1943.*

Wartime to Playtime: Conversions Galore



(Facing page bottom and above) The overall construction of the life raft remained unchanged except the USAAF required the placement of the CO2 cylinder on the opposite side, and the bottom to be light blue, because it was believed that a darker color would be less likely attract sharks. Specifications M-524 and AN-R-2 had specified that all external surfaces be orange-yellow, including the bottom. For the USAAF the life raft would be directly secured to the user by a lanyard attaching the neck of the CO2 bottle to a D ring on the life preserver. The procedure for boarding the raft was over the stern, placing the CO2 and lanyard connection on the user's right hand side. The contract number for this raft indicates it was one of the originals from July 1942, though manufactured after the acceptance of specification AN-R-2A.

(Right) Wartime image demonstrating the correct method of boarding. If the CO2 bottle was on the left of the user, they would risk getting entangled.

(Below) Accessories were stowed and folded with the raft with no discernible increase in thickness. When the user was released from the parachute harness, the top cover was completely removed. The raft and accessories remained with the user and the case was discarded with the harness. The concertina pump was deleted to reduce bulk when packing, replaced by a 16" oral inflation tube.

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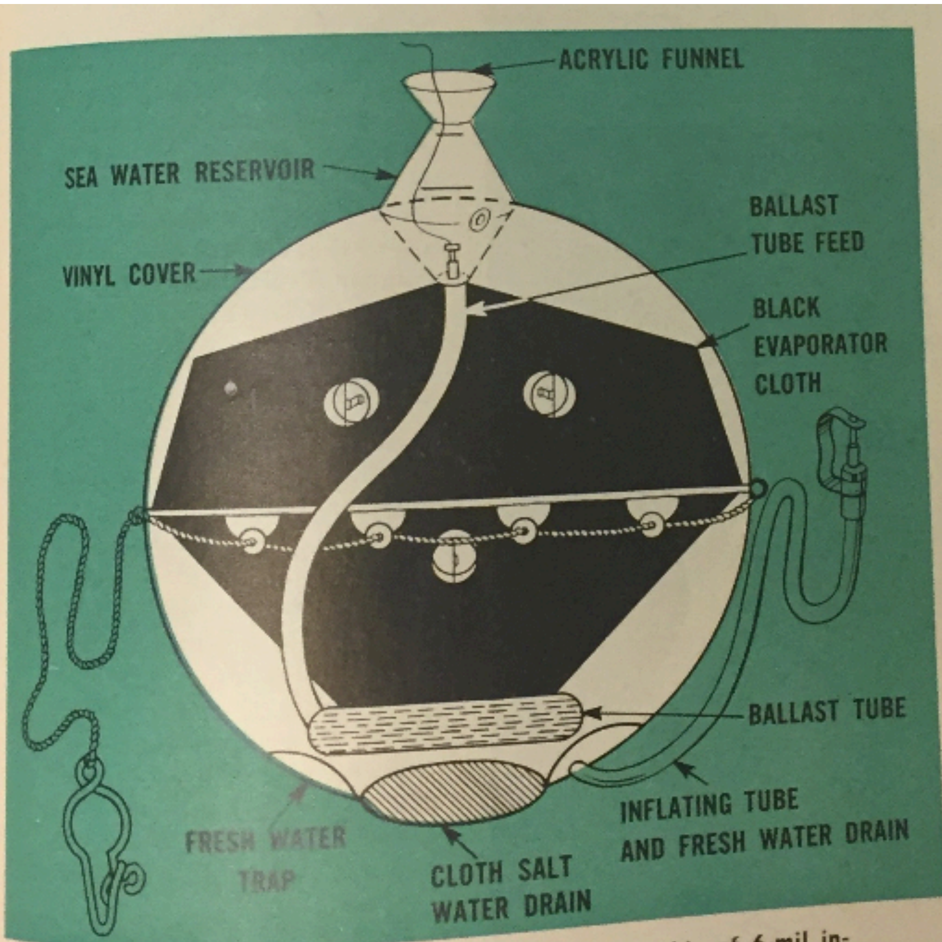
Figure 4-4: Playcraft advertisement and colour photo of original army boat. From Playthings *magazine, April 1946, 88; and* Survival and Rescue Equipment of World War II, Vol 1 *by Dustin Clingenpeel, 103.*

With the greatly increased production capacity of wartime uses for vinyl, the technology developed during the war easily translated into consumer applications. At the end of the war, a market of millions of children sick of fragile and easily broken balsa and paper toys, (and their parents with pent-up consumer demand) eagerly consumed anything and everything put to market. In December 1945, an article ran in *Playthings* magazine detailing how Eagle Rubber won the Army-Navy "E" award for Excellence in war-time manufacturing. It described how their combined 32 years of experience with rubbers and their "war-time experience with synthetics" manufacturing allowed them to make life-saving equipment for the troops, which included "inflatable rubber boats, life belts, decontamination bags, clothing bags and … special waterproof cases for radios."[322] A mere four months later, an advertisement appeared in the April 1946 *Playthings* magazine, advertising the "famous inflatable boat, originated for the Army and Navy"[323] as a high-end purchase for summer play.[324] The boat cost $45 in 1946 money (the equivalent buying power of $600 today) and is one of the earliest examples of what would soon become a huge sector of the toy industry: the summer toy inflatable market.

In the interwar period, there were only a few examples of summer toys, and none of them were made of plastic. Cellulose acetate's susceptibility to warping and melting in heat and styrene's fragility meant that the only plastic materials commonly used for toys pre-war were unsuitable for play outside. More thermostable and sturdy plastics than polystyrene and cellulose acetate existed, but the cost of production was too high to make them viable for their relatively inexpensive application to summer toys. Summer toys of that era were confined largely to accessories for sport - tennis racquets, baseball gloves and golf clubs featured prominently in one display - and backyard playthings, including wooden play structures and bicycles. Beach toys were confined to wooden sailboats and metal pails.

The American toy industry had long been attempting to create a summer toy buying event. Their first attempt was in 1916, where it was suggested that July 4th become a "second Christmas."[325] The most brashly manufactured of the summer toy holidays was the introduction of "Children's day" in 1927. Originally promoted by the Toy Fair Chamber of Commerce, it was instituted as a "time midway between the Christmas seasons" so that the industry might not suffer a summer downturn.[326] While the idea faded into obscurity over the depression years, it experienced a revival once the economy turned to war-time production in 1939. Children's Day was seen as an opportunity for general merchandising, rather than seasonal merchandising: the industry wanted a shopping experience similar to Christmas in its scope. Postwar, however, Children's Day disappeared entirely within a few years, as the toy industry realized that no artificial holiday was necessary. The massive tracts of suburban housing being constructed all over the country meant that many children were now looking for things to do in their backyard. The industry's focus tangibly shifted to toys amenable to suburban backyard play and was further encouraged to see it as a safety strategy. One article encouraged retailers to sell backyard toys as a way of keeping children off the street, in a clear signal to the changing norms of the safety and care of children postwar.[327]



Solar still, used to convert salt water to fresh, has outer skin of 6-mil inflatable-type vinyl film, with inner cloth skin suspended by round vinyl tabs

Playball of 12-gage vinyl is 18 in. in diameter, comes in many colors

Figure 4-5: Playball and solar still. From Modern Plastics*, June 1950, 69.*

The inflatable boat was therefore the beginning of a huge glut of inflatable products in the toy industry that came directly from the technologies developed during the war. In June 1950, for example, *Modern Plastics* ran an article titled “Solar Stills Lead to Inflatables,” which demonstrated the direct evolution from a solar still to a beach ball. The company US Fiber & Plastics Corporation “ha[d] spent several years in developing a heat-sealing, reinforcing, and handling method built upon experience gained in fabricating the US Navy’s new and improved solar still for making sea water potable.” The article explained that although US Fiber “has had to build special equipment and develop new techniques to handle this operation,” the “same apparatus together with other machines and the knowledge gained in this precision operation have been employed in the manufacture of a complete line of inflatable consumer items.”[328] Pictured in the article, directly above one another, was a diagram of a solar still, and an image of a beachball (figure 4-5, above). The design paradigm and comparison were made obvious to the reader. The innovations wrought by building a better life raft and water collection method for the planes that went down over the Pacific Ocean translated directly into a more reliable toy product which very quickly took over the market. Even the smallest innovation – an improved method for sealing vinyl film – had enormous repercussions for not only the industry, but for consumer culture itself, and eventually the entire planet.

The Inflatable Grows: Summer Sales and the Start of the Backyard Beach

In March of 1952, the sales manager at Boltaflex, JA Wilcox, published an in-depth piece about inflatable summer toys in *Playthings*. He wrote that “in four or five years, plastic inflatables have become big business. Even as late as last summer, however, the potential of the market was still not recognized by a great many of America’s toy dealers.” Wilcox pointed out that vinyl inflatables were considered a “fringe” toy when they first came on the market in the 4-5 years previous: “a fill-in for the big gap created by the lack of rubber and by the restrictions against selling fireworks or firecrackers” but had now come into their own.[329] He gives a short history of vinyl’s use in the toy industry from the point of being first “developed during the last war when substitutes were developed for rubber… it was first used for stitched toys that offered fast colour and a washable, sanitary surface.” [330] He lauded the invention of “bar sealing or electronic welding,” which eliminated the need for stuffing, increased compactness and reduced the shipping weight required. These small toys brought a summer toy market to those merchants whose spaces were too diminutive to feature backyard play equipment and gyms. He finally points to the invention of beach-balls as the ultimate trigger for a cascade of summer toys to follow: “swim-rings, roly-polys, water toys and so on… a whole new selling campaign was in the making.” [331]

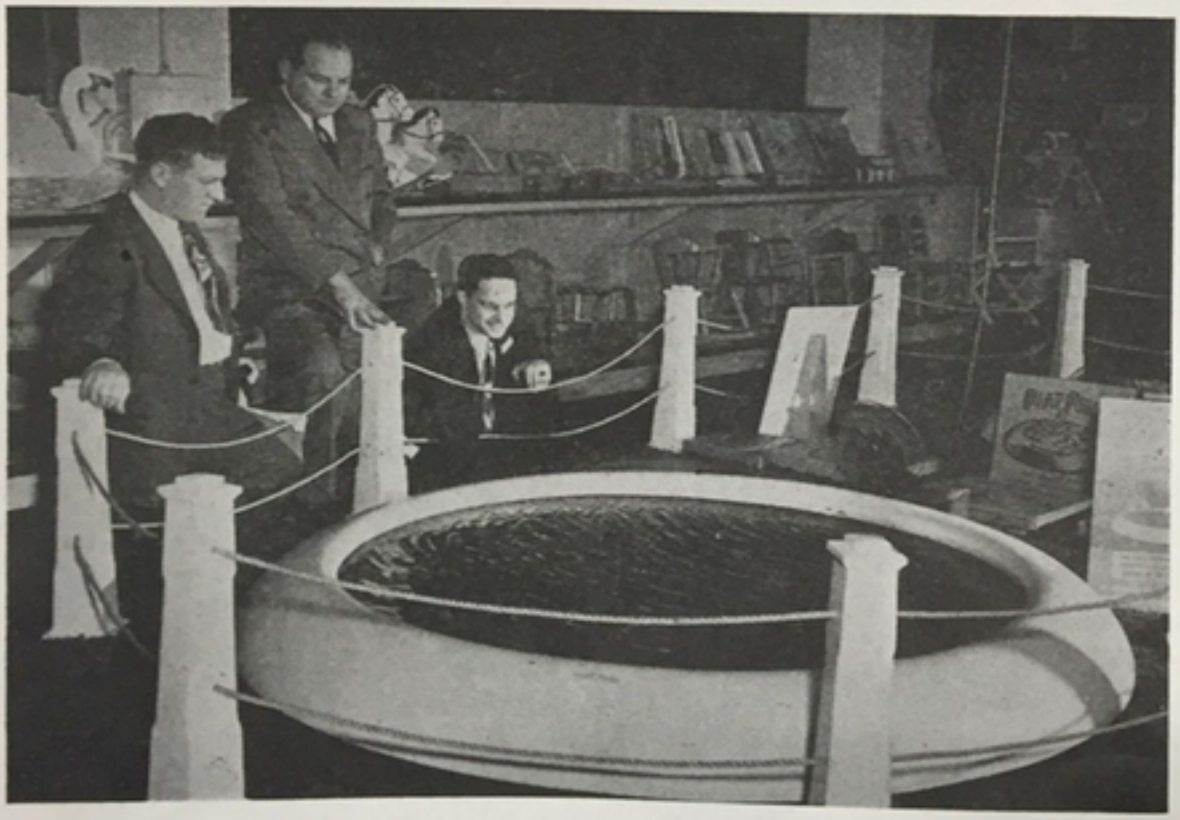
This article clearly signals that by 1952, the dominance of vinyl inflatables had become evident. Wilcox pointed out that the colourful and eye-catching vinyl inflatables were previously restricted to drug stores and beach clubs but had by then become a staple of toy stores everywhere. He suggested a ratio of “50% pools; 20% novelties, water animals; 15% swim aids, swim rings, water wings; 5% inflatable boats; 5% beach mats and surfboards; 5% play balls.”[332] He emphasized the need to sell them inflated, in contrast to the tightly packaged deflated toys that are sold today, as most purchases for these items were impulse-based. He wrote, “to properly present the items in all their colour and beauty, inflatables should be fully inflated at all times, and should be displayed in prominent locations.”[333]

The inflatable vinyl toy market was so fast growing that it doubled in size in each of the years from 1947-1953.[334] *Modern Plastics*, in its January 1954 issue, surveyed the state of the industry. They stated that out of the 110 million pounds of vinyl film used in 1953, vinyl inflatables used 15 million pounds (14% of total use). By way of comparison, industry and the military used only six million pounds (7% of total use).[335] Inflatable's prominence only continued to grow over the 1950s and into the 1960s. "[T]he 'backyard beach' popularized by the postwar sale of millions of plastic play ponds" lent itself to the creation of an entire industry of vinyl inflatables.[336] The US Fiber and Plastic Corporation, writing in 1954, claimed that its facilities for its "Million-Air" line air mattress had to be tripled over 1953 in order to handle the demand for their merchandise. Later in the same issue an in-depth interview with prominent toy buyer Hermine Myers discussed how differently the summer season was being approached in comparison to the years previous: "a major coordinated selling effort will be made at the consumer and trade levels to encourage peak toy sales in early June and thereby give added impetus to what is becoming a second major toy selling season."[337] This "new summer business" was directly attributed to "inflated vinyls that helped sell millions of pieces."[338]

Figure 4-6: Advertisement for prewar pool. From Playthings*, February 1946, 51.*

Several factors contributed to the meteoric rise of vinyl inflatables, but there was no factor larger than the suburbanization of America. “Victory Housing” built for returning veterans, and eventually in massive tracts of family-oriented, automobile-focused communities, the idea of the “backyard beach” began to become popularized. While the toy industry focused on the proliferation of vinyl inflatables that acted as toys, the fact that Wilcox stated that the display should be “50% pools” shows how the two things grew hand in hand. The plastics industry saw a different opportunity in the backyard beach phenomenon, in that the suburbanization of North America meant that the privatization of a leisurely day at the “beach” could occur.

The small splash pools designed for toddlers pre-war had been metal framed with oil-cloth liners. An advertisement for a metal framed wading pool in February of 1946 boasts that it is “in every respect – pre-war quality!” with a “heavy angle iron frame, lacquered in green, supporting heavy waterproof green duck.”[339] These metal and canvas contraptions didn’t last for long, however. In May of 1948, the first Koroseal “Play Pond” was pictured in the toy briefs area of *Playthings*, as a photo from the recent toy fair and providing information on the sole national distributors. The pond “needs no rigid supports, is sun-proof, leak-proof, [and] grease-proof” in marked distinction to that play pool pictured above.[340] The saucer-like atomic age appearance of the pool, as well as its far lesser shipping weight in a transport-strapped economy, surely must have made a positive impression in contrast to the utilitarian appearance of the wading pool of previous years.



This Koroseal Play Pond display was a center of attraction at the showroom of Blake & Conroy, 1107 Broadway, N.Y.C., during the recent Toy Fair. They have been appointed sole national distributors for this item, which needs no rigid supports, is sun-roof, grease-proof, leak-proof. The buyers shown here are, L. to R., Frank Bauer, Jack Weiss and Dave Grundfest, all of the Cash Wholesale Company, Inc., Little Rock, Arkansas.

Figure 4-7: Koroseal Play pool. From Playthings*, May 1948.*

The Koroseal pool had appeared in *Modern Plastics* Magazine in September 1947 and is an early example of the birth of an entire industry shaped around backyard leisure.[341] Always the exhibitors of innovation, by April of 1948 *Bakelite Review* had in it the competition to the Koroseal play pond, a fully inflatable pool made of Vinylite. There, they call the three-foot diameter pool a "Small-Fry Ocean." Their claim that the "plastic pond can be deflated and stored in a closet or bureau drawer when splashing season is over" illustrates the ephemerality the plastics industry strove for with vinyl inflatables. Rather than a cumbersome iron frame and canvas contraption, or the special occasion and/or geographical convenience that a beach outing would require, the small fry ocean would be able to be stored away in a bureau drawer and would be conveniently accessible at a moment's notice. From here, ever larger (but no less ephemeral) backyard pools became a design challenge for the plastics industry. In 1949, the marquee product for the Bilnor company was "6 ft. in diameter and will hold water up to a depth of one foot." Far from the "cement ponds" of the *Beverley Hillbillies*, which only the higher echelons of society could afford, plastic pools – in both their above-ground and eventually their inground iterations – became one of the many items of "affordable luxury" that were a symbol of the democratization of consumer culture in the postwar years. Pools were a status symbol, and the larger the pool, the greater the status.

This custom-built pool installed at Florida Cypress Gardens has a liner and inflatable bumper fabricated by the Bilnor Corporation. This pool is 27 feet long and 13 feet wide.

Figure 4-7: Custom Pool, made of Vinylite. From Bakelite Review, *June 1952, 17.*

A month after Wilcox's piece in *Playthings*, *Modern Plastics* published an article about an entirely vinyl pool. A strange hybrid between the inflatable play pool and the large above ground and inground pools to come, the pool was "designed for permanent installation, [and] made from specially compounded 20-gage sheet. Its base and walls are joined by electronically welded seams and form a liner which fits snugly into an excavation below ground level… while the liner itself is a complete and useable swimming installation, the manufacturer also supplies an inflatable bumper… as optional equipment."[342] The photo from Bakelite Review (figure 4-7) has mostly adults in the pool area, though there is a single child in one of the corners of the pool, entering tentatively. [343]

The focus for the next several years was on ever larger installations of backyard pools, and their growth is indicative of how popular the idea became. There were various iterations, some more practical than others, in the following years. In June of 1952, for example, a wooden structure with a vinyl lining was featured, which did not quite fit into the design language of the swimming pools before (and after). Geared toward the "amateur carpenter," the swimming pool was sold as a liner and drain, with "complete directions of the wooden framework" and makes it "possible for a home-owner to get a back-yard swimming pool for $125 plus the cost of lumber."[344] In comparison to the exorbitant cost of a backyard excavation, building a form, pouring concrete, curing, and waterproofing a concrete pool, this was within the reach of most modest income homeowners.

Achievement in Plastics

Vinyl liner for Doughboy swimming pool is removed from the cardboard carton in which it is compactly packed with the metal fence

Photos courtesy Bakelite Co.

Packaged Pools

Junior's wading pool has grown into a family affair as large as 20 ft. in diameter

THE original inflatable one-child wading pool of a few years ago has developed into a king-size swimming pool that can accommodate a dozen or more children or adults. Made technically and economically feasible by larger and more adaptable heat-sealing equipment and by even better vinyl film formulations, these family-size pools are a direct development of the popular "blow-up" type of wading pools and are being marketed by the same companies making the inflatables.

This summer, two such companies will be marketing similar types of family pools. Bilnor Corp., Brooklyn, N.Y., offers a family pool decorated with an appropriate nautical design. These pools, all 3 ft. high, are available in 8½-, 12-, 16-, and 20-ft. diameters. Doughboy Industries, Inc., New Richmond, Wis., markets a similar series of family-type wading pools also 3 ft. high and in 8½-, 12-, and 18-ft. diameters.

Both pools can be quickly set up (To page 355)

Family-size Bilnor pool set up, with heavy-gage vinyl liner supported around the circumference by wire fence

Figure 4-8: Packaged Pools.From Modern Plastics*, June 1954.*

In June of 1954, though, iterations began of above-ground pools that resemble those that exist today. Lauded as "Packaged Pools," the article featuring them had a bright orange ribbon that stated it was an "Achievement in Plastics." The pool was made "technically feasible by larger and more adaptable heat-sealing equipment and by even better vinyl film formulations… a direct development of the popular 'blow-up' type of wading pools and are being marketed by the same companies making the inflatables."[345] The packaged pools resembled the above-ground pools that are today ubiquitous in working class and lower middle class neighbourhoods, but in an odd juxtaposition of the still competing public/private environments, the lead photo in the article showed a family unpacking their pool at what looks to be a sandy beach, suggesting the ephemerality, portability, and convenience of a large above ground structure made of vinyl sheeting and chain-link fence to support it. While the photo below that initial photograph has more of a backyard feeling to it, the very mature trees in the background also suggest a public park or campground, as most new build suburbs in 1954 would have only had trees that were little more than saplings in growth.

By 1955, the plastics industry also began to corner the design of permanent in-ground pools made of "polyester resin-fibrous glass laminate," previously the sole purview of specialized concrete and steel construction.[346] Costing between twenty five hundred and three thousand dollars (in 1955), they were "one-third to one-half less than concrete or steel structures of comparable size."[347] Recognizing the enormous market available in the backyard pool boom, in June 1956 *Modern Plastics* published a feature article about "Leisure Markets," stating that "sharing credit for this fantastic upsurge in pool sales have been, on the one hand, the expansion of outdoor living brought on by the mass exodus to the suburbs and, on the other hand, the adaptability of plastics… to mass produced pools within the reach of families in the eighty five hundred to ten thousand dollar income bracket."[348] In 1956, there were 56,000 pools in all of the US, a full *one-third* of which were sold in 1955. One prediction was that "if sales of pools continue at their present rate, 'by 1960, some 250,000 pools will be in use, of which over 100,000 will be based on vinyl sheeting or reinforced plastics.'"[349] The cost of a permanent installation above ground pool, by contrast, had dropped to around two hundred and twenty-five dollars by 1956.[350] At the beginning of 1957, the number of pools in the US had grown to 89,000, 57,000 of which were new-build residential pools.[351]

From Backyard Beach to Surf's Up: Inflatables' Contribution to Surf Culture

The "backyard beach" trend of the 1950s, originally designed to create a summer toy buying season, had far reaching effects, especially as the children who participated in it grew up. The ways in which the popularity of the backyard beach affected youth culture presaged the ways in which countercultures like the surfing boom took off during the 1960s. Demographically, the millions of vinyl inflatables and small Koroseal and Vinylite splash pools were introduced at a time where "peak boom"[352] children were toddlers and small children. The pools grew as the children did, and with the pools, a variety of cultural referents to the beach became dominant. The "Mickey Mouse Club"[353] ran from 1955 to 1958, which spawned the squeaky-clean stardom of Annette Funicello as well as she and Frankie Avalon's "Beach Party" movies throughout the early to mid-sixties.[354] The movie "Gidget,"[355] widely considered to be the first of the mass produced surf movie genre, was released in 1959, and the Beach Boys formed as a band in 1960, when the eldest of the baby boom children were 15, and peak boom children were 8-9.[356]

Here, for the first time, you see a commercialization and selling of the *simulation* of surfing, in the form of "surf culture." In a few years, the total amount of surfers on the mainland of US soil (not including Hawaii, where surfing's origins as the sport of royalty amongst its indigenous population meant that it had a very different and far longer story) went from an estimated 2500 to 200,000 in a matter of half a dozen years, but those numbers obscure the millions of baby boom children in flyover states who adopted the clothes, linguistic quirks, and movies of the California surfers without actually surfing. The surfers who pre-dated the boom watched the ways in which surf culture was exported to every suburb in America with disbelief – Annette Funicello and Frankie Avalon, both dark haired Italian Americans from the east coast, *neither of whom actually surfed*, became the de facto faces of a surf culture that had little to do with what they were selling. The Beach Party movies displaced the counter-cultural art cinema type movies that were produced by Bud Browne and Bruce Brown throughout the 1950s and 1960s. Those movies were often without narration, set to surf guitar music, and only showed different shots of surfing and surfers on the waves. Though Bruce Brown's 1966 *Endless Summer* enjoyed moderate commercial success, it was only because surf culture was incredibly hot at the time, due to the popularity of the Beach Party movies. The Beach Boys, *who also did not surf*, became the sound of the generation, displacing the more "authentic" surf sound of instrumental surf guitar music. Los Angeles based Mike Doyle, the 1964 World Championship finalist, recalled the first time he heard the Beach Boys music on the radio: "what a rip off! …it was like they were pretending they'd made it down the stairs at Malibu and were part of the crew—except they couldn't even surf, and everyone knew it."[357]

Doyle's disgust at the Beach Boys presaged a very pronounced feeling amongst those who valued the elite and localist vanguard of the sport.

The middle-class children from across the country that were attracted to surf culture were the same children who had been purchased ever larger backyard pools as they grew and matured, and they floated in/on vinyl inflatables as a matter of course. The backyard beach was ubiquitous across North America, particularly in the expansive suburban tracts far away from anything resembling a real beach. But lacking in actual surf experience, once the Baby Boomers came of age, they flocked to the "authentic" cities of southern California, in search of a more genuine existence. As I've shown, backyard pools, and the toys that children floated upon in them, ushered in the mass produced and middle-class surf culture of the early 1960s. But the quest for authenticity that the baby boom generation profoundly felt was not satisfied with the cute and kitschy Annette Funicello and Frankie Avalon beach parties. Since it drove an enormous boom in surfing, the serious surfers began to resent the throngs of people on "their" surf and sought other ways of delineating themselves from the masses. As the 1960s progressed, mass produced surf culture was rejected by anyone and everyone with some skill on the board, as they turned *en masse* to what is today considered one of the key countercultural movements of the late 1960s and early 1970s: the shortboard surfing revolution.[358]

The shortboard surfing revolution is mostly considered to have been started by George Greenough. Greenough was notable in that he did not ride surfboards in the traditional way. Instead, he was a kneeboarder. Born in 1941, he lived off a trust fund from old California railroad money, and never needed to support himself – leaving him free to do nothing but surf full time. By 1961, he had moved away from traditional longboard surfing and found both the kneeboard and a vinyl inflatable surf mat instead. The lower profile of the kneeboard, and especially the belly ride of the surf mat, meant that Greenough could enter the "tube" of the wave far more easily than people on longboards. Greenough, importantly, also filmed what he did, using a massive custom made 28-pound camera with a waterproof casing to capture film of himself inside the curl. Being inside the curl was the holy grail of surfing, and nearly impossible to do for any length of time with a longboard.[359] Filming inside the envelope of the curl was even more so. Those movies, while having the same niche appeal as Bud Browne and Bruce Brown's films, were so inspiring that the audience would often cheer throughout their showings, in a jubilant spasm of the new possibilities of shortboarding.

Greenough, disgusted by the crass commercialization of the sport taking over the beaches of Southern California, left Santa Barbara in 1966 to catch some waves in Australia instead. It was here that he found a kindred soul with a business sense, and together they started producing shorter boards, which performed better in the big wave surfing of coastal Australia. Dubbed "The Plastic Machines," their design relied on the flexible properties of polyurethane and fibreglass and became shorter and shorter by the month. It was here that the environmental aspects of surfing found their fullest expression. Christened "Soul Surfing," the surf magazines of the early 1970s were modeled after the *Whole Earth Catalog* and surf utopia included a farmstead with chickens and cabbages.[360]

Surfing, by dint of its reliance on a clean ocean, had always been somewhat associated with environmental and sustainable ideals. Although the countercultural movement of surfing was highly associated with the modern environmental movement ushered in by Stewart Brand's *Whole Earth Catalog* and the ethos of the "appropriate" or "sustainable" technology movement, there was an irony at play, as Neushul and Westwick point out: "this craftsman ideal, however, was underpinned by the industrial-scale, highly toxic process… used to make polyurethane foam, polyester resin, and fiberglass… the main ingredients in these surfboards."[361] The proliferation of mainstream depictions of surfing in the early 1960s was seen as an affront to the 'true' or 'authentic' surfer; those not fitting into the countercultural anti-mold were considered "'phonies,' 'pseudos,' or 'plastics'."[362] The Disney-backed beaches of the 1950s and early 1960s were denigrated by the dirty, drug taking shortboard surf culture of the 1970s that typified a DIY counterculture. Because shortboard surfing requires an even higher level of skill than longboard surfing does (longboard surfing is still quite difficult), it was a subcultural movement that explicitly used authenticity as a delineator and gate-keeping mechanism to separate the "real" from the "fake" surfers. Because of plastic's ongoing semantic and real association with replacement materials, and because the middle class's mass culture was associated with superficial, hollow, or 'artificial' values, the two become inextricably linked in the minds of many counter-culturalists, while the material itself had become so prevalent as to be used by the self-same subculture. As Graham Burnett points out, what it meant to be a part of the counterculture that was so prevalent in the first years of the environmental movement: "it meant knowing how to hang, how to float, how to be at one with others, with animals, with the universe itself."[363] The young surfers who made up this counterculture were utterly reliant on the same material whose properties they despised.

The Graduate: A Bookend to Youth, a Bookend to Plastic

I started this dissertation with a pair of surreal and fantastic images that each conceptualized the future of plastics in America, and I end it with a quote, uttered 28 years later, in an iconic film: "Plastics. There's a great future in Plastics." It is perhaps the most iconic moment in film history related to plastic (and a never-ending source of jokes about my dissertation from my parents' generation), and it occurs in the opening scene of *The Graduate*, where a young Dustin Hoffman, having just graduated university, is encouraged by Mr. McGuire—one of his fathers' friends--to go into the plastics industry.[364] But after watching (and re-watching) *The Graduate*, I am struck by how very much the imagery of plastic was used in the movie. The opening joke about plastic is far from the only instance of the use of plastic in the film, and always plastics are used to typify everything that Benjamin does not want--but is sometimes compelled--to be. The movie opens with a slow pan away of Benjamin sitting in his room, a fish tank behind him, with a small plastic diver placed conspicuously in the tank. He leaves his room and enters the figurative fishbowl of his parents' celebratory graduation party thrown for him, but lacking in any of his friends, running the gauntlet of praise and questions as to what the proverbial "plan" is, next steps he has clearly no idea about. He goes outside to get away from the crush, only to be absconded in front of the pool by Mr. McGuire, proclaiming his belief in plastics being the veritable sure bet for the future.

The suffocation that Ben is feeling throughout this scene is palpable, but in case the point about the multivalent meaning of 'plastic' in late 1960s America hasn't been made clearly enough, there is a second scene that mirrors the opening one. "The pool scene" opens to another gathering of Benjamin's parents' friends. Here again is the plastic diver, but now transmogrified into Benjamin himself. His father had purchased a full scuba diving outfit for Benjamin and is encouraging Ben to come out and show all his father's friends. Benjamin is embarrassed, and does not want to, but is eventually cajoled into doing so. The remainder of the scene is from Benjamin's perspective, through the circular diving mask, breathing through his oxygen tanks, silent except for the exaggerated *PISH…whoosh* of the artificial breathing system. He lumbers slowly to the pool, flippers awkwardly flapping with each step. He jumps into the deep end of the pool, glugging downwards, then popping up again, only to be physically pushed down by his father's hand back underwater. He ends up on the bottom of the pool, and as the camera pans away Benjamin recedes, solitary and smothered in the aqua depths.

The irony of the diving suit wouldn't have been lost on the youth who were the target audience of the movie. Benjamin lives on the west coast, where surfing had become insanely popular in the previous few years. Some of the things that typify surfers – near nakedness and freedom, floating on the waves, being one with nature – are conspicuously absent in the carceral experience of Benjamin's diving suit. In contrast to nakedness, he is sheathed, head to toe, in neoprene. In contrast to freedom, he is forced to parade his outfit in front of all his parents' friends. In contrast to floating, he is literally pushed down into the water so that he sinks. And in contrast to being one with nature, he is having this experience in a backyard pool--a backyard beach, made from fibreglass, lined with PVC. Even though the toxic chemical processes that produce plastic enabled both lifestyles, only one is explicitly associated with the material and the generation who believed in it as a utopian and alchemical solution to all of life's problems. Benjamin only feels smothered by it.

Finally, after Hoffman's first tryst with Mrs. Robinson (played by Anne Bancroft), there is a prolonged scene of Hoffman floating in his backyard pool, on a vinyl inflatable mattress (most likely made by US Fiber & Plastic, as they had a virtual monopoly on this design at the time). "The Sound of Silence" by Simon and Garfunkel plays in the background while the sun twinkles off the water in the ephemeral blue of the backyard pool. The contrast between the diving suit and the vinyl inflatable mattress can't be made any more stark: Hoffman floats, self-satisfied and young, drinking a beer while the music plays. The scene transitions to he and Bancroft in the hotel room, and then finally to him alone in his room. Throughout, he keeps the same expression on his face, at times shown as a disembodied head when the scenery behind fades to black. Hoffman, through bedding Bancroft, undermines the portrayal of him as a nice young man, with everything going for him, and inadvertently becomes the ultimate countercultural icon. Indeed, the imagery of Hoffman floating aimlessly in his backyard pool on an inflatable mattress is *so* intertwined with his transgression, that in a scene where Hoffman launches himself out of the water onto the inflatable mattress, through a quick cut in editing, the air mattress becomes Bancroft in the hotel room. The inflatable – ephemeral, light, only surface, synthetic, filled with nothing more than air – becomes Bancroft.

The frank ephemerality of vinyl inflatables, their insubstantiality and plastic-as-plastic nature, and their ubiquity in American life in the 1960s, surely contributed to the downward cultural trajectory that plastic experienced over the 1970s. Vinyl already had image problems due to what I called earlier its recalcitrance as an unchanging material. Because of different plasticizer formulations, vinyl becomes either sticky and gummy or brittle over time (depending on whether the plasticizer used was either oil or volatile based). While the Minamata Disaster in Japan, where the manufacture of the vinyl chloride monomer from 1956-1959 produced a waste product of methylmercury which subsequently poisoned a large population of subsistence fishers who relied on the bay for sustenance.[365] The famous photograph of "Tomoko Uemura in Her Bath" that showed the disaster to the world was published in 1972 in *Life* Magazine by W. Eugene Smith.[366] Quickly following the increased social awareness in the West about the dangers of PVC manufacturing that such early 1970s publications created, was the 1974 cancer cluster amongst vinyl workers that received widespread coverage in the media, including a Rolling Stone feature article about it.[367] The rare liver cancer, angiosarcoma, was discovered in uncontestably high rates in vinyl chloride workers at BF Goodrich in Avon Lake, Ohio, a discovery that lead to far more stringent Occupational and Safety Health Association (OSHA) standards being adopted in 1975.[368] As the disclosure of angiosarcoma cases and the evidence of other types of cancer seen at unusually high rates spread to various companies across the continent, more and more health issues associated with the manufacture of vinyl chloride came to light, including the risks of living close to a vinyl chloride plant. Eventually it was discovered that vinyl chloride leached into food containers, which lead to their eventual ban for uses like liners for beer cans and margarine tubs. While vinyl remained a popular plaything for the subsequent generations, it was regarded with suspicion starting in the 1980s and has been the long and contentious subject of an environmental health campaign to ban its use in toys.[369] It seems like vinyl's defining characteristic – its softness and pliability – is its double edged sword, because while parents enjoy the safety of the material in its lack of sharp corners and edges, it is also the conveyer of a more ominous threat.

Conclusion: The Real Thing

Plastic today is cast, always and forever, as a poor substitute for "The Real Thing." In his book of the same name, Miles Orvell argued that the tensions between imitation and authenticity "pervad[e] layers of our culture that are usually thought to be separate."[370] Focused on the kitschy excesses of the Victorian era as a historical antecedent to early twentieth century streamlined (and thermoset) utopian modernism, Orvell makes arguments about mass production as an agent for democratizing luxury, arguments that were echoed repeatedly in the plastics trade magazines and business magazine advertisements of the era, such as the *Fortune* advertisements I've featured throughout.

Much of the interwar period focused on retooling the image of plastic from its imitation ivory roots. Prominent industrial designer Henry Dreyfuss, in an interview with *Modern Plastics* E. F. Lougee, is explicit when he says "it is unfortunate for its future that plastics began its career as a substitute material and has been used mainly in small items of low price… [it has] created a prejudice against it as a material with intrinsic value of its own."[371] The tensions between the fake and the real find their fullest expression in plastic's postwar realities, however, as the proliferative postwar consumer society was largely driven by plastics. Plastic is, first and foremost, a material that enabled mass production, and the domestic luxuries so lauded in the postwar era relied on the ability to produce an abundance of products. Contrary to the machine-age interwar era which only had eyes on the future; the postwar era had a strong taste for the traditional, the nostalgic, and the kitsch, wanting to return to a safer, less complex time.[372] In a return to plastic's role as the great imitator that the original celluloid collars and imitation ivory comb and mirror sets evoked, plastic became the faker of not just ivory, tortoiseshell, and linen as it was in the Victorian era; but wood, ceramic tile, glass, stone, concrete, leather, cotton, silk, and a myriad of other materials to boot. And like the effects that imitation linen collars of celluloid had on Victorian class mobility, postwar thermoplastics instead moulded the expansive middle-class American dream, which is precisely why cultural critics like Norman Mailer began to rail against them.

Norman Mailer first wrote about plastics in *Esquire* in 1963, where he made links between the narrowly averted nuclear apocalypse of the Cuban Missile Crisis and the (highly embraced) creeping plastic annihilation. In his opinion, we had "divorced ourselves from the materials of the earth, the rock, the wood, the iron ore… we looked to new materials which were cooked in vats, long complex derivatives of urine which we called plastic." [373] Due in part to this article, Meikle argued that Mailer's animosity for plastic represented the anxiety surrounding the threat of nuclear obliteration; but Mailer's railing against plastic is part of a larger argument that Mailer had been making throughout his career: that against superficiality and inauthenticity. Plastic was the material that was the great equalizer, but Mailer, rather than seeing a greater equality as a laudable goal, saw a greater equality as something that inoculated the masses from any sort of innovation, ambition, or creativity. In the same paragraph as above, he lists all the domestic places where plastic had "invaded," and then states that "the world of our surfaces was the simple embodiment of social cowardice. We had tried to create a world in which *all could live*, even if *none could breathe*."[374] His column in Esquire was later printed as part of his book *The Presidential Papers,* which was marketed as a snapshot into the JFK years of America (1960-1963). Throughout that book, he evokes plastic as the root of all evil, using metaphor to liken it variously to the Devil, metastatic cancer cells, censorship, cannibals, and the gas chamber, saying at one point that "the modern condition may be psychically so bleak… so artificial, so plastic – plastic like styrene – that studies of loneliness, silence, corruption, scatology, abortion, monstrosity, decadence, orgy and death can give life, can give a sentiment of beauty."[375]

Mailer called his vision "left conservatism," which most closely resembles a Libertarian ethos today.[376] According to Cyrus Zirakzadeh, the point of his vision was to rail against a bland, corporately controlled centre, that by the "mid twentieth century, large-scale, bureaucratically organized, and heavily mechanized methods of production had replaced traditional capitalism for most Americans."[377] As the oil and chemical companies were exemplary for what he despised, it makes sense that plastics bore the brunt of his criticism of the passivity of American corporate capitalism, which he called "Technology Land." Zirakzadeh argues that Mailer's Technology Land pushed Americans to "no longer take seriously their own values about how best to live… surrounded by standardized goods, citizens stop believing their wills matter and gradually lose their desire to shape their destinies… middle-class affluence and luxury hide ubiquitous patterns of conformity and timorousness." The conservatism is important, here, because although today we associate anti-plastic sentiment with the environmental left, as Orvell points out, the hue and cry for authenticity in the Victorian times was a conservative one. It was, at that point, a thinly veiled judgement about the new and gaudy, the socially mobile bourgeois class, able to afford replications of art and finery, previously to which only the upper classes had access. But in the postwar world of a ballooning, voracious middle class, a newly minted consumer class made possible by unions and easy access to credit in the form of victory housing HELOCs and the vernacular ‘plastic’ of credit cards; authenticity of self-- rather than artworks and fineries-- became the important metric to hit. And how else to be authentic in a time of unparalleled prosperity other than to be authentically poor? Mailer’s highly influential 1959 essay titled “The White Negro: Superficial Reflections on the Hipster” coined the word hipster, while addressing and making accessible a previously small subculture of beatniks in Greenwich Village in the 1950s. Those Village Voice reading, jazz listening, marijuana smoking hipsters became a model for the youthful rebellion that followed. The mass production of his novels and writing, which frequently invoked the same fragile, emasculated identities of the postwar, white, middle-class American male, meant that a generation of children rejected their comfortable, bland, suburban, middle-class upbringing. More than anything else, that suburban existence was made possible by plastic.

From sulfurized rubber all the way through to materials like carbon fibre composite, plastics’ amorphous identities have always thwarted understanding of the materials of modernity. This dissertation is no different: it could be a thousand pages long and still only scratch the surface of the meanings of a material that is perpetually intermediary, always thus far unfinished. Those perpetually intermediary spaces of plastics – from surrealisms derangements on the first page of my introduction, to the ever-growing continent of Synthetica, to the toy-cum-sugar-cum-trash of a pez dispenser, to a hula hoop that changed hygienic practices, to vinyl inflatables that merged the very meaning of surface and structure, authenticity and artificiality –became grounded in the traces of childhood, and allowed insight into something that has otherwise ended up in the dustbin of history, literally.

The pink plastic diary that began this dissertation suffered in my mind from a lack of meaning, identity, and above all, affect. In contrast, childhood has so much meaning, identity and affect that it becomes nearly parodical in its admonishments to 'think of the children.' The metaphor of childhood was a theme that was frequently invoked in plastic's early days, as I demonstrated in my introduction. The innocence of childhood was used to convey the newness and freshness of a class of materials that were still largely unfamiliar to the American public, but instead sealed its fate as the material that refuses to grow up and be taken seriously, only noticed for its misbehaviour rather than its potential. It is a rather spectacular fall from grace, as any utopian vision of the future inevitably is. I limited my analysis to four consumer plastics that are particularly pervasive in both childhood toy boxes and waste flows: high- and low-density polyethylene, polyvinyl chloride, and polystyrene. In doing so, I demonstrated that the first generation to grow up surrounded by plastics at every turn were the first generation to reject artificiality so violently that it devoted its entire youthful ethos to authenticity.

Plastics embody both the short-term interests of a novelty driven economy and the long-term effects of the proliferative detrital forms of consumption that are synonymous with present day capitalism. Further, they capture the paradoxical experience of the practices of parenting within that capitalism, where parents are admonished to both practice unbridled consumption of every child-based product on the market, and to perform a perfect environmental stewardship of those objects that they buy. The stratification of childhood into finer and finer ages – infancy to toddlerhood to childhood to tween to teen to young adult to adult – becomes one way in which more material goods are sold, and more waste is created. The harms that those wastes exact on human life and the environment are both real and rhetorical, and the rhetoric surrounding plastics have a social, temporal, and political basis. To approach any issue with respect to plastics ahistorically or apolitically erases nearly as much as the word plastic itself does – from the dizzying array of precursor chemicals to the war machine that allowed our current proliferative plastic reality to scale. If we think of plastic as a complicated and complex material, it deeply destabilizes notions of both temporality and durability in the commodity world. Its refractive temporality where, depending on which view one takes, one can see it either as instantaneous or as eternal, functions to bring plastics political economy into sharp contrast with its political ecology, as its devaluation stands in sharp contrast to its devalorization.

My focus on fully synthetic thermoplastics was intentional, as they were all birthed in the interwar era due to research and development at the hands of the chemical company giants, and they all experienced supply side driven scaling of production during World War II through military contracts. That increased supply led to large, under-utilized plant infrastructures searching for new commercial and consumer markets mid-century. That search coincided with the postwar baby boom, where by 1964, four in ten North Americans were under the age of 20. Those children were a substantial market as they grew and matured, and plastic filled that market with a huge proliferation of toys marketed toward ever finer gender and age stratification and ever more sophisticated consumer culture. The same iconic toys that defined postwar childhoods taught a generation of manufacturers to use the materials in increasingly disposable ways and a generation of children to mistrust and discard it. Through the milieu of trade magazines, I was able to glean a unique perspective into both the manufacture and the marketing of the materials of modernity to those who are the arbiters of what comes into and what goes out of the home.

Ignorance surrounding the materials of modernity is so complete that I had to start the content chapters of this dissertation with a plastics primer of sorts. *Synthetica*: *A New Continent of Plastics* provided a visual representation of an industry in its infancy, from which the world of plastics grew and developed.[378] Through a close reading of that map, I was able to break down the precedents of the time period that I focused on in later chapters. Since maps are, as Brian Harley posits, a "kind of language," *Synthetica* is a particularly apt metaphor, as a close reading shows how the multivalent *Synthetica* became the nominalized plastic. Plastic suffers from the opposite of most twentieth century classificatory schemas as instead of ever finer stratifications it was aggregated into a single term. Instead of the manufactured utopia *Synthetica* posits, then, Foucault's concept of a heterotopia more accurately describes transgressive plastic realities where a perpetually intermediary name evokes more than it can ever contain.[379]

Through the histories of vulcanized rubber, celluloid, Bakelite, and ethylene, the early heterotopic days of *Synthetica* become clear. The popularization of the sulfurization of latex rubber was driven by massive cultural and manufacturing changes found in the motorization of the latter half of the nineteenth century, as well as an enormous colonial undertaking in South Asia to cultivate rubber. Even though most cultural histories of plastics do not start with vulcanized rubber, the chemical technology of the sulfurization of rubber provided a key breakthrough for the later nitration of cellulose. But despite the similarity in chemical engineering for the two materials, the manufacturing methods of the finished products of each differed enough that Hyatt had to develop entirely different modes of manufacturing for his celluloid. But the manufacturing method of vulcanized rubber proved to be extremely important to the development of successful manufacturing methods for Bakelite, as their mutual status as thermoset plastics meant that the production of Bakelite had to reach back in time to an older modality of compression moulding found in vulcanized rubber. The ways in which the epistemic advances in chemical engineering created different paths than the ontic uncertainty of what these materials were and how they behaved in real life forming conditions meant that the three materials played off each other in ways that heterotopically shaped each of their developments.

But the largest and most important development in creating the proliferative and detrital plastic reality we live within today was the development of petrochemically derived ethylene, as opposed to the older chemical engineering of ethylene from alcohol. The glut of petrochemical ethylene appeared right as the deeply destabilized economy of the depression was experiencing its nadir. It meant that Dow Chemical had a material without a market, as its intended use as a fuel additive for automobiles crashed alongside the economy that could no longer afford to buy or fuel as many cars. The confluence of those factors meant that polystyrene came into being at Dow Chemical, and that postwar, the manufacture of ethylene from petrochemicals was the basis for many of the fully synthetic thermoplastics that single use plastic is made from.

The next chapter begins with a hybrid object: a pez dispenser made of polystyrene. The pez dispenser exists as both a toy, and a package for the candy that exists within it, a single use plastic with an eternal life in landfill. Michael Thompson's organizing principles of durable and transient are central to the chapter's argument, and the radical discontinuities he posits provided the traces in which I can tell the story. But the radical discontinuities themselves are anachronistic, as the time period I focus on is where they were created, so instead I suggested a refractory vision, that allowed us to see the story of polystyrene and disposability from slightly different perspectives.

To answer the question of how we get to full disposability, we must do a deep dive into the history of polystyrene. The next section therefore starts with another *Fortune* magazine advertisement. *Styrene: A Triumph of Synthesis* captures the utopian vision of a polystyrene based reality, focusing on its clarity and beauty and not any specific applications. The enigmatic figure pictured in the corner of the advertisement is shown to be none other than the woman who made polystyrene possible, Dr. Sylvia Stoesser. Through her innovative methods at Dow Chemical, a viable polystyrene was developed, with all the forward thinking and progressive ideals of the interwar period that plastic holds. But the addition of colour to a different plastic (urea formaldehyde) and its use in depression era premiums as a way of circumventing price floors set by the National Recovery Administration, set the stage instead for plastics to be associated with frivolity and childish applications such as the Little Orphan Annie shaker cup and mug. Premiums also had the effect of teaching people to devalue plastics, as although they were marketed as durable goods, their association with consumable products meant that one would accumulate an excess of the durable good, and eventually its discard would be the only way to deal with it.

The successes of premiums shaped the ways in which people interacted with plastic and made it possible for plastics to move into the realm of toys, because of the obvious crossovers that occurred with premiums. It was only after 1934, with the successful invention of the first injection moulding machine, that plastic became more common in toys, with cellulose acetate being the most common plastic used. The start of World War II put an end to all frivolity, however. As material restrictions were introduced many of the plastics factories that previously produced small domestic objects like premiums and toys moved into producing war materiel instead. One of the biggest and most successful of these toy factories was Ideal Toy Company, and under the direction of Dr. Islyn Thomas, it produced both the proximity switch and manufactured the first small polystyrene toys, which were a higher quality toy than what most toy companies were able to produce. Thomas's contacts in the plastics industry allowed him to find scrap plastic that had been set aside for goods no longer able to be manufactured by wartime. His move into toy manufacturing with his own company, Thomas Toys, demonstrated the special relationship that plastics manufacture and toys developed postwar, and how very tightly coupled the two industries became.

Immediately after the end of World War II, the special significance of Christmas in polystyrene's hybridity becomes clear. In Christmas, we see the hybridization of polystyrene packaging for the first time, in that the same object exists as ornament, toy, and packaging. The ways that these hybrid objects, by dint of their status as packaging, accumulated, became a unique problem for women especially, as women are generally the arbiters of what stays and what goes in the household. The novelty packaging undermines its own durability by their sheer numbers of accumulation, which exposes the inherent contradiction existing in these objects.

The final sections in my polystyrene chapter took us through the odd advertising campaign that Dow Chemical Company ran with respect to Styron and Styron 475 and shows another refraction in that it was the material that was being advertised, and not the toy itself. It exposes an odd liminality postwar where Dow Chemical Company still wanted their materials to be held with the same high regard it held during the war, and spent millions of dollars to maintain it. Despite the advertising campaign, however, there was such a proliferation of manufacturers wanting to cash in on the baby boom, that many poor quality toys were pumped out in quick succession, most of them made of plastic. The problem was so bad that the plastics industry itself lamented about mothers being put off of plastic entirely by poor quality toys. But it was a losing battle, as my final sections point out. As manufacturing moved offshore, the American toy industry shifted focus to licensing agreements rather than making the toys themselves, and Thomas toys went under. The final refraction is therefore two images – one of a toy boat from Thomas's own collection, today housed in the Museum of Plastics at the University of Syracuse, and one from an advertisement for "banana boats" from Modern Plastics. The final piece that becomes clear is that the same moulds that gave us Dimestore toys gave us disposable food trays.

My third chapter's focus is on two materials: low-density and high-density polyethylene (LDPE and HDPE respectively). LDPE's wartime scaling was covered in chapter one, where its status as a covering for radar equipment was decisive in helping Britain stave off air attacks from the Germans. Postwar, however, LDPE's main use was as one of the most feminized domestic products that there can be: Tupperware. Earl Tupper's access to LDPE through his role as a sample maker for DuPont meant that he was the first out of the gate with a postwar product as soon as it came off military restriction. But due in part to Tupper's regressive views on gender, Tupperware nearly failed, until a single mother from Detroit, Brownie Wise, invented and popularized the Tupperware party.

Tupperware came along just as there were enormous cultural shifts afoot in the change from a depression era economy to the great wealth of the postwar boom. According to Alison Clarke, Tupperware represented both thrift (saving leftovers, not wasting food) and abundance (its price point made it a status object). But what Clarke misses is the central tension that Gavin Lucas points out. Lucas starts with thrift as an organizing principle in domestic spaces, but he argues that instead of abundance, the shift is to hygienic practices. Tupperware was also a profoundly hygienic product, as it allowed for delineation of different foods into different containers and its seal (the famous Tupperware burp) kept out bugs, dust, and other contaminants.

HDPE, in contrast to LDPE, was the only plastic I covered that was not invented in the interwar period of innovation and progressive ideals, although it was still invented because of them. HDPE was invented in Germany by Karl Ziegler in 1954. His use of organometallic catalysts rationalized polymer production, as chemical engineers could precisely control the reaction time and create bespoke plastics of specific qualities. Part of Ziegler's acceptance of his post at the Max Planck Institute for Coal Research was that he be allowed unfettered access and to do as he pleased in the laboratory, research into what Ziegler himself called "exotic materials with no industrial significance whatsoever." He won the Nobel Prize for his research into organometallic catalysts in 1963. The use of catalysts in the invention of HDPE was so profound that it changed the very language that the plastics industry used. It rationalized the process and made the chemical formula rather than the manufacturing method the dominant vernacular. HDPE was invented right at a point where the culmination of thirty years of attempts by the plastics industry to break into the formidable building industry seemed to be finally paying off. The 7th National Plastics Exposition (NPE), held in 1956, showed the "Monsanto House of the Future" as its marquee exhibit. It seemed to herald a new age in plastics design and hearkened back to the machine age utopianism of the interwar years. Which is why the 8th NPE felt so disjunctive in retrospect, as the marquee exhibit only two years later was a children's toy. The hula-hoop sold an estimated one hundred million hoops in the span of only slightly over a year and taught an entire generation of moulders to use HDPE in short order. The same complaints that were levied at children's toys were again brought up by the plastics industry, but it was soon not to matter in the slightest, as the moulding knowledge that was gained with the hula hoop was immediately applied to the potentially far larger industry of packaging synthetic detergents, which until this point had been packaged in tin cans which leaked and rusted in moist environments like the kitchen and the bathroom. The use of these types of packages meant that the synthetic detergents, developed in close parallel to plastics themselves, were finally able to be scaled to the same degree as plastics enjoyed during the war. Chemists already used LDPE as a packaging material to transport strong acids, but the use of HDPE for detergents was a far larger consumer market than the need for hydrofluoric acid, for example. The difficulty in packaging detergent comes from its materiality – its ability to dissolve both hydrophobic and hydrophilic agents meant that many of the glues, metals, and coatings that were used in tin cans were subject to degradation. Polyethylenes undermined the earlier "damp cloth" cleaning paradigm as its status as a polyolefin meant that it remains feeling greasy until you wash it with detergent. In combination with changing ideals of hygiene where the sanitary aspects of toys began to diminish after the invention of the polio vaccine, HDPE helped to usher in an entirely new paradigm of chemical cleaning.

The final plastic I chose to focus on was polyvinyl chloride. Polyvinyl chloride is in many ways the ultimate example of some of the themes I have intimated throughout, in that it is the most recalcitrant of plastics, the plastic that merges surface and structure, the plastic that feels the most alien, especially when it comes to its inflatable form. As I covered throughout, the Marxist commodity is insufficient to contain plastic in any of its forms, instead the plastics and chemical industries are an entangled process of becoming throughout the feedback loops, waste products, and chemical manipulations that created a packaged in plastic planet. Nevertheless, a polyvinyl chloride inflatable may well be the ultimate commodity fetish, as the process to create that colourful, insubstantial, and fleeting object is radically separate from its production. Plastic's materiality is inviolably whole, there are no gears, switches, or parts that can offer a glimpse into the conditions of its production. The conditions of its production are largely devoid of humans anyways, taking place in vats at temperatures and pressures that preclude monitoring except through the abstraction of instrumentation. But the ignorance of the material as a class has a material and social history. While scientists and engineers assumed that more knowledge was going to help the public accept and feel safe around plastics, a bewildering array of chemical compounds instead aroused distrust. Nowhere was that mistrust deeper than with polyvinyl chloride, as its difficulty in manufacture, plasticizer instability, and its tendency to become either gummy or brittle if the mixture between the material and plasticizer was not precise meant that postwar polyvinyl chloride was a notorious material, often the "other" plastic that better plastics got compared favourably to.

Nonetheless, postwar children were surrounded by the stuff. Vinyl inflatables found their niche first during World War II, where innovations in sealing seams were first developed for the army and air force to help downed pilots over the pacific. The creation of the first inflatable rafts and solar stills led directly to the postwar market of consumer inflatables, with the raft not even undergoing any form change at all before being sold just four months after the end of the conflict. The solar still technology developed to be able to create fresh water out of sea water translated directly into the first beach balls. As the heat-sealing seam technology became more advanced, the ability for ever larger designs became feasible, and it was not long before vinyl sheet was being used first for small play pools, then for full-sized pools in the backyards of the expansive suburbs postwar. The backyard beach phenomenon was largely driven by a surf culture that had started in the late 1950s and early 1960s, appropriated by ever larger swaths of the expansive middle class midwestern states that adopted the lingo, dress and attitudes of a rebellious youth culture that was forming on the coasts, but who only had the artificial pools and “beach blanket bingo” movies that Disney created to go by. The massive migrations to more authentic coastal cities like San Francisco and New York was a mass rejection of that falsity, which was described as plastic, standing in for anything and everything that their parents’ generation stood for. This kind of rejection is well represented in the movie *The Graduate*, where, aside from its famous line about plastic having a great future, the imagery of plastics, pools, and inflatables were used masterfully to represent everything that the protagonist did not want. The 1960s ended with the rise of the real harms of polyvinyl chloride with the publication of the Minamata bay disaster photographs in *Life* magazine and a very famous case of environmental harms wrought by a rare cancer found in vinyl chloride workers, which drove much of the 1970s formation of OSHA and the EPA.

A final word…. Plastic

I started this dissertation with a search for meaning in plastic, as I was unable to access any sort of affective or deep feelings about it, despite it being nearly the only material I or my child interacted with daily. I found it, but I feel deeply ambivalent about what I found. The narratives surrounding plastic now are so strongly anti-plastic, that they seem to crowd out any other arguments that could be made about the material of modernity, to suggest that it might have worth is seen as anathema to most environmentally minded or progressive people. But as I started this dissertation, I began to realize that to tell that story effectively, I had to understand the rhetorical harms as separate from the real harms and see how we got to where we are today. Throughout that story, I found that again and again I was left defending plastic as a material, whilst still questioning deeply how it was used in our current proliferative and detrital framework. It got to the point where I joked about being a plastics apologist, still feeling deeply unsettled about its role in our material world. I found three dichotomies to blow up along the way: the first, durable and transient; the second, thrift and hygiene; and the third, surface and structure. Through those dichotomies I found that plastics even undermined the entire idea of production and consumption being discrete entities, instead showing that the chemical conglomerates are an entangled process of using waste products of one thing to produce something else, ironically a (market-driven) no-waste attitude toward chemicals provided us with some of the most wasteful things ever to be foisted on a population of humans or the planet as a whole.

We are taught, from a very early age, how to waste. Plastics in children's toys is an essential component of that education. Amy Ogata argued that mid-century toys were a crucial tool to teach children to be creative thinkers, but she missed what toys actually taught. Through their proliferation, through their sheer numbers; their breaking, bending, fading, and popping; and finally through their discard, plastics in toys and other domestic objects ensured that a generation of children learned that abundance was the default, and that they had enough of *everything* to waste *anything*. In a play on Norman Mailer's earlier words, it was a world in which everyone had everything, even if none could value what they had.

The strangeness of today, with its privatized secondary use markets that are utterly full with things that still have use, but are no longer wanted, devalorized but not devalued, often only because the objects are a bit dirty, or faded, has to be taught. The valorization of a minimalist mindset, strangely, stems directly from this culture of abundance, in that whatever is rare is valued. In a world drowning in stuff, to have nothing is seen as the ultimate goal. But through the exposition of how we collectively arrived at this place of proliferation and wasting, I hope to provide a small space to revalue plastics. The objects I chose to enter that space – pez dispensers, hula hoops, and inflatables – were exemplary of the problems of each of the plastics I chose to focus on. Through the histories of polystyrene, polyethylene, and polyvinyl chloride, I demonstrated how exactly those plastics became devalued, associated with packaging, and ultimately discarded at an astonishing rate. The thermoplastic giants are the culprits of most of the plastic problems we have today, and as I made evident, there are specific cultural and social histories behind how we are taught to cast them aside. But as we become more aware of the fact that there is not a real away for them to be thrown, the specific cultural and social histories I displayed here may indeed make us able to imagine a future otherwise, where plastic is valued for its durability, rather than used and disposed. We might even learn how to trust the material of modernity to house us, to guard us against sea level rise and climate extremes, to be an adaptable, lightweight, waterproof, and modular material that an unstable climate requires. We might then well live up to its original adjectival meaning, in that we must become more adaptable, more flexible, more …plastic.

[1] Hess and Hutton, GUTS: Does Recycling Matter?
[2] Thompson et al., "Theme Issue 'Plastics, the Environment and Human Health.'"
[3] Thompson et al.
[4] MacArthur, "The New Plastics Economy."
[5] Scott, *Our Chemical Selves*; Di Chiro, "Polluted Politics? Confronting Toxic Discourse, Sex Panic, and Eco-Normativity."
[6] Meikle, "Material Doubts."
[7] Freinkel, *Plastic*.
[8] Madden et al., *The Age of Plastic*.
[9] Benjamin, "The Work of Art in the Age of Mechanical Reproduction."
[10] Hawkins, Potter, and Race, *Plastic Water*, 22.
[11] Packard, *The Waste Makers*, 104.
[12] Appadurai, "The Social Life of Things: Commodities in Cultural Perspective," 16.
[13] Edelman, *No Future: Queer Theory and the Death Drive*.
[14] O'Brien, "Rubbish Values: Reflections on the Political Economy of Waste."
[15] O'Brien.
[16] O'Brien, 272 original emphasis.
[17] Herod et al., "Waste, Commodity Fetishism and the Ongoingness of Economic Life."
[18] O'Brien, "Rubbish Values: Reflections on the Political Economy of Waste."
[19] Faircloth, *Plastics Now*, 33–84.
[20] Also known as phenol formaldehyde resin, seen in the first column directly below coal tar.
[21] Meikle, *American Plastic*, 108.
[22] Plasticizers are, briefly, chemicals (usually phthalates) added to a class of plastic to make it more pliable, flexible, or "plastic" (the verb).
[23] Shashoua, *Conservation of Plastics*; "The Age of Plastic: Ingenuity and Responsibility"; Harper, *Handbook of Plastics Technologies*; Rosen, *Fundamental Principles of Polymeric Materials*; Derraik, "The Pollution of the Marine Environment by Plastic Debris."
[24] Yarsley and Couzens, *Plastics*; Weil and Anhorn, *Plastic Horizons*; Wolfe, *Plastics, What Everyone Should Know*; Worden, *Nitrocellulose Industry: A Compendium of the History, Chemistry, Manufacture, Commercial Application and Analysis of Nitrates, Acetates and Xanthates of Cellulose as Applied to the Peaceful Arts*.
[25] Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*; Sparke and Victoria and Albert Museum, *The Plastics Age*; Meikle, *American Plastic*; Mossman, *Early Plastics*; Bijker, *Of Bicycles, Bakelites, and Bulbs*.
[26] Kaufman, *The Chemistry and Industrial Production of Polyvinyl Chloride: The History of PVC*.
[27] Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*.
[28] Meikle, *American Plastic*.
[29] Corn, *Imagining Tomorrow: History, Technology and the American Future*.
[30] Faircloth, *Plastics Now*.
[31] Barthes, "Plastic."
[32] Barthes.
[33] Rubin, *Synthetic Socialism*.
[34] Rubin, 221.
[35] Bijker, *Of Bicycles, Bakelites, and Bulbs*, 144.
[36] Mulder and Knot, "PVC Plastic."
[37] Liboiron, "Discard Studies."
[38] Gabrys, Hawkins, and Michael, *Accumulation*.
[39] Hawkins, Potter, and Race, *Plastic Water*.

[40] Hawkins, "Disposability."
[41] Carson, Lear, and Wilson, *Silent Spring*.
[42] Colborn, Dumanoski, and Peterson Myers, Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story.
[43] A U-shaped dose-response curve shows that when a chemical is found at either very large or very small amounts, it is considered toxic, but with different effects. See Michelle Murphy's *Sick Building Syndrome* for a complete treatment of the problems of measurement, accuracy, and precision with respect to measuring trace chemicals in the body and in the environment.
[44] Yang, "Test Results on Toxic Toys Raise Industry Standard."
[45] Thompson et al., "Theme Issue 'Plastics, the Environment and Human Health'"; Derraik, "The Pollution of the Marine Environment by Plastic Debris."
[46] This is not to say that plastic pollution on land does not have problems associated with it beyond aesthetics, but that most of the environmental focus on terrestrial plastic pollution is on the visual blight it produces.
[47] Douglas, *Purity and Danger*.
[48] Beyond the obvious carbon emissions associated with that, and all, manufacture.
[49] MacBride, *Recycling Reconsidered*.
[50] Crews, Rich, and Niemeyer, "A Summary of Environmental Legislation Targeting Disposable Diapers and Review of Related Literature."
[51] MacBride, *Recycling Reconsidered*.
[52] Packard, *The Waste Makers*. The first use of the term is attributed to the 1932 paper by Bernard London, "Ending the Depression through Planned Obsolescence," but Packard is most associated with the concept as it is understood today.
[53] Thompson, *Rubbish Theory*.
[54] Herod et al., "Waste, Commodity Fetishism and the Ongoingness of Economic Life."
[55] Hawkins, Potter, and Race, *Plastic Water*, 11.
[56] Hawkins, Potter, and Race, *Plastic Water*, 4.
[57] Hawkins, "Plastic Bags Living with Rubbish"; Hawkins, *The Ethics of Waste*; Hawkins, "CommentaryMaking Water into a Political Material"; Gabrys, Hawkins, and Michael, *Accumulation*; Hawkins, Potter, and Race, *Plastic Water*; Hawkins, "Disposability."
[58] Gabrys, Hawkins, and Michael, *Accumulation*; Bennett, *Vibrant Matter*; Rekret, "A Critique of New Materialism: Ethics and Ontology."
[59] Meikle, "Material Doubts."
[60] Cohen, *A Consumers' Republic*.
[61] Bijker, *Of Bicycles, Bakelites, and Bulbs*.
[62] Kordas, *The Politics of Childhood in Cold War America*.
[63] Ogata, *Designing the Creative Child*.
[64] Pellow, *Resisting Global Toxics*.
[65] Herman, "The Bricoleur Revisited"; Harrison, "An Introduction to Material Culture."
[66] Martin, "Material Things and Cultural Meanings."
[67] Cook, *The Commodification of Childhood*, 18.
[68] Cook, 18.
[69] Meikle, *American Plastic*, 99.
[70] Meikle, 101.
[71] *Playthings* was taken over by Robert McCready's son, Ben McCready, in 1945.
[72] Cross, *Kids' Stuff: Toys and the Changing World of American Childhood*, 30.
[73] One striking example of just how closely the two industries map is that both the plastics industry and the toy industry were depression resistant and were two of the only industries that experienced large amounts of growth during the 1930s.
[74] Cook, *The Commodification of Childhood*, 20.

[75] The annual toy fair took place in New York City every year except for 1945, when a moratorium was placed on all trade fairs because of World War II. It was a massive event, comprising a virtual "who's who" of the toy industry,

and where hit toys were introduced to the market. The majority of buying for the year for most toy wholesalers took place during the event.
[76] Meikle, *American Plastic*, 173.
[77] see figure 1 above; Henry Robinson Luce, "Plastics in 1940," *Fortune Magazine*, October 1940, Internet Archive.
[78] Schaffner, *Salvador Dali's Dream of Venus: The Surrealist Funhouse From the 1939 World's Fair*.
[79] A chair for a doll house.
[80] Total plastic production in 2015 reached 381 million metric tons (MMT). LDPE and HDPE together are the most numerous at 116 MMT, polyvinyl chloride is fourth most numerous at 38 MMT, and polystyrene is seventh most numerous at 25 MMT. Geyer, Jambeck, and Law, "Production, Use, and Fate of All Plastics Ever Made."
[81] "Every Fourth Toy Is Plastic"; Plastics Europe, "Christmas: Plastic Toys in Vogue."
[82] Luce, "Plastics in 1940."
[83] Corner, "The Agency of Mapping," 89.
[84] Harley, "Maps, Knowledge and Power," 281.
[85] A note on capitalization: There are an odd mix of trade names and generic names that I use in the following, as well as representative territorial names on the map of *Synthetica*. I have capitalized trade names, but not chemical or generic names, except in the instance of their appearance as territory on *Synthetica*. In general, when I talk about a material by its trade name, it is because the name has become the more recognizable term (such as Bakelite and Celluloid representing phenol formaldehyde and nitrocellulose respectively). If I call it by its generic name, it is not for lack of a trade name, but that that trade name did not manage to enter into the vernacular. (For example, few people would know I was talking about vulcanized rubber if I referred to it as "Vulcanite" or "Ebonite.") When I refer to the chemical compound that the territory of *Synthetica* is named after, I do not capitalize the name. My (at first glance) inconsistent capitalization mirrors some of the tensions that plastics themselves experienced during this time period, as it reflects the ways in which some plastics (and industrial concerns) became dominant, as shown by who won the trade name wars and who did not.
[86] Harley, "Maps, Knowledge and Power," 285.
[87] Pickles, "Texts, Hermeneutics, and Propaganda Maps," 219.
[88] Luce, "Plastics in 1940."
[89] Luce., "Plastics in 1940."
[90] Whereas styrene is technically a vinyl, acrylic's proper name is polymethyl methacrylate, and has an acetate functional group as opposed to a benzene functional group.
[91] Luce, "Plastics in 1940."
[92] Luce, "Plastics in 1940."
[93] Schulten, "Richard Edes Harrison and the Challenge to American Cartography."
[94] Schulten, 180.
[95] Cosgrove, "Maps, Mapping, Modernity: Art and Cartography in the Twentieth Century," 273.
[96] Bijker, *Of Bicycles, Bakelites, and Bulbs*; Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*; Kaufman, *The First Century of Plastics*; Mossman, *Early Plastics*.
[97] Meikle, *American Plastic*, 5.
[98] Bensaude-Vincent and Stengers, *A History of Chemistry*, 202.
[99] Foucault, *The Order of Things: An Archeology of the Human Sciences*; Foucault and Miskowiec, "Of Other Spaces."
[100] Foucault and Miskowiec, "Of Other Spaces," 24.
[101] Foucault, *The Order of Things: An Archeology of the Human Sciences*, xix.
[102] Weil and Anhorn, *Plastic Horizons*.
[103] Miodownik, *Stuff Matters*.
[104] Bensaude-Vincent and Stengers, *A History of Chemistry*, 201.
[105] Quoting from Hyatt's own writing, Kaufman relates an amusing story where "occasionally the violent contact of the balls would produce a mild explosion like a percussion gun cap. We had a letter from a billiard saloon proprietor in Colorado, mentioning this fact and saying that he did not care so much about it but that instantly every man in the room pulled a gun" (Hyatt qtd. in Kaufman 1963, 33).

[106] Bijker, "The Social Construction of Bakelite: Toward a Theory of Invention," 160.
[107] Bijker, 161.

[108] Kaufman, *The First Century of Plastics*, 22.
[109] Kaufman, 22 original emphasis removed, italic emphasis mine.
[110] Kaufman, 26.
[111] Kaufman, 30.
[112] Bijker, "The Social Construction of Bakelite: Toward a Theory of Invention," 163.
[113] qtd. in Kaufman, *The First Century of Plastics*, 33; see also Bijker, *Of Bicycles, Bakelites, and Bulbs*, 106; Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*.
[114] Kaufman, *The First Century of Plastics*, 33.
[115] Bijker, "The Social Construction of Bakelite: Toward a Theory of Invention," 166.
[116] Lederer 1894, qtd in Bijker, 167.
[117] Bijker, 170; Bijker, *Of Bicycles, Bakelites, and Bulbs*, 151.
[118] Bijker, *Of Bicycles, Bakelites, and Bulbs*, 158.
[119] Baekeland 1916, qtd in Bijker, 158.
[120] Meikle, *American Plastic*, 72.
[121] Bijker, *Of Bicycles, Bakelites, and Bulbs*, 158.
[122] Bijker, 158.
[123] The language of plastic was not the only unstable thing about the plastics industry at the time. The Moulder's Association was an early group of manufacturers that were focused on the creation of plastic from existing knowledge, rather than chemical engineering.
[124] "A Round Robin Discussion on the Molders' Generic Name."
[125] Connor, qtd. in "A Round Robin Discussion on the Molders' Generic Name," 704.
[126] Reeves, qtd. in "A Round Robin Discussion on the Molders' Generic Name," 714.
[127] Connor, qtd in "A Round Robin Discussion on the Molders' Generic Name," 704.
[128] "In Closing."
[129] In fact, "Bakelite" has become the generic word for thermoset plastics, whether they are phenol or urea formaldehyde based.
[130] A functional group is a group of atoms responsible for the characteristic reactions of a particular compound.
[131] Amos, Oral History 00516.
[132] Bohning, "Introduction."
[133] "Oil Gluts, Great Depression Style: From the Archives."
[134] While this is the current heat and pressure at which Naphtha is dehydrogenated, the temperatures and pressures in early manufacturing were far lower.
[135] Boundy and Amos, *A History of the Dow Chemical Physics Lab*, 92.
[136] Boundy and Amos, 92.
[137] Boundy and Amos, 92.
[138] This is a substantial simplification, though it is the one repeated in most technical and popular texts about styrene. See the introduction of *Styrene: Its Polymers, Copolymers, and Derivatives* for an exhaustive account, including complications of nomenclature, the same material being identified by different names, and other twists and turns in its earliest years.
[139] Al-Malaika, "History of Antioxidants and Stabilizers for Polymers," 225.
[140] Ostromislensky, "Styrol Products Now Suitable for Molding."
[141] Ostromislensky was also the inventor of GR-S, the rubber substitute used by the American military in WW2, which is also important to the story of the proliferation of polystyrene, as will be detailed below.
[142] There is a single example, in 1935, of an imported German material called "Trolitul," described as a "German poly-styrol plastic" in an article about which plastic to choose for various applications (Chase 1935, 52), but Dow Chemical was definitively the first North American producer.
[143] Bohning, "Introduction."
[144] Bohning, 7.
[145] qtd in Reese, "World War II: The Rubber Shortage," 54.
[146] Mulder and Knot, "PVC Plastic."
[147] Kaufman, *The History of PVC, the Chemistry and Industrial Production of Polyvinyl Chloride.*
[148] Mulder and Knot, "PVC Plastic."

[149] Mulder and Knot.
[150] Mulder and Knot, 269.
[151] Kaufman, *The First Century of Plastics*, 75 The addition of plasticizers to PVC today accounts for 85% of all plasticizer use. Plasticizers – particularly phthalates – are implicated in endocrine disruption and decreased fertility.
[152] Kaufman, 75.
[153] Luce, "Plastics in 1940."
[154] Kaufman, *The First Century of Plastics*, 75.
[155] Meikle, *American Plastic*, 84.
[156] Buchanan, "Synthetic Houses," 180.
[157] Mulder and Knot, "PVC Plastic."
[158] Demirors, "The History of Polyethylene."
[159] Shackleton, "Polyethylene--A New Thermoplastic."
[160] Myers, "Polyethylene."
[161] Shackleton, "Polyethylene--A New Thermoplastic," 99.
[162] Clarke, *Tupperware: The Promise of Plastic in 1950s America*.
[163] The name "Pez" is derived from the German word for peppermint, or PfeffErminZ. While they were originally sold in containers similar to Altoids tins, the 'regular' dispenser was invented to appeal to adult smokers, and made its debut at the Vienna World's Fair in 1949. The addition of cartoon heads and fruit flavours only occurred after the candy was imported to the US.
[164] Rothman, "The Small-Scale Story Behind EBay's Big Bucks."
[165] Thompson, *Rubbish Theory*.
[166] Thompson.
[167] Latour, *Science in Action: How to Follow Scientists and Engineers through Society*, 41.
[168] Bohning, "Styrene at Dow for the World War II Synthetic Rubber Program."
[169] Stoesser, "Polystyrene."
[170] Stoesser.
[171] Amos, Oral History 00516.
[172] Boundy, "Styrene."
[173] One of the 39 patents she holds.
[174] Amos, "Polystyrene."
[175] This process worked to produce the first 200 million pounds of polystyrene for Dow, and only changed when wartime restrictions on tin forced the development of a continuous process in 1942.
[176] Miller, "Vinyl Resins (Including Polystyrene)," 43.
[177] Gibb, "Polystyrene," 53.
[178] Meikle, "Plastics in the American Machine Age, 1920-1950."
[179] Meikle, *American Plastic*, 76.
[180] Wells, "Urea Formaldehyde."
[181] Hayes, "From Cyanide To 'Beetle.'"
[182] Meikle, *American Plastic*, 77.
[183] See Meikle, 1990 for an excellent treatise on how plastic and industrial design created a 'machine age' aesthetic that stimulated sales of household goods throughout the 1930s.
[184] Dunk, "Premiums, Plastics and Profits!"
[185] Dunk, 40.
[186] Dunk, "Is the Premiums Field a Plastics Field?"
[187] Broadcast from 1931-1942, Little Orphan Annie was one of the most popular radio serials of all time. As was in the Saturday Review in 1969, "All people during [the Thirties and early Forties], budding delinquents, safe-crackers, stock market manipulators, or whatever, listened to Little Orphan Annie" (Gehman, 1969). As "much as a third of every fifteen-minute episode was devoted to having the announcer sing Ovaltine's praises, telling kids it would give them added 'pep' and imploring them to 'do a favor' for Annie and tell their mothers about it" (Schwartz, 2015).
[188] Schwartz, "American Children Faced Great Dangers in the 1930s, None Greater Than 'Little Orphan Annie.'"

[189] Spencer, "Molded Boxes Are Coming Into Their Own."
[190] Spencer.
[191] Spencer emphasis mine.
[192] Kaufman, *The First Century of Plastics: Celluloid and Its Sequel*, 59.
[193] "Playing Up a Market."
[194] "OPM Classifies Plastics."
[195] Knowlson, "WPB Limitation Order Toys and Games (L-81)."
[196] Hanlon and Belda, *Plastic Toys*, 27.
[197] In the April 1942 issue of Playthings, there was an editorial article suggesting that nearly everything could be made of wood, including tricycles.
[198] Hanlon and Belda, *Plastic Toys*, 26.
[199] Hanlon, "Dr. Islyn Thomas, O.B.E."
[200] Hanlon, 27.
[201] Kleiderer, "Ideal Works on Secret Project."
[202] Kleiderer.
[203] Hanlon, "Dr. Islyn Thomas, O.B.E.," 29.
[204] Thomas, *Injection Molding of Plastics*.
[205] "Plastic Engineers Elect Islyn Thomas."
[206] Hanlon, "Dr. Islyn Thomas, O.B.E.," 29.
[207] Morris, "Synthetic Rubber: Autarky and War."
[208] Reese, "World War II: The Rubber Shortage."
[209] Pinkerton, *Holiday Plastic Novelties: The Styrene Toys*.
[210] Abbiati, "Merry Xmas with Plastic," 90.
[211] Abbiati, 90.
[212] Abbiati, 92.
[213] Abbiati, "Plastics Make Good Reuse Packages," 94.
[214] Pinkerton, *Holiday Plastic Novelties: The Styrene Toys*, 6 emphasis mine.
[215] The present-day equivalent of this phenomenon is reusable grocery bags, meant to be durable, their inevitable accumulation means they very quickly become clutter and are subsequently disposed of.
[216] Elliot, qtd. in Strasser, *Waste and Want*, 112.
[217] Cross and Proctor, *Packaged Pleasures*.
[218] "Every Fourth Toy Is Plastic."
[219] "Every Fourth Toy Is Plastic."
[220] The Dow Chemical Company, "Annual Report 1948," 14.
[221] Hanlon and Belda, *Plastic Toys*, 14.
[222] Hanlon, "Dr. Islyn Thomas, O.B.E."
[223] "Styrofoam #22 Sales For 1949-1952."
[224] Blair, "History of Chemistry in the Dow Chemical Company."
[225] "Estimated Styrene Resin Consumption in 1953, by End Products."
[226] The other two large categories that year were packaging – 14 percent of all polystyrene went into packaging uses, and refrigeration and air conditioning – 15 percent of all polystyrene went into refrigeration.
[227] McCann, "Toys Had Better Be Better," March 1955.
[228] McCann.
[229] Hanlon, "U.S. Dimestore."
[230] "Banana Boat."
[231] Benjamin, *The Arcades Project*.
[232] As is evidenced by the fact that Thomas Manufacturing has gone under, and many of the small plastics toy producers are selling their moulds off at this time. In 1959, there were 300 plastics manufacturers in Hong Kong; by 1964 this number had quadrupled. Many of those manufacturers specialized in toys.

[233] Salkinoja-Salonen, "Cleaning Can also be a Source of Indoor Air Problems (translated from Finnish)."
[234] Mikkola et al., "20-Residue and 11-Residue Peptaibols from the Fungus Trichoderma Longibrachiatum Are Synergistic in Forming Na+/K+-Permeable Channels and Adverse Action towards Mammalian Cells."

[235] Along with permanganate, an older class of disinfectant commonly used with skin issues.
[236] As before, the complications of chemical formulae, modifications, and continually progressing research makes these distinctions difficult. Enormous change and innovation as well as rationalization was occurring during the years I cover, and part of that was the language the industry itself used. To clarify these complications, and to avoid anachronism, I use *Polythene* as the name for low density polyethylene before HDPE's invention, and LDPE to contrast from HDPE after HDPE's invention.
[237] Clarke, *Tupperware*, l. 611.
[238] Clarke, l. 635.
[239] Clarke, l. 123.
[240] Clarke, l. 207.
[241] Kealing, *Tupperware Unsealed: Brownie Wise, Earl Tupper, and the Home Party Pioneers*.
[242] Clarke, *Tupperware*, l. 1957.
[243] Clarke, l. 1242.
[244] Lucas, "Disposability and Dispossession in the Twentieth Century," 6.
[245] Clarke, *Tupperware*, l. 2231.
[246] Shove, *Comfort, Cleanliness, and Convenience: The Social Organization of Normality*, 87.
[247] Elizabeth Shove, *Comfort, Cleanliness, and Convenience: The Social Organization of Normality*, New Seriesj (Virginia: Berg Publishers, 2003), 87.
[248] Lucas, "Disposability and Dispossession in the Twentieth Century," 12.
[249] Ziegler, 1956, qtd in Wilke, "Fifty Years of Ziegler Catalysts."
[250] Oesper, "Karl Ziegler."
[251] Van Boskirk, "The Plastiscope: News and Interpretation of the News."
[252] qtd in Wilke, "Fifty Years of Ziegler Catalysts."
[253] Bensaude-Vincent and Stengers, *A History of Chemistry*, 202.
[254] Nobel Lectures Chemistry, 1972, qtd in Wilke, "Fifty Years of Ziegler Catalysts."
[255] "Polyethylene Grabs the Spotlight: Part One."
[256] "Polyethylene Grabs the Spotlight: Part One."
[257] "Polyethylene Grabs the Spotlight," 80.
[258] "Polyethylene Grabs the Spotlight Part 2," *Modern Plastics*, October 1955, 103.
[259] "Polyethylene Grabs the Spotlight Part 2," 104.
[260] "Polyethylene Grabs the Spotlight Part 2," 233.
[261] "Polyethylene Grabs the Spotlight Part 2," 226.
[262] Clarke, *Tupperware*, l. 3632.
[263] Beall, "The Evolution of Plastics in America: As Seen Through the National Plastics Expositions."
[264] Faircloth, *Plastics Now*, 205.
[265] Curtis, "'Give Us Facts' Says Ely Jacques Kahn."
[266] Curtis, "Seeing the Ready Made House with Harvey Wiley Corbett," 18.
[267] Curtis, 52.
[268] McCann, "Editorial: Better Building Codes."
[269] "New Architectural Concepts in Plastics House."
[270] Hermach, "The Platform."
[271] Faircloth, *Plastics Now*, 25.
[272] Walsh, *Wham-O Super Book: Celebrating 60 Years Inside the Fun Factory*.
[273] "Bonanza for Extruders."
[274] "Bonanza for Extruders."
[275] "Sixth Annual Modern Plastics Competition."
[276] McCann, "Toys Had Better Be Better," March 1955.
[277] "Plastics' Stake in Toys."
[278] Stouffer, "Plastics Packaging: Today and Tomorrow."
[279] Stouffer.
[280] Editorial, "Color TV: An Opportunity and a Warning."
[281] Editorial, "Plastics for Disposables."

[282] Editorial.
[283] “Polystyrene.”
[284] “Polystyrene.”
[285] “Plastics in Disposables and Expendables.”
[286] Steen, *The American Synthetic Organic Chemicals Industry: War and Politics, 1910-1930*, 150.
[287] In an absolutely unforgettable scene in the popular show “Breaking Bad,” Jesse learns about HF acid’s ability to corrode ceramic the hard way while trying to dissolve a body in a bathtub. Bernstein, *Cat’s in the Bag...*.
[288] “New Champ of Detergent Bottles: High Density PE.”
[289] “New Champ of Detergent Bottles: High Density PE.”
[290] “New Champ of Detergent Bottles: High Density PE.”
[291] Hercules Powder Company, “The Hoops Have Had It... Now What?”
[292] Hercules Incorporated, Dunham, and Ziegler, *Records of Hercules Incorporated*.
[293] Dyer and Sicilia, *Labors of a Modern Hercules: The Evolution of a Chemical Company*, 293.
[294] Dyer and Sicilia, 296.
[295] Dyer and Sicilia, 302.
[296] Dyer and Sicilia, 306.
[297] Williams, *The Velveteen Rabbit*.
[298] Martin, *Flexible Bodies: Tracking Immunity in American Culture from the Days of Polio to the Age of AIDS*, 23.
[299] Martin, 26.
[300] Deane, “Search for New Mr. (or Ms.) Clean Is On.”
[301] Haraway, *Staying with the Trouble: Making Kin in the Chthulucene*.
[302] Meikle, *American Plastic*, 228.
[303] Sacharow and Griffin, *Food Packaging: A Guide for the Supplier, Processor, and Distributor*.
[304] Meikle, *American Plastic*, 83.
[305] Ibeh, *Thermoplastic Materials*, 276.
[306] Latour, *Pandora’s Hope*, 304.
[307] Sevenster, “Eco-Profiles and Environmental Declarations for PVC.”
[308] Smith and Smith, *Minamata: Words and Photographs by W. Eugene Smith*; Smith, “Death Flow from a Pipe.”
[309] One popular book from 1945 was titled “Plastics: What Everyone Should Know” and went into great detail about the history and manufacture of plastic up to that point.
[310] Bagsik, “Barbie’s Product Life Cycle: Raw Materials.”
[311] Ibeh, *Thermoplastic Materials*, 275.
[312] Meikle, *American Plastic*, 84.
[313] McCready, “Macy’s Presents ‘Magic Skin’ Dolls.”
[314] Knowles, “Changes in the Doll World.”
[315] See, for example, the Cada Toys “original floating ball” filled with typha, which is the fluff from cat-tail reeds. From “The Ever Popular Cada Toys” advertisement in *Playthings: The National Magazine of the Toy Trade*, January 1945, p. 87.
[316] Shirley Temple was one of the last popular dolls to be made of a composite material of wood dust and glue, similar in makeup to papier maché.
[317] McCready, “Macy’s Presents ‘Magic Skin’ Dolls.”
[318] McCready, “‘Magic Skin’ Inspires Interesting Inquiries.”
[319] Knowlson, “WPB Limitation Order Toys and Games (L-81).”
[320] Rapaport, “Realism a Requisite in Military Playthings.”
[321] During WW1, The Toy Manufacturers Association won permission to continue to create playthings on this argument, but was not successful during WW2. Cross, *Kids’ Stuff: Toys and the Changing World of American Childhood*.
[322] “Eagle Rubber Wins Army-Navy ‘E’ Award.”
[323] Clingenpeel, *Survival & Rescue Equipment of World War II: Army Air Forces and U.S. Navy*, 1:103.

[324] “Playcraft: The Inflatable Boat That Goes Everywhere.”
[325] Cross, *Kids’ Stuff: Toys and the Changing World of American Childhood*, 423.
[326] “Children’s Day! Make It a Red Letter Day.”

[327] "Kindergarten with Traffic Lights Stresses the PLAY SAFE Habit."
[328] "Solar Stills Lead to Inflatables," 69.
[329] Wilcox, "Inflatables, a Revolution in Toys," 474.
[330] Wilcox, 475.
[331] Wilcox, 475.
[332] Wilcox, 475.
[333] Wilcox, 476.
[334] Wilcox, "Inflatables, a Revolution in Toys."
[335] "Highlights of the Plastics Picture."
[336] "The Koroseal Air Mat for Beach or Backyard," 252.
[337] Hardwick, "A Chat with Toy Buyer Hermine Myers," 240.
[338] Hardwick, 240.
[339] Max E Brafman Company, "Child's Wading Pool: In Every Respect, Prewar Quality! (Advertisement)," 51.
[340] "Toy News and New Toys."
[341] "Plastics Products Brief."
[342] "Vinyl Pool and Cabana," 160.
[343] "Backyard Luxury - Country Club Style," 17.
[344] "Plastics Products," 90.
[345] "Achievements in Plastics: Packaged Pools."
[346] The title of the article detailing the process is "Swimming Pools for Mass Markets" and begins with the statement "middle income families who have long looked upon private swimming pools as luxury items far beyond their means are now being cultivated as a highly profitable market by the makers of such pools" (p. 99).
[347] "Swimming Pools for Mass Markets," 99.
[348] "Leisure Markets," 178.
[349] "Leisure Markets," 178.
[350] "Swimming Pools."
[351] "What Is the Future for RP Swimming Pools?," 81.
[352]Demographically, the "baby boom" covers children born from 1946 to 1964, with 1952 being the top total births year. There are, of course, a variety of ways to parse the demographics of the postwar baby boom, but in terms of pool & toy sales, this is the most appropriate.
[353] Many of the young teenagers in the Mickey Mouse Club became integral to the surf culture that proceeded it – Annette Funicello being the most famous example.
[354] The use of Annette Funicello and Frankie Avalon as surf culture stars was ironic, given they are dark haired, Italian-Americans from upstate New York and Philadelphia respectively, and neither surf.
[355] Based on a 1957 book of the same name, Gidget is largely considered to be the first commercially successful surf culture movie.
[356] May, *Homeward Bound*.
[357] Warshaw, *The History of Surfing*, 198.
[358] Neushul and Westwick, "Blowing Foam and Blowing Minds: Better Surfing through Chemistry," 51.
[359] Warshaw, *The History of Surfing*, 241.
[360] The movie that revealed 1966's world surf champion Nat Young living on a rented farmhouse homestead included shots of his treehouse, yoga books, and farmer's market trips with his partner and child. From Warshaw, The History of Surfing, 269.
[361] Neushul and Westwick, "Blowing Foam and Blowing Minds: Better Surfing through Chemistry," 52.
[362] Irwin, "Surfing: The Natural History of an Urban Scene," 159.
[363] Burnett, "Adult Swim: How John C. Lilly Got Groovy (and Took the Dolphin with Him) 1958-1968," 14.
[364] Nichols, *The Graduate*.
[365] These are the dates of the methylmercury being released into the bay, not the dates of the impacts on the people of Minamata Bay, which is still ongoing to this day.

[366] Smith, "Death Flow from a Pipe," 74.
[367] Klein, "The Plastic Coffin of Charlie Arthur."

[368] US Department of Health, Education, and Welfare, Center for Disease Control, and National Institute for Occupational Safety and Health, "Health Hazard Evaluation Determination."
[369] Schapiro, "Toxic Toys."
[370] Orvell, *The Real Thing: Imitation and Authenticity in American Culture, 1880-1940*, 30.
[371] Lougee, "Plastics as Fundamental Materials: An Interview with Henry Dreyfuss," 23.
[372] Meikle, "Plastics in the American Machine Age, 1920-1950," 52.
[373] Mailer, 1963; qtd. in Meikle, "Material Doubts," 280.
[374] Mailer, *The Presidential Papers: With a New Preface by the Author*, 173 emphasis mine.
[375] Mailer, 305. See also pages 196, 199, 201, and 214. .
[376] Zirakzadeh, "Political Prophecy in Contemporary American Literature: The Left-Conservative Vision of Norman Mailer."
[377] Zirakzadeh, 630.
[378] "Plastics in 1940."
[379] Canguilhem and Foucault, *The Normal and the Pathological*.

Bibliography

Science History Institute Digital Collections. "1930 Hercules Advertisements." Accessed November 17, 2021. https://digital.sciencehistory.org/works/ht24wk25s.

Abbiati, F. A. "Merry Xmas with Plastic." *Modern Plastics*, December 1946.

———. "Plastics Make Good Reuse Packages." *Modern Plastics* 24, no. 4 (December 1946): 94–96.

"About - Bud Browne Film Archives." Accessed August 9, 2017. http://www.budbrownefilmarchives.com/about/.

"Achievements in Plastics: Packaged Pools." *Modern Plastics*, June 1954.

Al-Malaika, S. "History of Antioxidants and Stabilizers for Polymers." In *History of Polymeric Composites: Proceeding of the Symposium Held during the 192nd ACS National Meeting*, edited by RB Seymour and RD Deanin, 223–68. Utrecht, The Netherlands: VNU Science Press, 1987.

American Chemical Society: Division of the History of Chemistry and the Office of Communications. "United States Synthetic Rubber Program, 1939-1945." American Chemical Society Office of Communications, 1998.

Amos, J. Lawrence. Oral History 00516. Oral History, May 26, 1976. 00516. Dow Historical Collection.

———. "Polystyrene." In *A History of the Dow Chemical Physics Lab: The Freedom to Be Creative*, edited by Ray H. Boundy and J. Lawrence Amos, 101–8. New York and Basel: Marcel Dekker Inc, 1990.

Anhorn, B. H. Weil and Victor J. *Plastic Horizons*. First Ed.-1st Printing edition. The Jaques Cattell Press, 1944.

Appadurai, Arjun, ed. *The Social Life of Things: Commodities in Cultural Perspective*. 1 edition. Cambridge University Press, 1986.

"Backyard Luxury Country Club Style." *Bakelite Review*, April 1952.

Baekeland, Leo. "A Round Robin Discussion on the Molders Generic Name." *Molded Products*, December 1929.

Bagsik, Isabel. “Barbie’s Product Life Cycle: Raw Materials.” Design Life-Cycle, March 11, 2013. http://www.designlife-cycle.com/barbie-dolls/.

“Banana Boat.” *Modern Plastics*, August 1958.

Barthes, Roland. “Plastic.” In *Mythologies: Roland Barthes*, 97–99. New York: Hill and Wang, 1957.

Beall, Glenn L. “The Evolution of Plastics in America: As Seen Through the National Plastics Expositions.” Occasional Paper. London: Plastics Historical Society, 2005

Benjamin, Walter. “The Work of Art in the Age of Mechanical Reproduction.” In *Illuminations*, 217–52. New York: Schocken Books, 1968.

Benjamin, Walter. *The Arcades Project*. Edited by Rolf Tiedemann. Translated by Howard Eiland and Kevin McLaughlin. 1 edition. Cambridge, Mass.: Belknap Press, 2002.

Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Durham: Duke University Press Books, 2010.

Bensaude-Vincent, Bernadette, and Isabelle Stengers. *A History of Chemistry*. Reprint edition. Cambridge, Mass: Harvard University Press, 1996.

Bernstein, Adam. “Cat’s in the Bag...” *Breaking Bad*, January 27, 2008.

Bijker, Wiebe E. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. New edition edition. Cambridge, Mass.: The MIT Press, 1997.

———. “The Social Construction of Bakelite: Toward a Theory of Invention.” In *The Social Construction of Technological Systems*, edited by Wiebe E. Bijker, Trevor Pinch, and T. P. Hughes, 159–87. Cambridge: MIT Press, 1987.

Blair, Etcyl. “History of Chemistry in the Dow Chemical Company.” Symposium presented at the ACS Central Regional Meeting, May 16-20, 2006, Frankenmuth, Michigan, May 18, 2006.

Blanc, Paul David. *Fake Silk: The Lethal History of Viscose Rayon*. 1 edition. New Haven ; London: Yale University Press, 2016.

Blaszczyk, Regina. “Styling Synthetics: DuPont’s Marketing of Fabrics and Fashions in Postwar America.” *Business History Review* 80, no. 03 (September 2006): 485–528. https://doi.org/10.1017/S000768050003587X.

Bohning, John. “Introduction.” In *A History of the Dow Chemical Physics Lab: The Freedom to Be Creative*, edited by Ray H. Boundy and J. Lawrence Amos. M. Dekker, 1990.

———. “Styrene at Dow for the World War II Synthetic Rubber Program.” *Chemical Heritage Magazine* 22, no. 3 (2004): 8–9, 40–45.

“Bonanza for Extruders.” *Modern Plastics*, November 1958.

Boundy, Ray H. “Styrene.” In *A History of the Dow Chemical Physics Laboratory: The Freedom to Be Creative*, edited by Ray H. Boundy and J. Lawrence Amos, 89–99. New York: Marcel Dekker Inc, 1990.

Boundy, Ray H., and J. Lawrence Amos. *A History of the Dow Chemical Physics Lab: The Freedom to Be Creative*. M. Dekker, 1990.

Bowker, Geoffrey C., and Susan Leigh Star. *Sorting Things Out: Classification and Its Consequences*. Cambridge, Mass.: The MIT Press, 2000.

Bregar, Bill. “Much-Honored Islyn Thomas Dies at 89.” *Plastics News* 14, no. 14 (2002): 8.

Buchanan, A. E. “Synthetic Houses.” *Scientific American*, 1933.

Burnett, Graham. “Adult Swim: How John C. Lilly Got Groovy (and Took the Dolphin with Him) 1958-1968.” In *Groovy Science: Knowledge, Innovation and American Counterculture*, edited by David Kaiser and W. Patrick McCray, 13–50. Chicago: University Of Chicago Press, 2016.

Cada Products. “The Ever Popular Cada Toys.” *Playthings: The American Toy Journal*, January 1945.

Canguilhem, Georges, and Michel Foucault. *The Normal and the Pathological*. Translated by Carolyn R. Fawcett. New edition edition. New York: Zone Books, 1991.

Carson, Rachel, Linda Lear, and Edward O. Wilson. *Silent Spring*. Anniversary edition. Mariner Books, 1963.

Chase, Herbert. “Which Plastics to Choose? VII: The Miscellaneous Plastics.” *Modern Plastics*, March 1935.

Clark, James L., and Mason E. Horton. Method of making inflatable toys. US2516552 A, filed July 19, 1948, and issued July 25, 1950. http://www.google.com/patents/US2516552.

Clarke, AJ. *Tupperware: The Promise of Plastic in 1950s America*. Washington, DC: Smithsonian, 1999.

Cloud, John. "A War to Win and a Job to Do." *Playthings: The National Magazine of the Toy Trade*, April 1942, 16.

Cohen, Lizabeth. *A Consumers' Republic: The Politics of Mass Consumption in Postwar America*. REPR edition. New York: Vintage, 2003.

Colborn, Theo, Dianne Dumanoski, and John Peterson Myers. *Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival?--A Scientific Detective Story*. Reprint edition. New York: Plume, 1997.

Cook, Daniel Thomas. *The Commodification of Childhood: The Children's Clothing Industry and the Rise of the Child Consumer*. Durham: Duke University Press Books, 2004.

Corn, Joseph J., ed. *Imagining Tomorrow: History, Technology, and the American Future*. Cambridge, MA, USA: MIT Press, 1986.

Corner, James. "The Agency of Mapping: Speculation, Critique and Invention." In *The Map Reader*, 89–101. John Wiley & Sons, Ltd. Accessed June 16, 2021.

Cosgrove, Denis. "Maps, Mapping, Modernity: Art and Cartography in the Twentieth Century." *Imago Mundi* 57, no. 1 (February 1, 2005): 35–54.

Couzens, E. G., and V. E. Yarsley. *Plastics in the Service of Man.* Illustrated edition. Penguin, 1956.

Crews, Patricia, Wendelin Rich, and Shirley Niemeyer. "A Summary of Environmental Legislation Targeting Disposable Diapers and Review of Related Literature." *Journal of Environmental Polymer Degradation* 2, no. 1 (1994): 39–48.

Cross, Gary. *Kids' Stuff: Toys and the Changing World of American Childhood*. Revised ed. edition. Cambridge, Mass.: Harvard University Press, 1999.

Cross, Gary S., and Robert N. Proctor. *Packaged Pleasures: How Technology and Marketing Revolutionized Desire*. 1 edition. Chicago ; London: University Of Chicago Press, 2014.

Curtis, Dock. “Give Us Facts, Says Ely Jacques Kahn.” *Modern Plastics*, October 1935.

Curtis, Dock. “Seeing the Ready-Made House with Harvey Wiley Corbett.” *Modern Plastics*, July 1935.

Deane, Natalie. “Search for New Mr. (or Ms.) Clean Is On.” *Toronto Sun*. October 13, 2016, sec. Homes.

Derraik, José G. B. “The Pollution of the Marine Environment by Plastic Debris: A Review.” *Marine Pollution Bulletin* 44, no. 9 (September 2002): 842–52.

Demirors, Mehmet. “The History of Polyethylene.” In *100+ Years of Plastics. Leo Baekeland and Beyond*, 1080:115–45. ACS Symposium Series 1080. American Chemical Society, 2011.

Douglas, Mary. *Purity and Danger: An Analysis of Concepts of Pollution and Taboo*. 1 edition. London ; New York: TAYLOR, 2002.

Dow Chemical Company. “Annual Report 1948.” Financial. Detroit: The Dow Chemical Company, July 20, 1948.

Dow Chemical Company. “Saluting 50 Years: Styron.” Dow Chemical Company, 1987. Products 00502. Dow Historical Collection.

Dow Chemical Company Plastics Department. “Styrofoam: Fabrication, Adhesives and Coatings.” Bulletin. Plastics Technical Service. Midland, Michigan: The Dow Chemical Company, November 1954.

“Dow Styron 475 Advertisement.” *Life Magazine*, November 24, 1952.

DuBois, J. Harry (John Harry), and Frederick W. John. *Plastics*. New York: Reinhold Pub. Corp., 1967.

Dunk, Howard. “Is the Premiums Field a Plastics Field?” *Modern Plastics*, 1935.

———. “Premiums, Plastics and Profits!” *Modern Plastics*, October 1934, 40–48.

Dyer, Davis, and David B. Sicilia. *Labors of a Modern Hercules: The Evolution of a Chemical Company*. 1st edition. Boston, Mass: McGraw-Hill, 1990.

Edelman, Lee. *No Future: Queer Theory and the Death Drive*. Duke University Press, 2004.

Edgard Gonzales-Gaudiano and Rosa Nidia Buenfil-Burgos. “The Impossible Identity of Environmental Education: Disseminatino and Emptiness.” In *Fields of Green: Restorying Culture, Environment, and Education*, edited by Marcia McKenzie, Paul Hart, Heesoon Bai, and Bob Jickling. Hampton Press, Inc. • 307 Seventh Avenue, Suite 506 • New York NY 10001, 2009.

“Estimated Styrene Resin Consumption in 1953, by End Products.” *Modern Plastics*, January 1953.

“Every Fourth Toy Is Plastic.” *Modern Plastics*, June 1946.

Faircloth, Billie. *Plastics Now: On Architecture’s Relationship to a Continuously Emerging Material*. Abingdon, Oxon ; Routledge, 2015.

Foucault, Michel. *The Order of Things: An Archaeology of Human Sciences*. New York: Vintage, 1966.

———. “Of Other Spaces: Utopias and Heterotopias.” Translated by Jay Maskowiec. *Architecture/Mouvement/Continuité*, October 1984, 1–9.

Freinkel, Susan. *Plastic: A Toxic Love Story*. Boston: Houghton Mifflin Harcourt, 2011.

Friedel, Robert. *Pioneer Plastic: The Making and Selling of Celluloid.* Vol. 58. Madison: University of Wisconsin Press, 1984.

“Fun in the Sun.” *Bakelite Review*, July 1952.

Gabrys, Jennifer, Gay Hawkins, and Mike Michael. *Accumulation: The Material Politics of Plastic*. Abingdon, Oxon: Routledge, 2013.

Gerard, Barbara. “Which Plastic Materials Are Used in Barbie Dolls?” Accessed April 20, 2016. http://info.craftechind.com/blog/which-plastic-material-are-used-in-barbie-dolls.

Geyer, Roland, Jenna R. Jambeck, and Kara Lavender Law. “Production, Use, and Fate of All Plastics Ever Made.” *Science Advances* 3, no. 7 (n.d.): e1700782.

Gibb, Donald L. “Polystyrene.” *Modern Plastics*, 1938.

Grubman, Leo J. “Molding Dolls Not an Easy Matter.” *Plastics and Molded Products*, June 1929, 329–41.

Guiterman, Arthur. “Strictly Germ-Proof.” In *Modern American Poetry: An Introduction*, edited by Louis Untermeyer, 170. New York: Harcourt, Brace and Howe, 1919. https://www.bartleby.com/104/50.html.

Halberstam, Judith. *The Queer Art of Failure*. Duke University Press, 2011.

Hanlon, Bill. “Dr. Islyn Thomas, O.B.E.” In *Plastic Toys: Dimestore Dreams of the 40s and 50s*, 26–29. Atglen, PA: Schiffer Publishing Ltd, 1993.

———. “U.S. Dimestore: Thomas Mfg. Corp. 1953-1955.” U.S. Dimestore. Accessed June 17, 2018. http://www.usdimestore.com/store.php?seller=americandimestore&per=6.

Hanlon, Bill, and David Belda. *Plastic Toys: Dimestore Dreams of the 40s & 50s*. First Edition edition. Atglen, PA: Schiffer Pub Ltd, 1993.

Haraway, Donna J. *Staying with the Trouble: Making Kin in the Chthulucene*. Illustrated edition. Durham: Duke Univ Pr, 2016.

Hardwick, Kay. “A Chat with Toy Buyer Hermine Myers.” *Playthings: The National Magazine of the Toy Trade*, February 1954.

Harley, J. Brian. “Maps, Knowledge and Power.” In *The Iconography of Landscape: Essays on the Symbolic Representation, Design and Use of Past Environments*, edited by Denis Cosgrove and Stephen Daniels. Cambridge University Press, 1988.

Harper, Charles. *Handbook of Plastics Technologies: The Complete Guide to Properties and Performance*. 2 edition. New York: McGraw-Hill Education, 2006.

Hawkins, Gay. “Commentary: Making Water into a Political Material: The Case of PET Bottles.” *Environment and Planning A* 43, no. 9 (2011): 2001–6. https://doi.org/10.1068/a44306.

———. “Disposability.” Discard Studies, May 21, 2019. https://discardstudies.com/2019/05/21/disposability/.

———. “Plastic Bags Living with Rubbish.” *International Journal of Cultural Studies* 4, no. 1 (January 3, 2001): 5–23.

———. *The Ethics of Waste: How We Relate to Rubbish*. Lanham Md.: Rowman & Littlefield Publishers, 2005.

Hawkins, Gay, Emily Potter, and Kane Race. *Plastic Water: The Social and Material Life of Bottled Water*. Cambridge, Massachusetts : The MIT Press, 2015.

Hayes. “From Cyanide to Beetle.” Academic. *Plastics Historical Society* (blog), 2007. https://plastiquarian.com/?p=13956.

“Health Hazard Evaluations (HHEs) | NIOSH | CDC,” October 7, 2020. https://www.cdc.gov/niosh/hhe/default.html.

Hercules Incorporated. “The Hoops Have Had It... Now What?” *Modern Plastics*, November 1959.

Hermach, George R. “The Platform.” *Modern Plastics*, December 1957.

Herman, Bernard L. “The Bricoleur Revisited.” University of Tennessee Press, 1997.

Herod, Andrew, Graham Pickren, Al Rainnie, and Susan McGrath-Champ. “Waste, Commodity Fetishism and the Ongoingness of Economic Life.” *Area* 45, no. 3 (September 1, 2013): 376–82.

Hess, Taylor, and Noah Hutton. *GUTS: Does Recycling Matter?* Digital, Documentary. The Atlantic Selects, 2019. https://www.theatlantic.com/video/index/591640/recycling-plastics/.

“Highlights of the Plastics Picture.” *Modern Plastics*, January 1954.

Ibeh, Christopher C. *Thermoplastic Materials: Properties, Manufacturing Methods, and Applications*. Boca Raton, FL: CRC Press, 2011.

Ideal Toys. “Ideal’s Plastic Boats Advertisement.” Ideal Toys, 1942. https://www.usdimestore.com/store.php/americandimestore/pg14124/ideal-toy-catalogs.

———. “Ideal Presents the Doll of Tomorrow.” *Playthings: The American Toy Journal*, October 1940.

“In Closing.” *Molded Products*, April 1930.

Irwin, John. “Surfing:: The Natural History of an Urban Scene.” *Urban Life and Culture* 2, no. 2 (July 1, 1973): 131–60.

Kaufman, M. *The First Century of Plastics: Celluloid and Its Sequel*. London: The Plastics Institute, 1967.

———. *The Chemistry and Industrial Production of Polyvinyl Chloride: The History of*

Kealing, Bob. *Tupperware Unsealed: Brownie Wise, Earl Tupper, and the Home Party Pioneers.* Gainesville: Univ Pr of Florida, 2008.

Keep America Beautiful: The Crying Indian. Short, 1970.

Kleiderer, C. W. "Ideal Works on Secret Project." *Playthings: The American Toy Journal*, December 1945.

Klein, Joe. "The Plastic Coffin of Charlie Arthur." *Rolling Stone*, January 15, 1976. https://www.rollingstone.com/culture/culture-news/the-plastic-coffin-of-charlie-arthur-79426/.

Knowles, Eleanor N. "Changes in the Doll World." *Playthings: The American Toy Journal*, October 1940.

Knowlson, JS. "WPB Limitation Order Toys and Games (L-81)." *Playthings: The American Toy Journal*, April 1942.

Kordas, Ann Marie. *The Politics of Childhood in Cold War America*. London: Pickering & Chatto, 2013.

"The Koroseal Air Mat for Beach or Backyard." *Playthings: The National Magazine of the Toy Trade*, February 1954.

Latour, Bruno. *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, Mass: Harvard University Press, 1999.

Latour, Bruno. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Mass: Harvard University Press, 1987.

"Leisure Markets." *Modern Plastics*, June 1956.

Liboiron, Max. "Tactics of Waste, Dirt and Discard in the Occupy Movement." *Social Movement Studies* 11, no. 3–4 (2012): 393–401.

Lougee, E. F. "Plastics as Fundamental Materials: An Interview with Henry Dreyfuss." *Modern Plastics*, November 1934.

———. "Toys For Sale." *Modern Plastics*, August 1939.

Lucas, Gavin. "Disposability and Dispossession in the Twentieth Century." *Journal of Material Culture* 7, no. 1 (January 3, 2002): 5–22..

MacArthur, Ellen. “The New Plastics Economy: Rethinking the Future of Plastics.” Accessed April 19, 2016. http://www.ellenmacarthurfoundation.org/publications/the-new-plastics-economy-rethinking-the-future-of-plastics.

MacBride, Samantha. *Recycling Reconsidered: The Present Failure and Future Promise of Environmental Action in the United States*. Reprint edition. The MIT Press, 2011.

Madden, Odile, A. Elena Charola, Kim Cullen Cobb, Paula T. DePriest, Robert J. Koestler, and Freinkel, Susan. *The Age of Plastic: Ingenuity and Responsibility (Proceedings of the 2012 MCI Symposium)*. Smithsonian Contributions to Museum Conservation, 2019.

Mailer, Norman. *The Presidential Papers*. N. e. edition. London: Panther Books, 1964.

Martin, Ann Smart. “Material Things and Cultural Meanings: Notes on the Study of Early American Material Culture.” *The William and Mary Quarterly* 53, no. 1 (1996): 5–12.

Martin, Emily. *Flexible Bodies: Tracking Immunity in American Culture from the Days of Polio to the Age of AIDS*. 1st ed. Boston, MA: Beacon Press, 1995.

Max E. Brafman Company. “Child’s Wading Pool: In Every Respect, Pre-War Quality!” *Playthings: The American Toy Journal*, February 1946.

May, Elaine Tyler. *Homeward Bound: American Families in the Cold War Era*. Fully rev. and Updated 20th anniversary ed. /. New York, NY: Basic Books, 2008.

McCann, Hiram. “Color TV: An Opportunity and a Warning.” *Modern Plastics*, August 1951.

———. “Editorial: Better Building Codes.” *Modern Plastics*, January 1954.

———. “Toys Had Better Be Better.” *Modern Plastics*, March 1955.

———. “Plastics for Disposables.” *Modern Plastics*, April 1956.

McCready, Robert. “Macy’s Presents: Magic Skin Dolls.” *Playthings: The American Toy Journal*, October 1940.

———. “Magic Skin Inspires Some Interesting Inquiries.” *Playthings: The American Toy Journal*, July 1941.

Meikle, Jeffrey L. *American Plastic: A Cultural History*. Rutgers University Press, 1995.

———. “Material Doubts: The Consequences of Plastic.” *Environmental History* 2, no. 3 (July 1997): 278.

———. “Plastics in the American Machine Age, 1920-1950.” In *The Plastics Age: From Modernity to Post-Modernity*, edited by Penny Sparke, 41–53. London: Victoria & Albert Museum, 1990.

Mikkola, Raimo, Maria Andersson, Laszlo Kredics, Pavel Grigoriev, Nina Sundell, and Mirja Salkinoja-Salonen. “20-Residue and 11-Residue Peptaibols from the Fungus Trichoderma Longibrachiatum Are Synergistic in Forming Na + /K + -Permeable Channels and Adverse Action towards Mammalian Cells.” *The FEBS Journal* 279 (September 20, 2012).

Miller, George C. “Vinyl Resins (Including Polystyrene).” *Modern Plastics* 12, no. 10 (October 1936): 43–45.

Miodownik, Mark. *Stuff Matters: Exploring the Marvelous Materials That Shape Our Man-Made World*. Boston: Houghton Mifflin Harcourt, 2014.

Morris, Peter J. T. “Synthetic Rubber: Autarky and War.” In *The Development of Plastics*, edited by Peter J. T. Morris and Susan T. I. Mossman, 54–69. Cambridge, England: Royal Society of Chemistry, 1994.

Mossman, S. T. I. (Susan T. I.). *Early Plastics: Perspectives, 1850-1950*. London: Leicester University Press in association with Science Museum, 1997.

Mulder, Karel, and Marjolijn Knot. “PVC Plastic: A History of Systems Development and Entrenchment.” *Technology in Society* 23, no. 2 (2001): 265–86.

Murphy, Michelle. *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*. Durham N.C.: Duke University Press, 2006.

Myers, C. S. “Polyethylene.” *Modern Plastics*, August 1944.

Neushul, Peter, and Peter Westwick. “Blowing Foam and Blowing Minds: Better Surfing through Chemistry.” In *Groovy Science: Knowledge, Innovation, and American Counterculture*, edited by David Kaiser and W. Patrick McCray, 51–69. Chicago: University of Chicago Press, 2016.

“New Architectural Concepts in Plastics Houses.” *Modern Plastics*, December 1955.

“New Champ of Detergent Bottles: HDPE.” *Modern Plastics*, August 1959.

Nichols, Mike. *The Graduate*. Comedy, Drama, Romance, 1967.

O’Brien, Martin. “Rubbish Values: Reflections on the Political Economy of Waste.” *Science as Culture* 8, no. 3 (September 1, 1999): 269–95.

Oesper, R. E. “Karl Ziegler.” *Journal of Chemical Education* 25, no. 9 (September 1, 1948): 510.

Ogata, Amy Fumiko. *Designing the Creative Child: Playthings and Places in Midcentury America*. Architecture, Landscape, and American Culture Series. Minneapolis: University of Minnesota Press, 2013.

The Economist (Online). “Oil Gluts, Great Depression Style: From the Archives,” December 30, 2014. http://www.economist.com/news/business-and-finance/21637484-too-much-oil-flooded-world-early-1930s-contributing-deflation-oil-gluts-great.

“O.P.M. Classifies Plastics.” *Modern Plastics*, August 1941.

Orvell, Miles. *The Real Thing*. Chapel Hill: Scholarly Book Services Inc, 2002.

Ostromislensky, Iwan. “Styrol Products Now Suitable for Molding.” *Plastics* 5, no. 1 (January 1929): 20–31.

Packard, Vance, and Bill McKibben. *The Waste Makers*. Reprint edition. Brooklyn, NY: Ig Publishing, 2011.

Pellow, David Naguib. *Resisting Global Toxics: Transnational Movements for Environmental Justice*. 1 edition. Cambridge, Mass: The MIT Press, 2007.

Pickles, John. “Texts, Hermeneutics and Propaganda Maps.” In *The Map Reader*, edited by Martin Dodge, Rob Kitchin, and Chris Perkins, 400–406. John Wiley & Sons, Ltd.

Pinkerton, Charlene. *Holiday Plastic Novelties: The Styrene Toys*. Atglen, PA: Schiffer Publishing Ltd, 1999.

“Plastic Engineers Elect Islyn Thomas.” *Playthings: The National Magazine of the Toy Trade*, April 1950.

Plastics Europe. "Christmas: Plastic Toys in Vogue," November 23, 2011. https://plastics-themag.com/Plastic-shakes-up-the-toy-industry

"Plastics in 1940." *Fortune*, October 1940.

"Plastics in Disposables and Expendables." *Modern Plastics*, April 1957.

"Plastics Products Brief." *Modern Plastics*, September 1947.

"Plastics Stake in Toys." *Modern Plastics*, March 1958.

"Playing Up a Market." *Modern Plastics*, July 1941.

"Polyethylene Grabs the Spotlight: Part One." *Modern Plastics*, September 1955.

"Polyethylene Grabs the Spotlight: Part Two." *Modern Plastics*, October 1955.

"Polystyrene." *Modern Plastics*, November 1955.

Rapaport, Meyer. "Realism a Requirement in Military Playthings." *Playthings: The American Toy Journal*, 1941.

Reese, Ken. "World War II: The Rubber Shortage." *Today's Chemist at Work*, June 1992. Synthetic Rubber 1942 Misc. Clips. Dow Historical Collection.

Rekret, Paul. "A Critique of New Materialism: Ethics and Ontology." *Subjectivity* 9, no. 3 (September 1, 2016): 225–45.

Rothman, Lily. "The Small-Scale Story Behind EBay's Big Bucks." *Time*, September 3, 2015. https://time.com/4013672/ebay-founded-story/.

Rubin, Eli. *Synthetic Socialism: Plastics & Dictatorship in the German Democratic Republic*. Chapel Hill: University of North Carolina Press, 2008.

Sacharow, S., and R. C. Griffin. *Food Packaging. A Guide for the Supplier, Processor, and Distributor.* Westport, Connecticut: AVI Publishing Co. Inc., 1970. https://www.cabdirect.org/cabdirect/abstract/19700403169.

Salkinoja-Salonen, Mirja. "Homevastine Tohtori Salkinoja-Salosen Hyvismikrobeille." Rakennuslehti, January 27, 2016. https://www.rakennuslehti.fi/2016/01/homevastine-tohtori-salkinoja-salosen-hyvismikrobeille/.

Schaffner, Ingrid. *Salvador Dali's Dream of Venus: The Surrealist Funhouse Fro the 1939 World's Fair*. New York, New York: Princeton Architectural Press, 2002.

Schapiro, Mark. "Toxic Toys," October 18, 2007. https://www.thenation.com/article/archive/toxic-toys/.

Schulten, Susan. "Richard Edes Harrison and the Challenge to American Cartography." *Imago Mundi* 50, no. 1 (January 1, 1998): 174–88..

Schwartz, A. Brad. "American Children Faced Great Dangers in the 1930s, None Greater Than 'Little Orphan Annie.'" Smithsonian Magazine. Accessed November 18, 2021. https://www.smithsonianmag.com/history/american-children-faced-great-dangers-1930s-none-greater-little-orphan-annie-180957544/.

Scott, Dayna Nadine. *Our Chemical Selves: Gender, Toxics, and Environmental Health*. Vancouver : UBC Press, 2015.

Sevenster, A. "Eco-Profiles and Environmental Declarations for PVC." *Plastics, Rubber and Composites* 37, no. 9–10 (December 1, 2008): 403–5.

Shackleton, J. W. "Polyethylene: A New Thermoplastic." *Modern Plastics*, February 1944.

Shashoua, Yvonne. *Conservation of Plastics: Materials Science, Degradation and Preservation*. 1st ed. Amsterdam: Elsevier/Butterworth-Heinemann, 2008.

Shove, Elizabeth. *Comfort, Cleanliness and Convenience: The Social Organization of Normality*. Illustrated edition. Oxford: Bloomsbury Academic, 2004.

"Sixth Annual Modern Plastics Competition: Award to Childhood Interests." *Modern Plastics*, 1941.

"Small Fry 'Ocean.'" *Bakelite Review*, April 1948.

Smith, Eugene. "Death Flow from a Pipe." *Life Magazine*, June 2, 1972.

Smith, W. Eugene, and Aileen M. Smith. *Minamata: Words and Photographs by W. Eugene Smith*. Alskog-Sensorium Book. New York: Holt, Rinehart and Winston, 1975.

Sparke, Penny and Victoria and Albert Museum. *The Plastics Age: From Modernity to Post-Modernity*. London: Victoria & Albert Museum, 1990.

Spencer, H. S. “Molded Boxes Are Coming Into Their Own.” *Molded Products*, January 1930, 46.

Steen, Kathryn. *The American Synthetic Organic Chemicals Industry: War and Politics, 1910-1930*. Illustrated edition. Chapel Hill: University of North Carolina Press, 2014.

Stoesser, Sylvia. “Polystyrene.” In *A History of the Dow Chemical Physics Lab: The Freedom to Be Creative*, edited by Ray H. Boundy and J. Lawrence Amos, 109–16. New York and Basel: Marcel Dekker Inc, 1990.

Stouffer, Lloyd. “Plastics Packaging: Today and Tomorrow,” Section 6-A:1–3. Chicago, Ill: The Society of the Plastics Industry, 1963.

Strasser, Susan. *Waste and Want: A Social History of Trash*. New York, N.Y.: Holt Paperbacks, 2001.

“Styrofoam #22 Sales For 1949-1952.” The Dow Chemical Company, 1952. Products 00329-2. Dow Historical Collection.

“Swimming Pools.” *Modern Plastics*, January 1956.

“Swimming Pools for Mass Markets.” *Modern Plastics*, September 1955.

Teach, William C., and George C. Kiessling. *Polystyrene*. Reinhold Publishing Corporation, 1960.

“The Story of the American Doll.” *Playthings: The American Toy Journal*, September 1938.

Thomas, Islyn. *Injection Molding of Plastics*. Reinhold Publishing Corporation, 1947.

Thompson, Jennifer. “Toys Prove to Be ‘Recession Resilient.’” *Financial Times*, July 1, 2012. http://www.ft.com/cms/s/0/98b83b92-c371-11e1-ad80-00144feabdc0.html#axzz44L6Nn9Xe.

Thompson, Michael. *Rubbish Theory: The Creation and Destruction of Value*. Oxford University Press, 1979.

Thompson, R. C., C. J. Moore, F. S. vom Saal, and S. H. Swan, eds. “Theme Issue ‘Plastics, the Environment and Human Health.’” *Philosophical Transactions of the Royal Society B: Biological Sciences* 364, no. 1526 (July 27, 2009).

"Tomorrow's Plastics Packages." *Modern Plastics*, May 1958. Chemical Heritage Foundation.

"Toy News and New Toys." *Playthings: The National Magazine of the Toy Trade*, May 1948.

Van Boskirk, R. L. "The Plastiscope: News and Interpretation of the News." *Modern Plastics*, May 1958. Chemical Heritage Foundation.

"Vinyl Pool and Cabana." *Modern Plastics*, April 1952.

Walsh, Tim. *Wham-O Super-Book: Celebrating 60 Years Inside the Fun Factory*. San Francisco: Chronicle Books, 2008.

Warshaw, Matt. *The History of Surfing*. Illustrated edition. San Francisco: Chronicle Books, 2010.

Weinstein, David. "Plastic Fantastic Living: Disney's Spectacular 'Monsanto House of the Future' Combined Science, Showmanship, and Dreams." Eichler Network. Living Today: The Mid-Century Modern Way, 2016. http://www.eichlernetwork.com/article/plastic-fantastic-living?page=0,5.

Wells, Alan. "Urea Formaldehyde." *The Plastics Historical Society* (blog). Accessed November 18, 2021. https://plastiquarian.com/?page_id=14236.

Wendkos, Paul, Sandra Dee, James Darren, and Cliff Robertson. *Gidget*. Comedy. Columbia Pictures, 1959.

"What Is the Future for RP Swimming Pools?" *Modern Plastics*, August 1957.

Wilcox, J. A. "Inflatables, a Revolution in Toys." *Playthings: The American Toy Journal*, March 1952. Strong Museum of Play.

Wilke, Günther. "Fifty Years of Ziegler Catalysts: Consequences and Development of an Invention." *Angewandte Chemie International Edition* 42, no. 41 (2003): 5000–5008.

Williams, Margery. *The Velveteen Rabbit*. Garden City NY: Doubleday & Company, 1922.

Wolfe, Bernard. *Plastics: What Everyone Should Know,*. First Edition. The Bobbs-Merrill company, 1945.

Chauncey, Worden, Edward. *Nitrocellulose Industry: A Compendium of the History, Chemistry, Manufacture, Commercial Application and Analysis of Nitrates, Acetates and Xanthates of Cellulose as Applied to the Peaceful Arts, with a Chapter on Gun Cotton, Smokeless Powder and Explosive Cellulose Nitrates.* London: Constable, 1911.

Yang, Di. “Test Results on Toxic Toys Raise Industry Standard.” *Greenpeace USA* (blog). Accessed November 18, 2021. https://www.greenpeace.org/usa/victories/test-results-on-toxic-toys-raise-industry-standard/.

Zirakzadeh, Cyrus Ernesto. “Political Prophecy in Contemporary American Literature: The Left-Conservative Vision of Norman Mailer.” *The Review of Politics* 69, no. 4 (2007): 625–49.