PLASTICS NOW

ON ARCHITECTURE'S RELATIONSHIP TO A CONTINUOUSLY EMERGING MATERIAL

BILLIE FAIRCLOTH

ROUTLEDGE

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PLASTICS NOW

ACKNOWLEDGMENTS

This collection was partially compiled during a time of transition, from academia into practice. "I acknowledge that plastics are difficult to decipher" was my first admission to anyone willing to engage the scope of this project, individuals from two distinct contexts: The University of Texas at Austin, Austin, Texas and the architectural practice of KieranTimberlake, Philadelphia, Pennsylvania.

At the University of Texas at Austin, I thank research assistant Robert Gay, a talented practitioner who worked alongside me while discovering historical gems that would ultimately lead to this project. I also thank colleagues Elizabeth Danze, Larry Doll, David Heymann, Larry Speck, Fritz Steiner, and Nichole Wiedemann, who listened and provided insight into my schemes.

At KieranTimberlake, I thank Stephen Kieran and James Timberlake, who provided considerable support and encouragement to finish this project and consistently asked, "Are you getting everything that you need?" Your support of querying inside our profession is one to be emulated. I thank Roderick Bates, Stephanie Carlisle, Peter Curry, and Eric Eisele, individuals with respective backgrounds in environmental management, lifecycle assessment, materials engineering, and fabrication, who deciphered and interpreted several technical aspects of this story. I thank Laura Buck, Andrea Calabretta, Laurent Hedquist, Crystal Peebles, Ryan Mellier, Carly Regn, Sarah Richendollar, and Hale Youngblood, who provided administrative, editorial, or illustrative support. I particularly thank Alex Cohn and Carin Whitney, who worked through several compiled and original data sets to help concoct original timelines and indices.

This book represents ten years of interaction with plastics across emerging and conventional paradigms. Working through plastics began in design studios taught at the University of Texas at Austin and in partnership with Cornerstone Research Group of Dayton, Ohio, in 2005 and 2006. At Cornerstone Research Group, I thank Patrick Hood, Ben Dietsch, and Tat Tong, who provided shadowing opportunities with their scientists and engineers which allowed me to understand the inherent design processes embedded in materials engineering and the considerable overlap between our professions. Tracking down plastics use in architecture began in December 2005 with work funded by the Association of Collegiate Schools of Architecture (ACSA) and the American Chemistry Council (ACC), work that provided the initial spark toward framing the position taken in this book. I thank ACSA Executive Director Michael Monti, ACC associates Rob Krebs and D'Lane Wisner for supporting the querying that ultimately led to this deeper investigation and for facilitating interaction with several in the plastics industry who might provide insight into chemistry, manufacturing, and processing. Finally, I thank the Graham Foundation who provided initial funding for this project and through their granting programs value and promote similar works of scholarship by architects and designers.

Along the way there have been noted presentations of the accumulated body of evidence alongside those individuals, designers, manufacturers, and chemists possessing a similar bent to dissect and sleuth materials in their context. The subject of "defining plastics" was presented at the fall 2009 symposium entitled *Plastics Modernities* organized by Jonathan Massey at Syracuse University's School of Architecture. Findings from this manuscript were delivered in the presentation "All. Plastics. In. Building.," at the spring 2011 symposium *Permanent Change* organized by Michael Bell and held at Columbia University's Graduate School of Architecture, Planning and Preservation. This presentation was subsequently formatted into the essay "All-Plastics (-in-Building)," and published in *Permanent Change: Plastics in Architecture and Engineering*, edited by Michael Bell and Craig Buckley (New York, NY: Princeton Architectural Press, 2014).

During the writing of this book I became convinced that plastics and the application in architecture was an inert proposition. Nowhere could I find a more effectual, yet problem-causing material, one capable of exciting much interest and debate simultaneously, yet willing to remain explicitly unnamed. This game of material "20 questions" that plastics are so prone to excite at times astounded, taxed, and overwhelmed.

In light of my admitted struggle, bordering on obsession with sleuthing why we use plastics the way that we do, and the fits and starts associated with many of these historical materials, I thank Jim and Calliope for your encouragement to do good work and to be patient. Finally, I dedicate this work to Julia, Bill, Ellen, Lynne, Holly, Jim, Lucas, and Calliope.

PROLOGUE

HOW SHOULD WE USE PLASTICS?

> The macromolecular compounds include the most important substances occurring in nature such as proteins, enzymes, the nucleic acids, besides the polysaccharides such as cellulose, starch and pectins, as well as rubber and lastly the large number of new, fully synthetic plastics and artificial fibers. Macromolecular chemistry is very important both for technology and for biology … In light of this new knowledge of macromolecular chemistry, the wonder of Life in its chemical aspect is revealed in the astounding abundance and masterly macromolecular architecture of living matter.[1]
>
> (Hermann Staudinger
> Chemist)

Plastics are defined by their complexity. They are products to be accounted for and processes to be described: a phenomena. Their sheer number and proliferation justifies the proclamation of a material ecosystem fully formed in a short 100 years.

Plastics' descriptive chatter is sometimes barely comprehensible, but offers certainty – the melting temperature of polycarbonate, additives for stability in ultraviolet light, and coefficients portending thermal expansion. But plastics' play is altogether different; in our minds it promises (tacit) knowing, comprehensibly worked out by the working of material in tune and step – moldable – "plastics" is synonymous with "plasticity." Plastics were never so easy to work with, never so easy to specify, never intended for architecture's physical and formal largeness – never so easy, but oh so alluring.

In the beginning, plastics' thermal transformation and mass manipulation was best understood, best controlled at the scale of the button, the hair comb, the snuffbox, the small and ornamental things. "How should we use plastics?" – a question with its origins in the profession of chemistry. Hermann Staudinger's persistence in describing the attributes and functionality of a macromolecular terrain in 1920 would only – could only – end with one word: application.[2] "How should we use plastics?!" – a question posed but unanswered by readers of *Modern Plastics* in 1926. "What we wanted, and are still looking for, is a really NEW use for the various plastic materials used in industry."[3] Momentary disappointment prevailed; not one idea merited a prize. The same comb, the same snuffbox, the same small things were suggested. "Plastics" or phenols were 15 years old; backer rod, rug underlayment, and skylights were just out of imagination's reach, along with the "all-plastic house." "How should we use plastics?" – an equally tired and boring question. Industry answered with "By the pound!"[4] Yet, multiple professions and popular culture claimed plastics, all rife with form, fashion, and function.

Who answered this question for architecture? And how was it answered?

NOTES

1 Hermann Staudinger. "Macromolecular Chemistry," in *Nobel Lectures, Chemistry 1942–1962* (Amsterdam: Elsevier Publishing Company, 1964), 397.

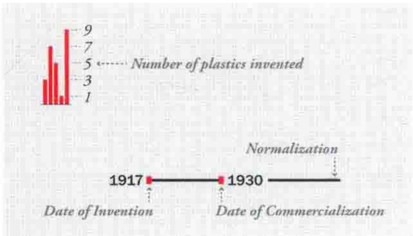
2 In the 1920s Hermann Staudinger hypothesized the existence and established the study of very large, long molecules with high molecular weight – cellulose, rubber, starch, sugars, those naturally occurring and those synthetically made. These are polymers. While working these types of materials began long before with others, Staudinger persisted in describing the attributes of such molecules, arguing that they were a class unto themselves and setting them apart from other molecular arrangements. He then dedicated his life's work to describing the attributes of "macromolecules." In 1953 he would receive a Nobel Prize for his work in the field. See his Nobel Lecture recounting this work delivered on December 11, 1953, titled "Macromolecular Chemistry."

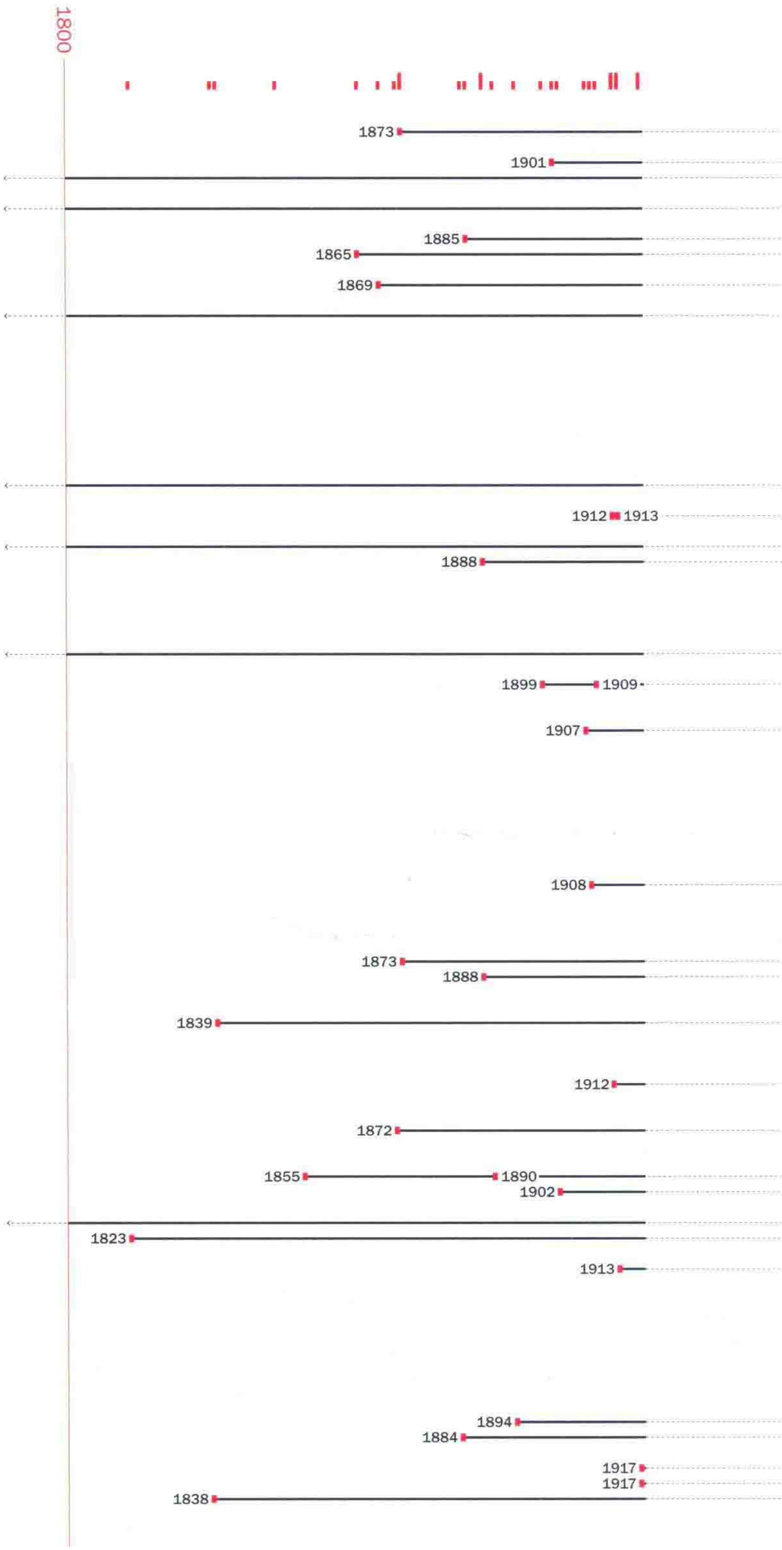
3 *Modern Plastics*. 1926. "Ideas! Ideas!" 349.

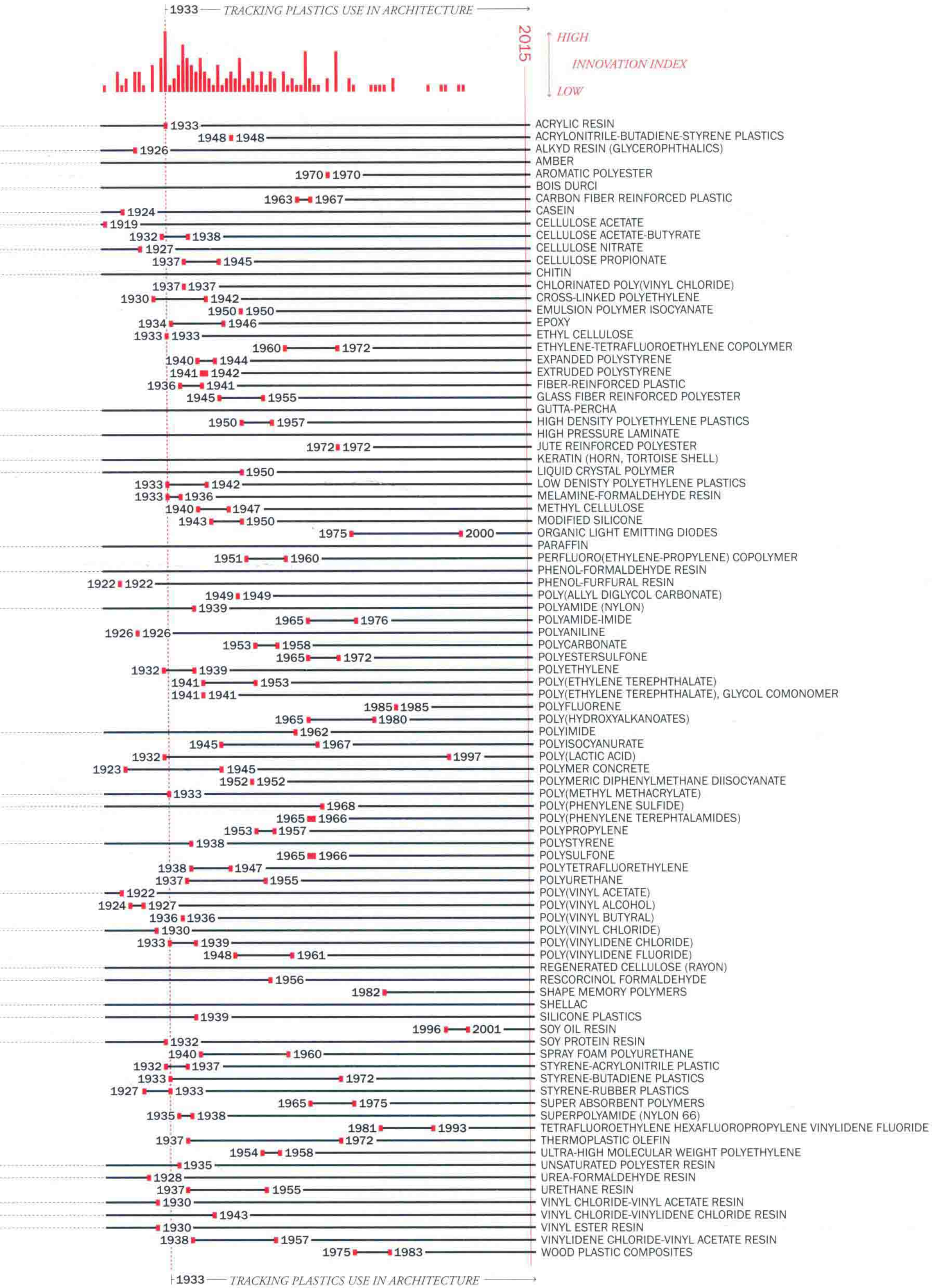
4 Bruce Martin of *Architectural Review* likewise asked this question in the article titled "How Should We Use Plastics?" – a review of the first "all-plastics" house. See *Architectural Review*. 1956.

The emergence of plastics in architecture

Ninety-plus polymers listed by name and their phenomenal emergence over time. The first tick notes year of discovery (by accident or by intentional search), and the second notes year of commercial availability. Is 90 an important number? Not necessarily. There are hundreds if not thousands of polymers. Yet, these 90 plus have been "found" affiliated with architectural production as early as 1933 through direct mention in architectural journals, or direct use in prototypical experiments. Though synthetic polymers or "plastics" dominate, this list is inclusive of some naturally occurring ones such as keratin, and some recently emerged "smart" or "multifunctional" ones such as shape memory polymers. In aggregate this list suggests our implicit comprehension – materials in general and plastics specifically require much working as they continuously emerge.






1933 TRACKING PLASTICS USE IN ARCHITECTURE
2015
HIGH
INNOVATION INDEX
LOW
1933 ACRYLIC RESIN
1948 1948 ACRYLONITRILE-BUTADIENE-STYRENE PLASTICS
1926 ALKYD RESIN (GLYCEROPHTHALICS)
AMBER
1970 1970 AROMATIC POLYESTER
BOIS DURCI
1963 1967 CARBON FIBER REINFORCED PLASTIC
1924 CASEIN
1919 CELLULOSE ACETATE
1932 1938 CELLULOSE ACETATE-BUTYRATE
1927 CELLULOSE NITRATE
1937 1945 CELLULOSE PROPIONATE
CHITIN
1937 1937 CHLORINATED POLY(VINYL CHLORIDE)
1930 1942 CROSS-LINKED POLYETHYLENE
1950 1950 EMULSION POLYMER ISOCYANATE
1934 1946 EPOXY
1933 1933 ETHYL CELLULOSE
1960 1972 ETHYLENE-TETRAFLUOROETHYLENE COPOLYMER
1940 1944 EXPANDED POLYSTYRENE
1941 1942 EXTRUDED POLYSTYRENE
1936 1941 FIBER-REINFORCED PLASTIC
1945 1955 GLASS FIBER REINFORCED POLYESTER
GUTTA-PERCHA
1950 1957 HIGH DENSITY POLYETHYLENE PLASTICS
HIGH PRESSURE LAMINATE
1972 1972 JUTE REINFORCED POLYESTER
KERATIN (HORN, TORTOISE SHELL)
1950 LIQUID CRYSTAL POLYMER
1933 1942 LOW DENISTY POLYETHYLENE PLASTICS
1933 1936 MELAMINE-FORMALDEHYDE RESIN
1940 1947 METHYL CELLULOSE
1943 1950 MODIFIED SILICONE
1975 2000 ORGANIC LIGHT EMITTING DIODES
PARAFFIN
1951 1960 PERFLUORO(ETHYLENE-PROPYLENE) COPOLYMER
PHENOL-FORMALDEHYDE RESIN
1922 1922 PHENOL-FURFURAL RESIN
1949 1949 POLY(ALLYL DIGLYCOL CARBONATE)
1939 POLYAMIDE (NYLON)
1965 1976 POLYAMIDE-IMIDE
1926 1926 POLYANILINE
1953 1958 POLYCARBONATE
1965 1972 POLYESTERSULFONE
1932 1939 POLYETHYLENE
1941 1953 POLY(ETHYLENE TEREPHTHALATE)
1941 1941 POLY(ETHYLENE TEREPHTHALATE), GLYCOL COMONOMER
1985 1985 POLYFLUORENE
1965 1980 POLY(HYDROXYALKANOATES)
1962 POLYIMIDE
1945 1967 POLYISOCYANURATE
1932 1997 POLY(LACTIC ACID)
1923 1945 POLYMER CONCRETE
1952 1952 POLYMERIC DIPHENYLMETHANE DIISOCYANATE
1933 POLY(METHYL METHACRYLATE)
1968 POLY(PHENYLENE SULFIDE)
1965 1966 POLY(PHENYLENE TEREPHTALAMIDES)
1953 1957 POLYPROPYLENE
1938 POLYSTYRENE
1965 1966 POLYSULFONE
1938 1947 POLYTETRAFLUOROETHYLENE
1937 1955 POLYURETHANE
1922 POLY(VINYL ACETATE)
1924 1927 POLY(VINYL ALCOHOL)
1936 1936 POLY(VINYL BUTYRAL)
1930 POLY(VINYL CHLORIDE)
1933 1939 POLY(VINYLIDENE CHLORIDE)
1948 1961 POLY(VINYLIDENE FLUORIDE)
REGENERATED CELLULOSE (RAYON)
1956 RESCORCINOL FORMALDEHYDE
1982 SHAPE MEMORY POLYMERS
SHELLAC
1939 SILICONE PLASTICS
1996 2001 SOY OIL RESIN
1932 SOY PROTEIN RESIN
1940 1960 SPRAY FOAM POLYURETHANE
1932 1937 STYRENE-ACRYLONITRILE PLASTIC
1933 1972 STYRENE-BUTADIENE PLASTICS
1927 1933 STYRENE-RUBBER PLASTICS
1965 1975 SUPER ABSORBENT POLYMERS
1935 1938 SUPERPOLYAMIDE (NYLON 66)
1981 1993 TETRAFLUOROETHYLENE HEXAFLUOROPROPYLENE VINYLIDENE FLUORIDE
1937 1972 THERMOPLASTIC OLEFIN
1954 1958 ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE
1935 UNSATURATED POLYESTER RESIN
1928 UREA-FORMALDEHYDE RESIN
1937 1955 URETHANE RESIN
1930 VINYL CHLORIDE-VINYL ACETATE RESIN
1943 VINYL CHLORIDE-VINYLIDENE CHLORIDE RESIN
1930 VINYL ESTER RESIN
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1975 1983 WOOD PLASTIC COMPOSITES
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WRESTLING WITH THE EMERGENCE OF PLASTICS