PIONEER PLASTIC

The Making and Selling of Celluloid

Robert Friedel

THE UNIVERSITY OF WISCONSIN PRESS

Published 1983

The University of Wisconsin Press
114 North Murray Street
Madison, Wisconsin 53715

The University of Wisconsin Press, Ltd.
1 Gower Street
London WC1E 6HA, England

First printing

Printed in the United States of America

For LC CIP information see the colophon

ISBN 0-299-09170-8

List of Figures

List of Tables

Acknowledgments

THE STUDY of history is a series of intellectual adventures, and so it seems fitting that I begin these acknowledgments with thanks to those who were most responsible for leading me into these adventures, even if they had little direct hand in this particular one: A. Hunter Dupree, A. Rupert and Marie Boas Hall, Jonathan Hughes, Eric Jones, and all my colleagues at the John Hopkins University.

All of the individuals and institutions that assisted in the completion of this work are too numerous to name, but it would be unthinkable not to acknowledge and give thanks to at least some of them. For their encouragment and good advice at crucial stages in this work, I must thank J. Harry DuBois, Reese V. Jenkins, Morris Kaufman, and Jeffrey L. Meikle. Valuable help was rendered by Mary Ann Bury and Harriet Raymond Stemmler of the Celanese Corporation and Helen Login of the Free Public Library, Millburn, New Jersey. The staffs of the Columbia University Library, the Eleutherian Mills Historical Library, and the Legal Records Division of the Washington National Records Center of the National Archives have given courteous and efficient assistance, often with a measure of added enthusiasm well beyond the call of duty.

Most of the research and writing of this work was completed while I was a Research Fellow at the National Museum of History and Technology (now National Museum of American History), Smithsonian Institution. The adventure recorded here would have been a far less exciting and satisfying one without the people and resources of one of the world's most wonderful museums. One of the great joys of studying the history of the first plastics was the opportunity that it gave for exploring the resources in half-a-dozen of the museum's divisions. My heartfelt thanks for patience and good humor as well as generously extended expertise go to the staffs of the following curatorial divisions of the Museum of History and Technology: Costume and Furnishings, Electricity and

Modern Physics, Medical Sciences, Photographic History, Preindustrial Cultural History, and Musical Instruments. Special thanks go to my host division, Physical Sciences, and its Curator of Chemistry, Jon Eklund, who steered me in the direction of celluloid in the first place. Other units of the museum, notably the History and Technology Branch Library and the Warshaw Collection of Business Americana, provided indispensable assistance along the way. Of the numerous individuals at the museum whose assistance went beyond their ordinary obligations, I would like to give special thanks to George Norton, Joanna Kofron, Margaret Sone, Susan Frey, and Robert Multhauf.

For his steadfast encouragement and friendship, in this as well as other enterprises, I thank William Coleman, of the University of Wisconsin-Madison. My gratitude is also extended to the Institute of Electrical and Electronics Engineers, my current employers, for their sympathetic understanding of the demands of scholarship, and to the University of Wisconsin Press, its editorial staff and its readers, for their expert guidance and wise judgment, as well as their patience. Finally, the last thanks — but far from the least — go to my wife, Toby Appel, for her ever faithful help, criticism, and encouragement.

Introduction

A Material and Its Meaning

PLASTICS. The very word conjures up images in the mind that are both complex and evocative. As a derogatory term, "plastics" refers to those parts of our culture that are cheap, disposable, and undependable. In the realm of style, the word is associated with design that emphasizes smooth, flowing lines and either bold colors or glasslike transparency. Despite representing an enormously varied class of materials, "plastics" commonly evokes expectations of behavior within a fairly narrow range, including lightness, color-fastness, moisture-resistance, and flexibility. Above all, perhaps, "plastics" carries the meaning of "unnatural"—the epitome of the artificial or synthetic, whether applied literally to the materials of which things are made or figuratively to the artifacts or activities of our culture. Certainly few other substances carry with them the kind of symbolic meanings that are associated with plastics.

The sources of these meanings lie in part in everyday experience. If plastics did not actually behave in ways consistent with our feelings about the material or if they were not often used for the purposes that we commonly associate with them, even the most firmly entrenched images would not be long sustained in the popular mind. The fact is that eating implements or containers made of plastic *are* usually cheap and disposable; furnishings *are* often brightly colored with smooth lines and finishes; objects *are* made waterproof or mar-resistant by housing them in plastic. Nonetheless, it is obvious that there is more at work here than simply the observations of everyday experience. Other materials behave in predictable and ordinary ways that people are generally familiar with, and yet they do not carry with them such a host of associations and values. Only the precious metals, particularly gold, have acquired similar symbolic baggage, but their associations, deeply rooted in culture and language, are less ambiguous and are the products of several millennia of use and experience. The plastics, on the other hand, have been with us for little more than a century, and their widespread technical and economic importance is an exclusively twentieth-century phenomenon.

Despite their relatively brief history, plastics do owe their cultural status to their past. The origins of modern plastics are clear and easily delineated, for in the middle of the nineteenth century, the experiments and dabblings of a number of individuals resulted in the material we know as celluloid, whose properties and applications turned out to be unlike those of any earlier substance. The processes of inventing celluloid and then of making it into a technically and commercially useful material took several decades, and in that period emerged the associations and images that are now attached to the whole complex class of plastics—most of which are far different chemically and physically from celluloid. Celluloid thus ushered in the plastics age culturally as well as technically.

The revolutionary nature of celluloid is apparent only from the hindsight of a century of subsequent plastics technology. When it first appeared in the 1860s, it was greeted simply as one of a myriad of "useful additions to the arts" which nineteenth-century men had already come to expect in the normal course of things. Certainly celluloid was not seen in the same light as the triumphs of the age, such as the telegraph, the steam locomotive, or Bessemer steel. This was in part due to the fact that the processes for making celluloid were unspectacular adaptations of old methods of mixing and forming natural substances. It was also due to the applications of the material, which more often than not diminished celluloid's distinctiveness rather than called attention to it. Contributing not least to the quietness of plastics' debut was the simple fact that celluloid was always a relatively minor material in the scheme of things. At a time when industrialization had brought forth the capacity and the demand for producing materials such as iron, glass, or cotton in the millions of tons, celluloid output never exceeded some hundreds of tons. Only after it had been made and sold for two decades did uses for celluloid emerge that were dependent on the material; hence, its impact on other technologies or products was undramatic. As a result both of its appearance and its application, celluloid did not call attention to itself.

None of this detracts from the fact that celluloid did represent an innovation of great significance for the future. As the first material with the properties that we associate with plastics and yet manufactured entirely from nonplastic sources, celluloid was the forerunner of an enormous and important class of artificial substances. It was also one of the host of new materials that emerged as part of the dynamism of nineteenth-century technology. Perhaps the best known of these innovations were mild steel and vulcanized rubber, but more novel materials also appeared in the course of the century, and it is they that signified most for the technology of our own times. The new metals, such as aluminum or magnesium, and the plastics represented an expansion of material capabilities every bit as

important as the expansion of energy capabilities represented by the steam engine in the eighteenth century. Just as the growing use of steam power and the widespread application of iron were the hallmarks of the Industrial Revolution and the technological mode that Patrick Geddes termed "paleotechnic," so were the lighter new materials, along with the new energy technologies of electricity and internal combustion, at the heart of the creation of a "neotechnics" in the twentieth century. The plastics, still so strongly associated with novelty and modernity, are a somewhat neglected but key element in the creation of a neotechnic culture.

A look at the invention and exploitation of celluloid not only provides a better glimpse of the roots of twentieth-century technology, but it also presents special opportunities for understanding the nature of the technological dynamism that has propelled us through almost two centuries of revolutionary change. The creation of new materials raises important questions concerning the motivations for inventions, the means by which they are perfected, and the processes by which they are integrated into our culture. New machines tend to be obvious improvements in older ways of doing things; new materials, on the other hand, are often not obvious improvements in anything. They present novel combinations of properties whose functions may be quite unknown at first. Nonetheless, uncertainty about technical or economic value did not deter the development of new materials in the nineteenth century. Clearly, the creation of these materials put extraordinary pressures upon inventors and entrepreneurs to find important applications and secure markets in an environment that was only beginning to adjust to novelty as part of the expected order of things. The kind of responses evoked by these pressures gives us a clearer picture of the sources and consequences of technological innovation in the late nineteenth century.

This study is, therefore, to an extent a case history of technological innovation, after the manner of such well-known efforts as Donald Cardwell's study of the steam engine or Hugh Aitken's work on radio. No general model for technological change is proposed here, for the experience of celluloid is simply too narrow a base on which to build any kind of theoretical structure. Still, so basic are the issues involved in celluloid's early history that it is reasonable to suggest that conclusions reached here are relevant to anyone trying to reach a broader understanding of how new technologies emerge and how they are integrated into their economic and social milieu. The question that stirs Aitken, for example —how new things happen—is the question asked here too, but it is well to remind ourselves from the outset that the novelty and the creativity that are part of the introduction of a new technology are to be found not only

in invention—the refinement of technical elements—but are also inherent in the adoption and exploitation of the technology. The story of celluloid brings this point home with special clarity, as we might expect in the case of a material so versatile and so novel.

This study is also an effort to remedy some of the past neglect of the early plastics by historians of technology. The emergence of new materials in the late nineteenth century has not been one of the classic subjects for historians' attention. This therefore leaves considerable room for simply providing a clearer picture of celluloid's invention and subsequent technical history. The creation of a useful plastic material from nitrated cellulose was not the achievement of a single man or a specific period of activity. The attempt began with the first successful production of nitrocellulose by a Swiss chemist and was not concluded until the inventions of an American printer more than twenty years later. Owing to the extended period and the multiplicity of independent efforts, the course of celluloid's invention is not a simple one to trace. But if the complications of celluloid's invention engender some confusion and uncertainty, they also provide valuable opportunities. The history of celluloid presents particularly clear examples of the problems, technical and otherwise, that must be confronted in creating a new material. The definition of celluloid—simply determining what it could and should be—was a difficult process, throwing light on the problem of defining any technology. The technical dimensions of this process were crucial; hence, due attention must be paid to the events of the invention itself.

The most significant issues in the history of celluloid, however, arise in the story of its application and impact. This story can be followed only against the background of the technological context in which celluloid was introduced. This context consisted most especially of those materials already in use in the mid-nineteenth century which had the properties of plastics. These "natural plastics" were relatively new, but by the time that work on nitrocellulose plastics began to make progress in the 1850s and 1860s, they were in widespread use. Their properties and the manner in which they were worked set the stage for the acceptance and the use of an artificial plastic. They did not, however, create the demand for such an invention. To the extent that such a demand preceded the invention of celluloid, it stemmed from experience with more precious, traditional substances, especially with ivory. The relationship between the introduction of celluloid and the status of these antecedent substances had an impact not only on the invention of the new material but also on the manner in which it was perceived and applied.

The search for applications for celluloid was actually a search for markets. It was clearly not enough to demonstrate that the new material

could be used for various things. It was necessary to show that there were things for which it ought to be used. This effort included appeals to aesthetics, fashion, economics, and practicality. Celluloid met with many failures before securing stable and long-lasting markets. These failures are as instructive as the eventual successes, highlighting the uncertainty of celluloid's makers as to the proper images and functions of their product. The paths by which these images and functions were finally determined shed considerable light on the relations between perceptions of a new technology and real technical and economic needs. Eventually celluloid won a place for itself in a number of popular applications. The new technology established itself in traditional industries, sometimes with profound impact on these industries and the communities dependent upon them. The establishment of celluloid as a viable commodity reveals a great deal about the nineteenth-century response to new technologies, as well as about the accommodations made by inventors and entrepreneurs to the technological and economic environment around them.

During the twentieth century celluloid declined in importance. This decline was due largely to celluloid's replacement by newer plastics. Indeed, perhaps the most important result of celluloid's success was the fostering of the development of these more modern materials. By both its usefulness and its deficiencies, celluloid provided a model for the possible applications of plastics and for qualities to be sought and to be avoided in newly created materials. While celluloid was never the only useful plastic, it represented more than any other material the *idea* of plastics. The flourishing of this idea in the twentieth century was celluloid's most significant legacy.

It is not, however, the only legacy with which we live. The experiences of celluloid, caused by the nature of the material and of the markets into which it was introduced, have directly determined the social and cultural status of plastics in the twentieth century. Most especially, our association of plastics with the unnatural, the artificial, and the imitative can be clearly traced to celluloid. The way we think about our technologies determines how we use them and how we perceive their impact on us. Only when we begin to understand why we think about technologies the way we do can we hope to control them.

Contents

PIONEER PLASTIC

1

The Invention of Celluloid

THE INVENTION of celluloid was, like most inventions, a technical, economic, and social activity. At its foundation, however, it was a chemical activity, and therefore the understanding of the invention must begin with chemistry. To the twentieth-century chemist, celluloid is a solid solution of nitrocellulose and camphor.* Other materials were made throughout the last part of the nineteenth century and into the twentieth that were liquid solutions of nitrocellulose, solid compounds of nitrocellulose that lacked camphor, or cellulose plastics that were not nitrated. Only celluloid—and plastics called by other names because of trademark restrictions but otherwise identical—met all the qualifications of this definition. And it will be seen that the properties associated with these qualifications were of central importance to the technological and commercial role of the material.

"A Little Chemical Discovery"—Nitrocellulose

The essential source of celluloid was nitrocellulose. It was not until almost fifty years after the discovery of nitrocellulose that another soluble compound of cellulose (cellulose acetate) was manufactured. During this period (1845–1894) the properties of nitrocellulose were the subject of endless experiments and inventions. The two key properties of the material were explosibility and solubility. While these properties coexist in all forms of nitrocellulose, they predominate to different degrees depending on the extent to which the cellulose is nitrated. Highly nitrated cellulose is very explosive and, in the most nitrated forms, is largely insoluble in the ether-alcohol mixture that is the most important nitrocellulose solvent. Moderately nitrated cellulose, on the other hand, is

*In this work, the term *nitrocellulose* is used to refer to any form of nitrated cellulose, and no distinction is made between *nitrocellulose* and the more modern terminology *cellulose nitrate.*