Book Reviews

Polymers and Patents

The Chain Straighteners. Fruitful Innovation: The Discovery of Linear and Stereoregular Synthetic Polymers. FRANK M. MCMILLAN. Macmillan, London, 1981. xx, 208 pp. £17.

In the 1950's Frank M. McMillan worked in what he calls the "golden age" of polymer research. Following Karl Ziegler's discovery of a catalyst that produces very long but unbranched polyethylene molecules, widespread research between 1953 and 1955 led to new nsights into the three-dimensional structure of polymers and to the discovery of new substances, such as polypropylene. McMillan's narrative, based primarily on interviews and correspondence with the people involved, focuses on this two-year burst of activity. A former polymer research and business development manager for Shell Development Company, McMillan is very familiar with the events he recounts.

Karl Ziegler's path to fame, fortune, and a Nobel prize began when he became director of the Max Planck Institute for Coal Research in 1943. Though not interested in coal research, Ziegler commanded a contract guaranteeing him autonomy in directing research and granting him rights to inventions that fell outside the interests of the sponsoring coal companies. After the war ended, Ziegler discovered that an organometallic compound, aluminum triethyl, linked ethylene molecules together into short unbranched chains. Previously, polymerized by high pressure, polyethylene exhibited chain branching. After Ziegler patented and publicized his discovery, several companies licensed the new catalyst. No important innovations followed immediately.

In 1953, an experiment in a reactor contaminated with nickel yielded very long- and straight-chain polyethylene. Additional experiments showed that mixtures of a transition metal and an organometallic compound produced these polymers. While Ziegler concentrated on his catalyst, researchers elsewhere took the next step by making polypropylene. No one pursued it very far, either in deference to Ziegler or in anticipation of his patents for it. Within a few months of the polyethylene discovery, Ziegler prepared polypropylene. Upon filing his patent application, he learned that Giulio Natta had filed one ten days earlier. As a consultant for Montecatini Chemical Company, which had licensed Ziegler's initial catalyst, Natta had kept track of Ziegler's research.

This incident created a rift between the two men who would share a Nobel prize in 1963. Natta's contribution, however, was cited as the determination of the relationship between the highly regular molecular structure and the physical properties of polymers made with Ziegler catalysts.

Since others had prepared polypropylene before Ziegler did, Natta's patent application launched a complex five-way interference suit that lasted 15 years.

McMillan details the activities of various companies, such as Hercules, Exxon, and Phillips Petroleum, in this new area of polymer chemistry and technology. Some of them made independent discoveries, and others depended on Ziegler licenses. Ziegler's catalyst provided the basis for new types of plastics and synthetic rubber with improved properties.

McMillan uses his case study to point out the critical factors that lead to fruitful scientific and technological activity. Since almost all the discoveries were unexpected, he argues that researchers need freedom to pursue interesting results instead of working mechanically toward predetermined goals. Ziegler's discoveries had an immediate impact because the news spread quickly via channels such as the respected polymer chemist and publicist Herman Mark. Upon hearing the news, researchers appreciated its significance. Polymer science and technology had progressed to the point where Ziegler's and Natta's contributions provided answers to pertinent questions. The expansion of polymeric products after World War II kept businessmen amenable to risking capital on new polymer ventures. Thus, flexible research management, effective communication, and proper timing led to rapid innovation.

Although these conclusions seem to be valid, McMillan draws some others that are not well supported by his case study. He notes that since Ziegler's discovery and Natta's work there have been no breakthroughs of the same magnitude. He does not accept the explanation that the major discoveries have already been made. He argues instead that the lack of significant innovation lies in the unwillingness of management, preferring to concentrate on cost-cutting process improvements, to take risks. This may be true, but it is not evident in his study.

At another point, McMillan maintains that Ziegler's lucrative contract reflects faith in non-targeted research even during the difficult circumstances of World War II. Yet he provides no evidence for this assertion. The sponsors of the institute may well have had other reasons for catering to Ziegler's demands.

This book gives an insider's view into the way in which multinational companies learn of new developments and scramble to stake out their claims in the new field. Ziegler's unusual situation aided the rapid diffusion of the technology. This created a competitive situation that led to a great deal of duplicated or wasted effort. The legal battle over polypropylene diverted energy from more productive pursuits. The case of polypropylene stands in marked contrast to other examples of innovation, such as nylon, that are solely the product of one company. Most cases probably lie somewhere between these two.

McMillan has assembled a considerable amount of information that is of interest to the historian of science and technology. This material could have been presented in a more straightforward and concise manner, however.

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The War Against Hookworm

The Germ of Laziness. Rockefeller Philanthropy and Public Health in the New South. JOHN ETTLING. Harvard University Press, Cambridge, Mass., 1981. xiv, 264 pp. $18.50.

Early in this century an estimated 40 percent of the residents of the southern United States suffered from hookworm infection, a malady that often led to iron-deficiency anemia and left its victims looking gaunt and sallow. Because of its enervating effects, journalists sometimes called it the "germ of laziness" and, especially in the North, identified it as the cause of the South's alleged backwardness. The offending parasites generally entered the human body through the

feet and exited in the feces; thus control depended as much on preventive measures—the wearing of shoes and the use of well-constructed privies—as on curative therapy, an inexpensive form of which had become available in the 1880's.

In 1909 John D. Rockefeller and his advisers created a Sanitary Commission for the Eradication of Hookworm Disease and endowed it with one million dollars. During its five-year history the Commission failed to eliminate hookworm infection in the South, but it nevertheless succeeded in alerting the region to the hookworm problem, in treating nearly 700,000 infected persons, and in infusing vitality into the public-health movement in the South. By the 1930's, thanks in large part to the efforts of the Commission, the incidence of hookworm in the South had declined by two-thirds.

In this splendidly written book, which has already won the Allan Nevins Prize of the Society of American Historians, John Ettling draws on the rich (and recently opened) records of the Rockefeller Sanitary Commission to tell the story of the war against the hookworm. The first half of his book sets the stage for the Commission by focusing on the careers of two men: Charles Wardell Stiles, a government parasitologist, described as "the John the Baptist of the hookworm work" (p. 111), who labored for years to convince skeptical southerners of the dangers of hookworm infection; and Frederick T. Gates, a former Baptist minister who climbed to the top of the Rockefeller philanthropic empire and who played a pivotal role in its anti-hookworm campaign. The second half of the book is devoted to the medical and educational activities of the Sanitary Commission, headed by Wickliffe Rose, dean of George Peabody College in Nashville. Although administered and staffed by southerners, the Commission initially encountered stiff opposition, in part because of Rockefeller's unsavory reputation. According to one of the Commission's investigators, some southerners thought that "Mr. Rockefeller was preparing to go into the shoe business and had financed the hookworm campaign as a preliminary move to scare the people of the South into wearing shoes at all times and not in the winter season alone" (p. 130). By the end of its brief life, however, the Commission had won over all but its most jaundiced critics.

In a much-discussed book entitled *Rockefeller Medicine Men* E. Richard Brown has recently argued that the Rockefellers and Gates sponsored the anti-hookworm crusade primarily because of their interest in increasing the productivity of southern workers (even though they owned no southern mills). Without denying the possible influence of economic motives, Ettling stresses instead the religious roots of the Sanitary Commission. He not only likens the county hookworm dispensaries to southern tent revivals and describes hookworm as the medical equivalent of sin but maintains that Gates and his associates tried to exterminate the hookworm for basically religious reasons. "One of the important things that a study of the Sanitary Commission demonstrates," he says, "is that their instincts were overwhelmingly religious—specifically evangelical" (p. 223). Although I find Ettling's interpretation far more persuasive and better documented than Brown's, it is only fair to note that his case for the evangelical origins of the Sanitary Commission rests disproportionately on the testimony of one person, Gates, and that his evidence, drawn "from the oftentimes unconscious attitudes and assumptions expressed in the memoirs and correspondence of the Foundation's architects" (p. 223), may be less coercive than he implies.

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Nineteenth-Century Shifts

Epistemological and Social Problems of the Sciences in the Early Nineteenth Century. Papers from a conference, Bielefeld, Germany, Nov. 1979. H. N. JAHNKE and M. OTTE, Eds. Reidel, Boston, 1981 (distributor, Kluwer Boston, Hingham, Mass.). xlii, 430 pp. $31.50.

This volume contains papers presented at a workshop held under the auspices of the University of Bielefeld's Institut für Didaktik der Mathematik. The title is both narrower and wider than the content: most of the book is about Prussian institutions or about mathematics, and a few contributions have no redeeming social (or epistemological) value.

The editors have arranged the papers under three heads: Science around 1800: Cognitive and Social Change; Science and Education; and Mathematics in the Early 19th Century. Many of the papers in the first part, and the editors' introduction, either have too much jargon and abstraction to be easily interpretable, or, like the essays by S. R. Mikulinsky and B. M. Kedrov on Russian and European science, are too general to relate directly to the declared theme of the workshop. An exception is Steven Turner's brief statement of a thesis he has worked out elsewhere: in Prussia the basis of learning and reputation for learning shifted from professional training (of doctors, lawyers, and ministers) in the late 18th century to the Wissenschaften of the arts faculty and the passing of required examinations in the middle of the 19th. The shift brought an emphasis on professorial research and the modern conception of the privileges and duties of a university instructor. Another exception is M. Heidelberger's claim that in practice little but rhetoric separated Naturphilosophen from straighter physicists around 1820 and that both were confounded and superseded by the methods of French mathematical physics, as represented in Germany by G. S. Ohm. Heidelberger's observation is a useful corrective to the usual exaggeration of the distance between the two sets of physicists.

There are several valuable papers on the social circumstances of mathematics and allied studies: D. K. Müller on effects of Prussian school reforms around 1800; B. Rang-Dudzik on curricular changes in Prussian grammar schools; W. Langsheimer on the organization of mathematics at the University of Halle-Wittenberg; G. Schubring on the frustrated plans for a polytechnic in Berlin, 1817–1850; and H. Mehrtens on the backgrounds of German mathematicians in the Napoleonic era. All, and Langsheimer and Rang-Dudzik especially, stress slips between theory and practice, between reform measures and their effects, between perceptions of innovators and of conservatives. The delusion of one reformer, that every human being "who is not completely demoralized by nature" likes mathematics, does not appear to exist in our enlightened age. Several matters are treated quantitatively, for example, the slow move from the 18th-century secondary school, which gave students considerable latitude in determining their programs, to the mid-19th-century gymnasium, which offered a fixed curriculum (Rang-Dudzik); and the changing emphasis on mathematics in the latter dispensation, from one hour to every four of classical languages between 1825 and 1840, to 1:2.3 in the '40's and 1:4.9 in the '50's (Schubring).

A favorite theme in the mathematics papers is the cause of concern with mathematical rigor around 1800. J. Grabiner thinks that increased teaching obligations forced mathematicians to worry about logical coherence; W. Schorlau argues that perception of previously unobserved connections between different