



BOOKS: ECONOMICS AND TECHNOLOGY

Innovative History of the Chemical Industry

Christopher Freeman

The authors of this heavyweight book on the history of the chemical industry set themselves an extremely ambitious and challenging task. They not only attempt to cover the history of the chemical industry in four countries (the United States, Germany, Japan, and Britain) over two centuries, but they also attempt to describe the legal and political framework within which the industry has evolved, as well as the influence of finance on corporate structure.

The 17 contributors include chemists, chemical engineers, business leaders, economists, and historians. The three editors wrote or contributed to 8 of the 15 chapters, including the introduction and the conclusions. Their chapters provide some degree of integration, although the volume nevertheless suffers from the usual problems of multi-authored books. The introduction is followed by three excellent "country overviews" and three fascinating chapters on technological innovations. The next seven chapters cover a range of topics including monetary and trade policies, industry structure, corporate strategy, regulation, and the context of general public policy in the four countries. They are very uneven in quality and do not successfully survey the "matrix of the sources of comparative advantage" mentioned by the editors.

In the book's preface, Ralph Landau describes his distinguished career as an entrepreneur and innovator in the postwar chemical industry. The company he founded, Halcon-Scientific Design, developed nine major chemical processes and built over 300 plants worldwide. Since his retirement, Landau has studied the chemical industry in collaboration with Nathan Rosenberg and other academic colleagues, at Stanford University and elsewhere. He became convinced that a book combining real-world experience and academic inquiry could be of great value, and, broadly speaking, this book justifies that belief. Landau's chapter on the process of innovation is of outstanding interest for the two case studies it presents: the major break-

throughs of polyester and polypropylene fibers and plastics. Such case studies are essential for any satisfactory understand-

ing of how the chemical industry has evolved, and it is a pity that more were not included. In particular, they justify the view that a continuing succession of technical innovations has been at the heart of the industry's impressive long-term growth. Even so, this book demonstrates why the relative performance of the chemical industry in these four countries in different historical periods can be explained in large measure by the clusters of innovations that firms in the countries were

able to introduce.

Since J. H. Beer's classic study of the German dyestuffs industry appeared in the 1950s, the role of innovation in Germany's

Chemicals and Long-Term Economic Growth

Insights from the Chemical Industry
Ashish Arora, Ralph Landau and Nathan Rosenberg, Eds.

Wiley-Interscience, New York, and Chemical Heritage Foundation, 1998. 576 pp. \$69.95. ISBN 0-471-18247-8.



Reaction sites. The Dow Chemical Company plant at Midland, Michigan.

overtaking the British chemical industry between the 1870s and 1914 has seldom been contested. Murmann and Landau's chapter nevertheless brings additional insights into this story of the German industry, especially with respect to marketing. Less well known is what Arora and Rosenberg describe as the success story of the U.S. chemical industry in the period after World War II. The shift in the basic feedstock (the starting material for organic chemistry) from coal to oil certainly facilitated this success, but as this chapter and Rosenberg's convincingly show, the re-

source endowment of the United States was less important than the capability of U.S. chemical engineering firms in the design and development of new processes and in the "scaling up" of chemical plants. "Specialist engineering firms" that provide process-design and engineering construction services (including Landau's own firm) were and remain a major source of strength for the U.S. oil and chemical companies. Their success may be attributed, in turn, to the early development of the chemical engineering profession and the teaching of chemical engineering in American universities. Rosenberg's chapter shows him at his best as a historian; he analyzes the role of university-industry relations in the origins and growth of this profession in the United States and contrasts it with the very different course of development in Germany.

Hikino *et al.* describe the growth of the Japanese chemical industry as a puzzle in that "the industry basically remains invisible on the international economic scene." Whereas such industries as electronics, robotics, and automobiles were universally acclaimed for their global success, and names like Sony and Toyota are household words, even many Japanese cannot name the leading firms in Japan's chemical industry. The chapter's four Japanese authors do not quite resolve the puzzle either, despite their extensive experience and the input from other scholars. The answer is not that the industry has lacked very rapid growth, at least until the 1990s. Nor is it simply attributable to a dearth of technical innovations. Although Japanese firms are not so strongly represented among the technological leaders as U.S. or German firms, by 1990 they were taking out twice as many U.S. patents as German firms. To a considerable extent, the problem seems to have been a structural one that led

to general overcapacity in the industry. Each major group wished to participate in each product market and to build its own plants. So long as the Japanese and world economies were growing fast, this approach enabled the industry to also grow very rapidly. But once overall growth slowed in the 1970s, the groups were reluctant to rationalize and specialize or to engage in the kind of restructuring that took place in the European and American industries.

These problems of structural change are discussed further in chapters by Arora and Gambardella (on the changing struc-

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ture of the entire chemical industry in the four countries) and by Chandler *et al.* (focusing on the leading companies). These are the best of the six chapters in the "levels of the matrix" section of the book, and Arora and Gambardella provide a particularly good account of the extensive process of rationalization in the European and American industries in the 1970s and 1980s. They offer an especially interesting table of trends in acquisitions in the chemical sector, illustrating the very small number of acquisitions by Japanese firms compared with the far larger number by their European and American competitors.

The failure to discuss the work of Gary Hufbauer on synthetic materials is regrettable. Not only did Hufbauer publish one of the most original comparisons of the innovative performance of the companies and countries included in this book, he also developed an explanation of "imitation lags" that was an important contribution to theories of international trade and company performance. He demonstrated that the leading innovators in synthetic materials were also the fastest imitators—a result highly relevant to the discussion in this book and especially to the longevity of the leading chemical firms and the industries in the four countries surveyed.

Another shortcoming is the relative neglect of the work of Achilladelis—most notably his study of insecticides, but also his analysis of corporate traditions and research specialization in several subsectors of the industry. It is quite understandable that pharmaceuticals were not systematically included, because so much has already been published on this industry and it is impossible to cover all the subsectors, even in a publication of this size. The fortunes of the pharmaceutical industry have been so closely linked to the chemical industry, however, that it is a pity these connections did not receive more consideration.

Horstmeyer's chapter attempts to provide an abbreviated, broad brush review of the "social, political and public policy context" in which the industry evolved in the four countries. Unfortunately, it does not meet this ambitious objective, even though the editors were undoubtedly right that a full understanding of the history of the chemical industry should include this context. Members of the British Labour Party will be surprised to hear of their "Marxist" legacy and its "peeling off" in 1995 (p. 243), and it is generally difficult to follow the abbreviated summaries of political and social history in each country. "British obtuseness with regard to science and tech-

nology," "British shortsightedness," and "British hostility to applied science and technology" (p. 239) are a bit too abbreviated for a summary of complex British social developments in the second half of the 19th century. While it is true that "enterprising foreigners with ideas and energy" settled in Britain in the 19th century (p. 234), it is certainly not true that Ludwig Mond, who founded his alkali works in 1873, "was probably among the last of this type." Marconi and Ferranti are only two of the best-known entrepreneurs among many who belie this statement. The role of "enterprising foreigners" in British, as in American industry, has continued to be important to this day, and the subject of entrepreneurship in the chemical industry deserves better treatment.

Despite these criticisms, *Chemicals and Long-Term Economic Growth* is a considerable achievement. Although there have been some excellent histories of leading chemical companies, there are relatively few of the entire industry. And Arora and Gambardella are correct in claiming that "the fortunes of the industry as a whole are different from those of individual firms" (p. 410). The book is therefore a landmark that helps to fill a very big gap in industrial history.

BOOKS: ORNITHOLOGY

Rainforest "Crows" in Fancy Dress

The 12-wired bird of paradise (right) belongs to a family of "elaborate crows" that inhabit closed humid forests in and near New Guinea. Many are renowned for the males' bizarre nuptial plumes (so strange that some early ornithologists interpreted specimens as glued-together fakes) and their polygynous courtship displays. Frith and Beehler combine thematic chapters—covering the birds' distributions,

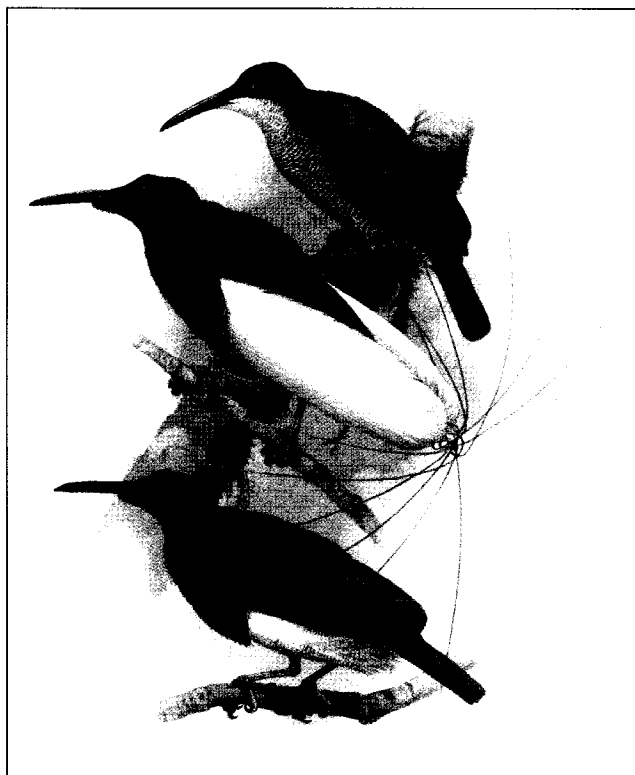
The Birds of Paradise
Paradisaeidae
by Clifford B. Frith and
Bruce M. Beehler

Oxford University Press,
Oxford, 1998. 643 pp.
\$85, £50. ISBN 0-19-
854853-2.

habitats, ecologies (especially diet, foraging, and plant-bird interactions), reproductive behavior, nesting, and parental care—with individual accounts of all 42 species to comprehensively summarize our knowledge of the family. The excellent descriptions and discussions focus on the birds, but Frith and Beehler also review a wide

range of topics to demonstrate the broader significance of the group. These summaries, and the considerations of the extent and context of variation within the family, will profit biologists with interests in questions such as sexual selection, mutualism, and evolutionary radiations. The authors' masterful presentation of information, competing explanations, and unresolved questions should effectively stimulate future researchers and naturalists. When trade skins of birds of paradise, prepared with wings and legs removed, first reached Europe in the 16th century, the birds were presumed to live perpetually floating in air, feeding on dew. Frith and Beehler show that the birds' true lives are much more substantial and interesting.

—SHERMAN J. SUTER



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