his 1701 inaugural address for his appointment as lecturer in medicine at the University of Leiden, reconfirmed the need to return to Hippocrates for the advancement of medical studies in an experimental direction.

The early modern appropriations of Hippocrates lay bare the ideological uses of history. The hermeneutical pliability of the Hippocratic figure made it possible for the legendary Greek physician to become at once the champion of iatrophysics and the original iatrochemist. But the variegated gallery of the early modern Hippocrates reminds us once more that dealing with the medico-chemical debate in terms of a polarization between vitalism and mechanism is unsatisfactory and misleading. In medicine, the adoption of the reassuring dichotomy between Aristotelian naturalism and mechanical philosophy is not so easy as in the physical sciences. Debus' introduction of the notion of 'chemical philosophy' was timely and it still is because it aids the development of a more complex historical panorama. But precisely because of this complexity, the category of chemical philosophy, not merely a heading for spagiric naturalism, turns out to be more varied than the Paracelso-Helmontian one: one has only to think of reluctant alchemists like Robert Boyle, of 'chymical Galenists' like George Castle and Francis Glisson, and of chemical iatrophysicists like Giovanni Alfonso Borelli and Marcello Malpighi. The principal merit of Debus' book lies precisely in relieving readers of their 'isms' and exposing them to the complexity of the early modern interplay between medicine and chemistry, rising mechanical philosophies and still influential naturalisms.

Guido Giglioni:
Dibner Institute for the History of Science and Technology, 38 Memorial Drive, Cambridge, MA 02139, U.S.A.;
giglio29@hotmail.com

The German Chemical Industry in the Twentieth Century, ed. by JOHN E. LESCH, Kluwer Academic Publisher, Dordrecht, 2000, viii + 472 pp., EUR 163.50 [ISBN 0-7923-6487-2].

One of the interesting issues for the philosophy of chemistry is identifying the forces that have shaped chemical development. Why is one type of research pursued vigorously while at the same time a similar topic is largely ignored? In the late 19th and early 20th centuries, interactions involving industry, government, the public, and academic research were responsible for creating the modern discipline of chemistry. Academics often focus mainly on research discoveries, even though it can be argued that these other influences were as important as the success or failure of research programs. Only by giving appropriate weight to each of these constituents is it possible to gain a balanced understanding of the forces that have created modern chemistry.

The German chemical industry in the 20th century provides an excellent opportunity to see all these forces at work. The inorganic chemical industry that developed in Britain in the late 19th century did not place a strong emphasis on research and development. The dyestuffs and pharmaceutical companies that were established later on in Germany emphasized research in order to respond to a public demand for new colors and drugs. Germany depended heavily upon imports for basic raw materials, so during the two World Wars the chemical industry had to respond to governmental needs for alternative sources of raw materials. Thus, it was Germany that first displayed the strong interactions among industry, government, public demand, and academic research that are typical of the modern chemical industry. Research on Germany is also informative because the aftermath of the two world wars made a great deal of documentation available,

giving the historian an unusual insight into what was happening behind the scenes during the 20th century. Finally, the German chemical industry was influential both nationally and internationally, suggesting that the events in this nation have implications beyond a single country.

The fourteen essays in this book are the result of a conference held in 1997 at the University of California in Berkeley, which brought together an international group of historians and economists who shared a common interest in the development of the chemical industry in Germany. Many of those involved are already well known for their previous writings on this topic. JOHN E. LESCH is the editor and also provides an introduction to the volume. He suggests (p. 3) that the papers are organized around three main themes dealing with the German chemical industry: the effects of research and development, its international influence, and its resurgence since the end of World War II. The interaction of industry, government, and the academy is at least implicit in many of these articles.

World War I has been called the chemist's war. Although research programs, like the Kaiser Wilhelm Institutes were initially funded mainly by industry, once the war began the German government realized the importance of research. Creation of synthetic fuels and the production of nitrogen compounds for explosives and agriculture were crucial problems. The efforts to meet these needs forced both the rapid improvement of existing techniques and the development of new technologies, such as high-pressure reactions and catalysis, that became cornerstones for the future of chemistry. MARGIT SZÖLLÖSI-JANZE's chapter gives a vivid picture of how nitrogen-fixing technologies were created, especially the role that chemists like Fischer and Haber played as mediators during the process.

Prior to World War I, most countries imported organic chemicals from Germany, and when these supplies were cut off, it might have been expected that chemical companies would have developed or expanded in many countries to fill this need. Many governments did try to encourage this development, often by appropriating German chemical patents and providing them to domestic producers. The crucial missing component seems to have been local expertise. For example, MIRA WILKINS explains that although Germany created production facilities in the United States, it maintained the basic research operations at home. Even though U.S. companies were created during World War I to replace chemicals that were no longer available, Germany's strong research base allowed it to rapidly regain its position as a dominant supplier once the war was over.

The Japanese situation was somewhat similar, as described by AKIRA KUDO. Like the United States, Japan depended heavily on German imports of dyes, pharmaceuticals, and fertilizers before World War I, and domestic production was unable to meet this demand. In the period after World War I, German firms, like I.G. Farben, both regained dominance in Japan and used Japan as an entry into other Asian markets. As was the case in the United States, German companies resisted Japanese requests for technological cooperation. Following the war, Kudo says the German companies used low prices and cartels to inhibit the development of local Japanese industries.

JEFFREY ALLEN JOHNSON continues the story after World War I. He rejects the traditional Marxist argument that industrial leaders simply used academic laboratories as extensions of their own research programs as too simplistic. During the war, the in-house research facilities of some companies, such as Bayer, had made them independent of academic research. Other companies, such as Hoechst, still made efforts to cooperate with academic researchers after the war, but the worsening economic conditions soon forced cuts in both industrial and government research sup-

port. Staff cuts were widespread, including many academically trained chemists. The general economic malaise continued until 1933, when the National Socialist (Nazi) Party took power.

The Nazi regime represents a case where governmental support proved to do more harm than good. Hitler stressed scientific research but considered it less important than his Aryan social policies. Johnson relates the story (p. 49) that when Carl Bosch told Hitler that dismissing Jewish scientists would set chemistry and physics back by a hundred years, Hitler responded that then the Reich could do without chemistry and physics. Despite Hitler's glib answer, the German chemical industry played a critical role in World War II and also conformed, with varying levels of enthusiasm, to the government's anti-Semitic policies. Several of the authors focus on this period, which is surely a low point in the history of the interaction between government and industry.

The chapter by ASHISH ARORA and ALFONSO GAMBARDELLA brings the story forward into the period following World War II. It is not limited to Germany, but makes some interesting explanations for modern trends, like globalization. Arora and Gambardella identify two main categories of technological innovations that were important during the latter half of the 20th Century, polymer chemistry and chemical engineering. The former was market driven and research intensive, like the dye industry in the early part of the century; however, the research focus was different. Instead of being totally concerned with how to produce new products, the need to anticipate and satisfy consumer demand became equally important. Chemical engineering represented a new emphasis on the science and economics of the chemical industry, and resulted in the creation of specialized firms to design chemical processes.

The factors that determine the direction of chemical progress are varied and complex, but it is clear that public demands for new products or changes in manufacturing have played an important role, most importantly in the latter half of the 20th century. Unfortunately, this topic is given very little attention in this book. New theoretical insights and serendipitous laboratory discoveries play an important role, but by themselves, they cannot fully explain why chemical research follows the path that it does. Perkins' accidental discovery of mauve was a necessary step in the development of the synthetic dye industry, but equally important were the prominent figures who showcased the new color, giving companies a strong impetus to create new products. It is amusing to think that industrial chemical research in the late 19th century may have been driven, at least in part, by the fact that Empress Eugenie of France thought the new dye matched the color of her eyes.

The impact of public opinion on chemical developments has been especially clear since World War II. Public concerns about energy shortages and environmental pollution probably have done as much to encourage new research on catalysis as did the need for explosives during World War I. Similarly, whether or not the criticisms were completely fair and justified, Rachel Carson's attack on the chemical industry did have a profound effect. Today's emphasis on 'Green Chemistry' is only the latest result of pressure from environmental concerns. These demands from environmentalists are continuing today to force the chemical industry to reshape and redefine itself. The failure to consider these developments is a major omission in this book.

During the 20th century, world public opinion has viewed the chemical industry with a mixture of admiration and unease, with the latter emotion becoming increasingly strong since World War II. Despite two world wars and several periods of political and economic confusion, German chemical companies have been looked upon as world-recognized leaders in chemical research and new product creation. They not only enjoyed some of the greatest public admiration

but also the most negative reaction because of their association with war gases and the use of slave labor. The various articles in this book do an excellent job of developing both the positive and negative aspects of this story. In addition, the authors provide some interesting insights into the forces that have shaped modern chemistry, insights that should be of special interest to philosophers of chemistry.

Harry E. Pence:
Chemistry Department, SUNY Oneonta, Oneonta, NY 13820, U.S.A.; pencehe@oneonta.edu

MAUREEN CHRISTIE: *The Ozone Layer. A Philosophy of Science Perspective*, Cambridge University Press, Cambridge, 2000, xii + 215 pp., £45.00 [ISBN 0-521-65072-0]

It is like an irony of the history of science that philosophy of chemistry emerged at a time when disciplinary research became increasingly replaced with transdisciplinary problem-orientated research. From bio-medical research via materials science to nanotechnology, chemists and chemical approaches are strongly involved in these areas. If the boundaries of the philosophies of science were to be defined by the boundaries of classical disciplines, we would not only get into demarcation troubles but also miss some of the most fascinating recent research fields. One such field is the study of the dynamics of the stratosphere, which in the 1970s, by the calculations of two chemists, turned from marginality to the greatest importance to securing future conditions of life.

Maureen Christie, in her doctoral thesis in the History and Philosophy of Science at the University of Melbourne, now published by Cambridge University Press, has taken up the challenge of transdisciplinary research in the atmospheric sciences. Quite a classic philosophy of science approach, her interest is in how evidence is provided for scientific theories – however, not in ideal science but in the actual scientific practice, and not in any field but in one of "strong relevance to today" (p. xi). Thus, she came to the recent history of scientific views of stratospheric ozone depletion.

Based on primary sources and interviews, the first part of the book knowledgeably narrates the story. Christie starts with early ideas about stratospheric ozone that were rather neglected by environmental chemists who then focused on tropospheric pollution. The stratosphere came on the environmental agenda only with debates over the im-