or electronics may be somewhat slower. Variation in available manpower among disciplines, the sophistication of the equipment involved, and the utility of the knowledge are among the principal factors determining absorptive capacity. Provided political interference is minimal, the volume suggests China is poised to take advantage of much more foreign technology than is ordinarily appreciated. A major challenge will be to integrate and use effectively the thousands of Chinese who will soon be returning to China from abroad.

The overall impression also is that China has a stronger scientific base than the poor-mouthing over the very real disruptions of the Cultural Revolution would suggest. In area after area, the conclusion is that the Chinese are at most 20 to 30 years behind, or approximate the Soviets and Japanese 20 years ago. Is the glass half full or half empty? After all, the 1950's and 1960's were not the dark ages, but rather provided a launching pad for the impressive advances of the past two decades. The issue boils down to politics: whether the governmental and social order will provide an environment conducive to research and training. This book does not probe this broader question, but it is hard to believe China's nurturing of knowledge during the coming 25 years can be more mismanaged than during the past 25. Since scientific advance tends to be more exponential than linear, the best guess based on this volume is that China will have a substantial scientific community within a generation—with or without American involvement.

The policy issues that confront the United States therefore are whether to remain aloof or to be constructively involved in China's advance, and if so how. In fact, with the signing of 14 cooperative accords in the sciences since 1978, Washington has already decided to be involved. These accords range from high energy physics to hydroelectric energy to atmospheric research. The NSF has recently signed an accord for encouraging collaborative research in astronomy, archeology, linguistics, natural products chemistry, materials science, and systems science. For the past two years, the CSCPRC has secured funding from the Department of Education, the International Communications Agency, and the NSF to fund a national program for approximately 60 American researchers in China. Even under the new situation of budget stringency, foreign policy interests dictate that these programs be sustained at current levels. *Science in Contemporary China* suggests that the United States will greatly benefit by playing a constructive rather than inhibiting role in China's inevitable development.

MICHEL OKSENBERG
Center for Chinese Studies, University of Michigan, Ann Arbor 48109

Antinuclear Forces in Europe

The Atom Besieged. Extraparliamentary Dissent in France and Germany. DOROTHY NELKIN and MICHAEL POLLAK. MIT Press, Cambridge, Mass., 1981. xvi, 235 pp., illus. $17.50.

Nuclear power is the technological issue of our time. Yet until recently governments in North America and Western Europe have uniformly been pronuclear. The important antinuclear movement emerged in the middle and late '70s from outside political orthodoxy, unable to find strong roots in established opposition parties, except in such rare cases as that of the Center party in Sweden. In Europe, the ecology greens were added to the Marxist reds and the other colors of the political spectrum.

In *The Atom Besieged*, Dorothy Nelkin and Michael Pollak document the development of these extraparliamentary forces in the two key Continental nations, France and West Germany. As in the United States, the antinuclear movement in these countries has employed civil disobedience and occupied or demonstrated at nuclear power plant sites. But also as in the United States, the success or failure of the antinuclears has rested with the established court system. France, in the absence of a judiciary independent of the strong presidential regime, has been proceeding full tilt with a nuclear program designed to provide over half its energy needs by the year 2000. In Germany, though as of the end of 1979 there were actually more nuclear megawatts being produced than in France, there is a virtual moratorium on further nuclear development, based on court interpretations of a 1976 atom law amendment "providing that a nuclear facility may be licensed only after all safety precautions have been taken to the limit of science and technology."

The German atom law amendment is symptomatic of the legislative tendency to deal with technology in absolutes, as evidenced in the United States by the Delaney amendment banning all cancer-causing substances and the 1972 water quality bill prohibiting the discharge of any polluting effluent by 1985. Unfortunately Nelkin and Pollak omit any background on the development of the stringent German atom law.

This omission is offset by the authors' generally capable presentation of the details of the French and German political, legal, and administrative structures in a way that is useful to readers lacking background information on European politics. The volume also usefully documents the licensing procedures in both countries, the history and organization of the antinuclear groups, and the development of legal proceedings. The status of other European nuclear programs is summarized in one of the concluding chapters. Appendixes present information on nuclear power plant installations and major court cases.

Nelkin and Pollak serve to inform pronuclear forces that the antinuclears are as absolutist as the German atom law. Technological improvements in the safety of plant operations or in waste disposal are unlikely to quiet the core of dissent. Indeed, the opposition, speaking in terms of nuclear societies run by nucleocrats, are using the nuclear issue to attack the interlocking power of government bureaucracies, private industry, and, in some cases, organized labor.

The antigrowth dissenters as portrayed by Nelkin and Pollak appear not to be deeply concerned with alternatives to nuclear power. There is an element of romantic illusion that individual liberties either were better protected before the advent of large political and economic organizations or might be better protected in some non-nuclear future. Yet nonnuclear futures will not likely involve the social transformations desired by many dissenters. While solar power may not engender the apocalyptic possibilities of nuclear, the gear on your roof, like the car in your garage, will probably be mass-produced by an organization with some degree of monopoly power. Modern technologies apparently imply economies of scale that make large organizations inevitable. It is disappointing, therefore, that the information in *The Atom Besieged* suggests that neither side in the nuclear debate is seriously interested in investigating how the incentives to and within large organizations might be structured to avoid the Three Mile Islands, Ford Pintos, and thalidomides. This key scientific and political problem will remain, with or without nuclear power.

Though Nelkin and Pollak are quite successful as chroniclers of the antinuclear movement, their attempts at analysis are flawed. For example, according

to them, France can implement a nuclear program because "a centralized administration allows the government to ignore social movements" and centralization exists because "French territorial unity has existed for at least six centuries, providing a basis of a centralized and stable state." Now centralization was less a consequence of territorial unity than a mechanism for maintaining and expanding the kingdom. Moreover, just a quarter-century ago France was widely regarded as an unstable state, despite the six centuries of its history. Centralization, even abetted by the lack of an independent judiciary, is thus not a sufficient condition for an elected government to pursue policies that are intensely opposed by significant minorities. Also necessary is a strong dose of political authority as exemplified in the current presidential regime. Born of the peculiar circumstances of the Algerian war (contrast Italy, which has gotten along with an unstable regime since 1946), this regime is undoubtedly maintained by negative preferences regarding a potential leftist or communist government. As the right can exploit the public's fear of the left, it has wide latitude in most areas of public policy, including nuclear power. Skimping on this relatively short-run political context, Nelkin and Pollak overemphasize long-run historical and sociological considerations.

My quarrels with various interpretative statements in *The Atom Besieged* could run to many pages, and I would advise reading the book with a heavy filter. Nonetheless, it is a worthy contribution on a subject of great public concern.

HOWARD ROSENTHAL
Graduate School of Industrial Administration, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213

Foundations of a Profession

History of Chemical Engineering. Papers from a symposium, Honolulu, April 1979. WILLIAM F. FURTER, Ed. American Chemical Society, Washington, D.C., 1980. xii, 436 pp., illus. $39. Advances in Chemistry Series, 190.

At several crucial junctures in the Manhattan Project, when conflicts arose regarding priorities in research and development, the leaders of the project created blue-ribbon committees to study and to report on the choices faced. Chemical engineers dominated many of the committees. Indeed, Warren K. Lewis, professor of chemical engineering at the Massachusetts Institute of Technology and dean of American chemical engineers, seems to have been the automatic choice as chairman of these review panels. It is striking that the physicists and chemists who managed the bomb project should have turned to chemical engineers so often for advice, especially since chemical engineering was a young profession, barely as old as many of the scientists themselves. The essays in this history of chemical engineering do not deal directly with the role of chemical engineers in the Manhattan Project, but the collection as a whole does much to clarify how and why chemical engineers, particularly in the United States, came to enjoy so much confidence and esteem so quickly. The book is especially valuable since little has been done to trace the history of this important discipline.

The 22 papers in *History of Chemical Engineering*, all but one written by chemical engineers themselves, may be divided into four topical categories. The volume opens with several essays that treat the genesis of the concepts fundamental to the emergence of chemical engineering as a distinct specialty; it concludes with brief reviews of the present image and future prospects of the chemical engineer. Sandwiched in between are essays on the individuals and institutions that contributed most significantly to the expansion and prosperity of the discipline during the 20th century as well as a number of studies that deal with the history of chemical engineering in specific national contexts.

Several generalizations emerge from the essays that take the conceptual foundations of the discipline as their subject. It seems clear, for example, that European and American chemical engineers followed two separate and distinct paths during much of the past century. In Europe, industrial chemists did not until recent years stray far from their roots in chemistry proper; chemists and mechanical engineers cooperated to meet the needs of European chemical industries. In turn-of-the-century America, however, a single chemical engineering profession emerged whose practitioners were distinct from both mechanical engineers and chemists. Unlike mechanical engineers, they were prepared to understand the strictly chemical aspects of industrial reactions; unlike chemists, they were trained to handle the problems of producing by the ton rather than by the test tube. Crucial to the emergence of this profession was the concept of unit operations, that is, the concept that a small number of elemental operations such as filtration, distillation, and evaporation are the common denominators of all chemical processes used in industry. Chemical engineers have come to look to the concept of unit operations as the origin of their science in much the way chemists look to Lavoisier's concept of element as the origin of modern chemistry, and for much the same reasons. Both concepts served to tie together facts and phenomena that would otherwise remain isolated, and both were invaluable pedagogical tools. Armed with unit operations, teachers did not need to give special courses on each of the scores of chemical process industries that might hire young engineers; instead instruction could be organized around a small number of operations common to all industries.

Unit operations became the basis of American education in chemical engineering early in the 20th century, and MIT was the pioneer in bringing the notion into currency. On this the writers in this volume agree. But there is debate, somewhat nationalistic in tone, over exactly when and where the concept of unit operations was first described. John T. Davies and D. C. Freshwater, both British chemical engineers, make a strong case for their countryman George E. Davis as the creator of the concept. American contributors, such as F. J. Van Antwerpen, emphasize the roles of Arthur D. Little, William H. Walker, and Warren K. Lewis—all of whom were associated with MIT. Perhaps it is best here to trust the judgment of Jean-Claude Guédon, a professor at the University of Montreal and the only trained historian among the contributors. In a very fine essay, Guédon all but ignores the question of who deserves priority for defining the concept of unit operations and instead examines the more fruitful question of why Europeans were so slow to adopt it. The idea did not occupy an important place in the chemical engineer's education in Britain and France until after 1925, and in Germany it did not win much attention until after World War II. Guédon seeks to demonstrate that the concept of unit operations could not have come into favor in Europe