



R & D for Industry: A Century of Technical Innovation at Alcoa.

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spread beyond the region. As Houston oil, gas, and petrochemical industries boomed, the firm followed suit.

Then came the Great Depression. The New Deal imposed standardization by means of national regulation; the Houston firm could either stagnate as a regional firm or compete with national firms. The firm competed in its areas of expertise—oil, gas, and chemicals—and prospered as Houston's leading corporate law firm into the 1970s.

Throughout, members of the firm sat on boards of directors and served as trustees for utilities, banks, and Rice University. Baker and Botts wove its interests into the fabric of community leadership because the firm's leaders shared interests and views with the other members of the elite. The firm also had strong ties in Austin because of its long years lobbying on behalf of its corporate clients. Baker and Botts played a key role in the economic (and social) development of Houston and Texas from the postwar colonial experience through the populist uprising and into the flowering and fading of twentieth-century capitalism.

This work breaks new ground because it describes lawyers as they practice rather than make the law. It also shows them as full members of an elite guiding a city. It tracks the major cases, some won and some lost, but it focuses on the bread-and-butter economic aspects of law as a business.

Baker & Botts is surprisingly good.

J. HERSCHEL BARNHILL, *Tinker AFB, Oklahoma*

R & D for Industry: A Century of Technical Innovation at Alcoa. By Margaret B. W. Graham and Bettye H. Pruitt. Cambridge: Cambridge University Press, 1990. Pp. x, 645. \$49.50.

Written as part of the celebration of Alcoa's one-hundredth anniversary, this book is much more than self-celebration posing as history. In examining the changing role of research at Alcoa, Margaret Graham and Bettye Pruitt address a wide range of issues of interest to both economic historians and students of industrial and technology policy. The format chosen by the authors allows a traditional business history, with its emphasis on the role of individuals within the organization, to take a more analytical perspective. Chapters giving an overview of changes in the relationship between research and company strategy, the organization of research activities, and so on, alternate with others that look in more detail at a particular research project undertaken during the period in question. These case studies illustrate concretely the effect of organizational and strategic changes on the quantity and quality of research undertaken at Alcoa.

The overarching theme of the book is that tensions—creative and otherwise—among research, marketing, and production, influence the kind of research and development activity in which a manufacturing firm engages. Alcoa's history includes examples of both the fruitful interaction of industrial researchers with other parts of the company, and others more fratricidal and counterproductive. The analysis contains a moral: certain organizational structures and certain corporate cultures are more conducive to constructive research than others.

Graham and Pruitt describe recurrent tensions between research and production, particularly over process innovations, that eventually had to be tested at full-scale production facilities. Analogous tensions arose when production units made demands on research's scarce resources for technical support. They argue that, for most of Alcoa's history, those tensions were constructive. Researchers identified important questions for further study in their attempts to help solve day-to-day plant problems. Production units maintained their own technological sophistication, both to solve simple technical problems themselves and to provide research with fruitful feedback on new

processes. During the post-World War II era, these tensions increasingly became open conflicts. Other units viewed basic research as a drain on their own resources, and Alcoa researchers themselves had no vision of their mission as other than a service to the rest of the corporation.

Similar tensions arose between research and sales. When sales was "missionary" in its attitude, looking for new products and new markets, the two could make demands on and learn from one another. But when sales was less "missionary" and thought of research more mechanistically, both suffered.

Research at Alcoa also depended on its interactions with its customers. The early history of Alcoa demonstrates how an industrial district with intersecting technological, geographical, and other interests can foster the growth of new firms and new technologies. It also makes clear the interdependence of companies in ways that are not always captured by market prices. More recently, joint ventures have begun to provide a contractual structure for this kind of interfirm cooperation.

A second theme, the effect of the "R&D environment" on the fortunes of research at Alcoa, runs throughout the text. This environment was shaped by government policy, as well as academic and popular attitudes toward industrial research. Overall, Graham and Pruitt argue, this external environment has adversely affected industrial R&D since Franklin Roosevelt's assumption of the presidency. Only Hoover's platitudes about technology as progress are favorably assessed. For example, they argue that federal support of science after World War II simply created competition for competent scientists and an emphasis on esoteric questions in physics. While this perspective presumably reflects Alcoa's subjective experience, the evidence presented is less than convincing. Alcoa research clearly benefited from a military with a longer-term perspective and a greater willingness to take risks than many of Alcoa's private customers.

But Graham and Pruitt do not recognize that the cold war also constituted government policy. Similarly, although their discussion on the demoralizing consequences of the government's antitrust prosecution of Alcoa for researchers is convincing, the overall negative effects of this episode on research itself were clearly as much the result of Alcoa's own response to the development of competition as the fault of the federal government.

On the other hand, their analysis of the antitrust battle over Alcoa's patents provides the keenest insights of an insightful book. They argue that both the government and the company's senior management believed that technology could be adequately viewed as an asset to be bought and sold (or licensed without fee), as opposed to an organizational capability that might provide the basis for strategic competition. The institution had knowledge distinct from its individual human capitals: the capacity to generate and use new knowledge was an important asset of the firm itself, an element of its competitive advantage. R&D was successful because it created the managerial capability to innovate, not because it produced "blockbuster inventions" or a stream of random innovation shocks on the production technology.

While this argument is similar to that of others writing in the Chandlerian tradition, Graham and Pruitt make it more concrete and convincing by analyzing the evolution of technological capability within a single corporation. By bringing their analysis forward into the present period and focusing on research rather than distribution, they are forced to take a more critical attitude toward the developments in organizational structure that Chandler found so laudable. They question both the use of "profit center" accounting techniques and the multidivisional structure, as well as management by financial managers and marketeers having little familiarity with research.

Because Alcoa has lived through periods of both monopoly and domestic and international competition, its experience provides a useful case study for evaluating Schumpeterian claims that monopoly is conducive to technological dynamism. Graham

and Pruitt find that during its "monopoly era," Alcoa was more willing to invest in R&D, especially basic research, confident that it would capture the rents from that investment. On the other hand, they give examples of competition having appeared to foster increased commitment to research—as when Alcoa almost lost its contract for construction of the *Shenandoah*, a naval air ship, to a foreign competitor. What becomes clear is that there is not a one-to-one correspondence between industry structure and technological innovativeness. Rather another key variable, firm strategy, influences how the firm responds to the industry structure and R&D environment.

The book's introductory technical note is not only of great use to the nonscientific reader but also provides clues to the outcome of specific research endeavors. This is helpful, as the authors have a tendency to write as though the reader has peaked at the last page of each chapter.

Overall, this book provides an insightful inside view of how technological decisions are made by a capitalist enterprise. Specific sections would also be of interest to those studying related industries and topics, including the aircraft industry, the food products industry, the steel industry, the histories of chemistry and engineering, and firm-specific responses to the Great Depression.

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The Public Debt of the United States: An Historical Perspective, 1775–1990. By Donald R. Stabile and Jeffrey A. Cantor. New York: Praeger, 1991. Pp. xiii, 243. \$42.95.

Although many scholars have examined the causes and consequences of the current federal debt, few have assessed it from a historical perspective. This volume assumes that task.

Donald Stabile and Jeffrey Cantor of C. H. Associates were contracted to write *A History of the Bureau of the Public Debt: 1940–1990, with Historical Highlights from 1789–1939* to commemorate the fiftieth anniversary of the Bureau. The book under review draws heavily from that work.

The book has three parts. An introductory chapter surveys the principles of public finance. Next, a specified period of time is covered by each of nine chapters. Finally, Chapter 11 offers the reader a variety of ways to view the size of the current debt as well as a debt reduction plan. The authors have put together a substantial quantity of data, much of which is drawn from primary sources. Altogether there are 26 tables of statistics, and the bibliography has 240 entries.

The heart of the book is its second part, in which the ratio of chapters to time covered increases noticeably. Chapters 2 through 4 cover the first 125 years of the nation's history. The last three chapters, on the other hand, cover only the years since 1960. In addition to chronicling the federal debt, each chapter offers a brief survey of government spending, sources of government revenue, economic conditions in the country, the views of various contemporaries on the debt, and debt administration.

The second part of the book also reveals an increasing level of attention devoted to debt administration. As defined by the Stabile and Cantor, debt administration is the "work involved with handling the sales of the securities, keeping the records of security ownership, and ensuring that interest payments on the securities are made properly and on time" (p. 7). Allocated a modest share in the early chapters, this topic comprises nearly 75 percent of the discussion in the last two chapters. Accordingly, there is an impressive array of details on the history of government securities, treasury activities, and, of course, the Bureau of the Public Debt. Given that all the chapters are, roughly the same length, there is a considerable "crowding out" of other topics by the focus on debt administration.

This approach has its price. Many critical questions are not addressed. For example,