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BOOK NOTES

Out of Thin Air: A History of Air Products and Chemicals, Inc., 1940-1990. Andrew J. Butrica with the assistance of Deborah G. Douglas, Praeger, New York, NY, 1990. 336 pp. Cloth (Typeset). $39.95.

Despite the significant role industrial gases have played in the development of the U.S. chemical industry, it's easy for historians to overlook them. Gases may be important, but they just don't seem glamorous. In this history of the Air Products and Chemicals Company, Andrew Butrica uses the company archives and interviews with many of the men involved to prove that there's more excitement in this story than one might suspect.

50 years ago, even industrial users that required large amounts of oxygen depended upon gas delivery in cylinders. Leonard Pool, who founded Air Products, planned to fill a market niche by building small, on-site oxygen generating plants. This proved to be a good idea in the long run, but it was difficult to get started. During much of its history, Air Products was at a severe disadvantage because it was competing with much larger, well-established companies, and it was perennially short of capital. Air Products was successful because its leadership combined a tenacious determination to make this idea work with the flexibility to take advantage of whatever opportunities the market offered.

The character of the company was established by its response to its initial disadvantages. Since the company had little money available for research and development, in some cases it would offer to provide a customer with new technology at a low price, then use the job as an opportunity to develop the expertise that it needed to compete. Butrica comments that Pool assumed that if he could sell a product, his engineers could build it. Fortunately Pool made sure that he hired engineers who were good enough to make his promises stick.

The list of the challenges the company faced is a summary of the changing uses of industrial gases in the past 50 years. Providing oxygen for high altitude aviation in World War II, supplying oxygen for the steel industry, liquid oxygen and liquid hydrogen for NASA, and liquid nitrogen for a variety of applications (including quick freezing of McDonald's hamburgers) are only some of the applications that contributed to the growth of Air Products.

As it grew, the company diversified, sometimes into new areas that complemented the basic business, and sometimes into areas - like agricultural chemicals or welding gases - that were less successful. Two of these initiatives have become permanent divisions of the company (specialty chemicals and environmental/energy services) but industrial gases are still the main business. Despite the growth in size, the company continues to show a willingness to take calculated risks, sometimes with poor results, such as synfuels development, but more often leading to profitable new directions.

Writing an authorized company history can place a historian in the uncomfortable position of choosing either to describe setbacks and adverse decisions frankly or else keep the sponsor happy. Butrica seems to have done a good job of balancing these considerations. He presents the special difficulties of Air Products, such as labor disputes, research policies, and unsuccessful expansion, in a concise and diplomatic way. It's perhaps inevitable that the company founder, Leonard Pool, receives special and extensive consideration, but it would have been equally interesting to know more about the personalities and contributions of others who played key roles in the establishment of the company, such as George Pool, Ed Donley, and Dexter Baker.

In this book, Andrew Butrica not only restores industrial gases to their rightful place in the story of the chemical industry but also provides a fine 50th anniversary commemoration of a company that played a major role in that development. *Harry E. Pence, Chemistry Department, SUNY-Oneonta, Oneonta, NY 13820*

Physical Chemistry from Ostwald to Pauling: the Making of a Science in America. John W. Servos, Princeton University Press, Princeton, NJ, 1990. xxii + 402 pp. Cloth (Typeset). $49.50.

This superb monograph by John Servos delivers both more and less than its title might indicate. More in that it encompasses

parallel biographies of Arthur Amos Noyes at MIT and Cal Tech and of Wilder Dwight Bancroft at Cornell. Neither was a scientist of the highest rank but both made unique contributions to the development of American physical chemistry: Noyes in fostering the careers of G. N. Lewis and Linus Pauling; Bancroft in founding and fostering the *Journal of Physical Chemistry*. Less in that this twin focus leads to the neglect of physical chemistry at Harvard, Johns Hopkins, Wisconsin, Chicago and elsewhere, to say nothing of developments in Europe. The author largely disarms the latter criticism:

A few words must be said about what some readers may find to be a disturbing emphasis on the history of this discipline in America. Physical chemistry as a network of ideas is not American any more than it is German or French. And if this were a work of straightforward intellectual history, my concentration on American institutions and scientists would be unforgivable. But disciplines are more than disembodied ideas. They find leaders who are imbued not only with the norms of science but with the values of national cultures.

In spite of this disclaimer Chapter 1, "Modern Chemistry is in Need of Reform", provides an excellent summary of how Arrhenius, Ostwald, and van't Hoff drew together the various strands of chemical theory into the synoptic fabric of physical chemistry, an achievement culminating in the founding of the *Zeitschrift für physikalische Chemie* in 1887. Chapter 2, "Physical Chemistry from Europe to America", documents the impact that Ostwald had on the founders of American physical chemistry - Noyes (1888), Bancroft (1890), Kahlenberg (1893), Richards (1895), and Lewis (1900) all studied in Leipzig. Chapter 3, "King Arthur's Court: Arthur A. Noyes and the Research Laboratory of Physical Chemistry [at MIT]" recounts the remarkable achievement of A. A. Noyes in establishing the first school of American physical chemistry in the not entirely sympathetic environment of Boston Tech. Chapter 4, "The Phase Ruler: Wilder D. Bancroft and His Agenda for Physical Chemistry" describes Bancroft's forlorn attempt to establish Gibbs' phase rule as the guiding light of 20th century physical chemistry. Chapter 5, "Physical Chemistry in the 'New World of Science'" is the least satisfactory in the book; indeed it prompts my only substantial criticism. As is common with history of science monographs, several of the chapters have appeared "in different form, elsewhere". This leads to certain "the-story-so-far" lead-ins and parts of Chapter 5 seem to interrupt the fine narrative flow of the rest of the book. The story line resumes with Chapter 6, "From Physical Chemistry to Chemical Physics" and concludes with the rather sad Chapter 7, "A Dissenter's Decline". Bancroft, however, went down fighting. In 1931, in a strange article "How to Ripen Time", a reference that seems to be missing from this generously, even obsessively, documented book, Bancroft wrote somewhat unfairly of the "victor" G. N. Lewis:

G. N. Lewis, now of the University of California, introduced the activity concept to meet the difficulty. We can always make the experimental data agree with the theoretical values by multiplying the data by the ratios of the theoretical values to the experimental values. Of course it was not done as crudely as that. The multiplying ratio was called the activity coefficient ... We might consider Mrs. Eddy and G. N. Lewis as the Gold Dust Twins of Christian and Physical Science. Mrs. Eddy eliminates sickness but admits error. Lewis admits sickness but eliminates error.

Servos writes well and he has a good ear and eye for the felicitous phrase:

Few schools commanded resources as rich as California's, and none had a talent greater than Lewis's, but a rising tide raises all ships.

or on Gibbs' belated recognition:

There is, however, a difference between being honored and being understood.

Lewis' urbane response, as General Pershing's scientific advisor, to repeated requests for the provision of gas masks for carrier pigeons is left for discerning readers to discover for themselves.

There are few monographs in the history of science that can be recommended unreservedly to practicing chemists. This book is one of the few. *Derek A. Davenport, Department of Chemistry, Purdue University, West Lafayette, IN 47907*

Linus Pauling: A Man and his Science. Anthony Serafini, Paragon House, New York, NY, 1989. xxii + 310 pp. Cloth (Typeset). $29.98.

Should the *National Enquirer* ever launch a scientific book club, Anthony Serafini's *Linus Pauling: A Man and His Science* would make an appropriate first selection. The second sentence of the Introduction sets the tone: "... he [Pauling] could well be called the American Cowboy of science". A few pages later we find: "Born into conflict and combat with the rawest elements of nature, poverty, and disease, he toughened himself for a life-time of struggle". Later chapters deal with "The McCarthy Era and the 'Race' for DNA", "On the Trail of a Cure for Mental Illness", "A Brush with Death", "At War with Herman J. Muller", "Squaring Off with William F. Buckley, Jr.", and "Pauling *vs.* the Medical Establishment". Under the circumstances it's a marvel the man has lived long enough to write *How to Live Longer and Feel Better*.

While Linus Pauling has been a public figure, even a *de jure* public figure, for close to 50 years, and though his non-scientific activities are all of a piece with his scientific ones (indeed he would probably dispute such nice distinctions), it is for his remarkably varied scientific achievements that he will

be chiefly remembered. The names of crusaders rarely outlast the crusade. And it is with Pauling's scientific work that our author is least happy:

> The parameters physicists use to "describe" electrons are called "quantum numbers" (a sort of measuring unit, used in much the same way that carpenters talk about lumber in terms of board feet).

As a consequence, Serafini shortchanges the seminal scientist in favor of the public figure. *The Fairfield Chronicle* is cited but not the *Journal of the American Chemical Society*. While he makes much of Pauling's vaulting imagination, he often does so at the putative expense of "competent, hard-working, ruthlessly accurate and technically correct" scientists such as John Slater. The repeated denigration of Slater does an injustice to a first-rank physicist and an outstanding teacher of several generations of physicists. Even less admirable is Serafini's tendency to make serious and snide assertions only to back away from them a few sentences later:

> Bragg was bristling ... about Pauling's thievery and lack of professional ethics ... Many people who have examined Pauling's early career believe that Pauling really did steal his famed principles from Bragg.

Who are these 'many people'? The chapter notes are silent.

> However, numerous scientists at Caltech ... seemed to believe he [Pauling] had actually written part of *The Structure of Line Spectra*.

Who are they? Where is the evidence that he did not? Pauling's and Goudsmit's names appear equally on the title page. Both were Associate Professors at their respective institutions, each no doubt eager for fame, if not fortune. Could Goudsmit have been so self-effacing as not to insist on an acknowledgment that Pauling was merely the translator? And why did he keep the charming photograph of Pauling and his son Peter reproduced in the book? Similar examples of journalistic sensationalism occur throughout, largely at the expense of any remotely adequate treatment of Pauling's remarkable scientific and teaching career. Potential readers would do well to check John Roberts' cautionary and caustic review [*Chemical and Engineering News*, 29 January 1990].

Is there nothing good to be said about this lopsided and shabby book? Since memories are short and Pauling's life happily long, it is salutary for chemists (and others) to be reminded of the astonishing range of Pauling's activities. No 20th-century scientist, not even the sainted Einstein, has assumed such an active public role, though under intimidatingly different circumstances Andrei Sakharov may have come close. A satisfactory "Life and Times of Linus Pauling" has yet to appear, though Robert Paradowski's work-in-progress augurs well. Perhaps the man himself could be persuaded to find time in his busy schedule to treat us to his own account. For in spite of Serafini's surly "writing is not Pauling's forte", he has a fine ear for language, a gift for narrative and a splendid sense of drama. Such an autobiography would be well worth waiting for. *Derek A. Davenport, Purdue University, West Lafayette, IN 47907*

Schwazer Bergbuch. Erich Egg (Editor), Akademische Druck- und Verlagsanstalt, Graz, Austria, and Verlag Glückauf GmbH, Essen, Germany, 1988. 53 + 396 pp. Cloth (Typeset and Photoreproduction). 780 DM.

This book on mining dates back to the year 1556. It has never been printed before, though ten hand-written manuscripts are known to exist in various locations in Austria and Germany: three in the Tirol Provincial Museum in Innsbruck; and one each in the Austrian National Library, Vienna; the Mining University, Leoben; the Salzburg Provincial Archives, Salzburg; the Mining Museum, Bochum; the Bavarian National Library, Munich; the German Museum, Munich; and in Werthein Parish. The importance of this document lies in the fact that it was made available in a hand-written form in the same year as Agricola's book, *De re metallica*, was published and that it surpasses Agricola's book in its drawings, which are brilliantly colored and of extreme beauty.

The book is written in Old German and its title, *Schwazer Bergbuch*, translates as "the Mining Book of Schwaz". In the Middle Ages, Schwaz was the second most important town in Austria after Vienna, the capital. Schwaz today is a small village in Tirol, 35 kilometers east of Innsbruck. The author of the book is unknown, but an artist by the name Ludwig Lassl signed the drawings.

The book was written during the age of Reformation, a period not only of great geographical discoveries and artistic movements, but also an age of great merchants. Two families dominated European commerce and banking: the Fuggers in Germany and the Medici in Italy. Both families made their fortune in textiles and then turned to banking: the Fuggers at Augsburg and the Medici at Florence. The Fuggers made many loans, especially to kings and princes, in return for which they got control of many enterprises. Among these were mines in Hungary, Germany, southern Spain, and the one in Schwaz.

Rich silver-copper ore containing 35-41% Cu and 0.3-0.8% Ag was discovered in Schwaz in 1410 and in the period 1470-1530 it became the largest copper and silver producer in Central Europe. In the 1550's, however, mining costs began to increase because of the necessity of having to go deeper underground and the resulting increase in problems due to ground water. Added to this was a decline in the quality of the ore being mined.

Only three pages of the book are devoted to the technical aspects of ore treatment. The rest of the book is devoted to the people operating the mine - about 20,000 working in about 300

galleries. Each job is described and illustrated, including methods of supplying food, clothes, tools, etc., and management of the work place. The book contains a translation of the medieval German of the text into modern German by Dr. Ing. Heinrich Winkelmann, the former director of the Mining Museum in Bochum. The supplementary, 53-page volume, "Schwazer Bergbuch Commentarium", by Erich Egg, the former Director of the Tiroler Landesmuseum Ferdinandeum in Innsbruck, gives valuable comments on the book and its history. It is thought that the book was written as a document for a mining conference called the "Synode" that was held in Schwaz in 1557. Previous conferences were held in 1494, 1496, 1498, 1500, 1501, 1507, 1510, 1512, and 1513.

The book contains 100 colored drawings and is available in two different bindings: the standard edition (facsimile and commentaries bound together) at a price of 780 DM, or the facsimile volume in leather binding (with the commentary volume in a separate half leather binding) at 1,560 DM. Both editions are gold decorated. The book is certainly a welcome addition to the mining library. *Fathi Habashi, Department of Mining and Metallurgy, Laval University, Quebec City, Canada G1K*

The Right Place at the Right Time, John D. Roberts; *From Cologne to Chapel Hill*, Ernest L. Eliel; *From Design to Discovery*, Donald J. Cram, American Chemical Society, Washington D.C., 1990. xix + 299 pp; xxi + 138 pp; xxi + 146 pp. Cloth (Typeset). $24.95 each.

These three volumes are the first of a projected 22-volume series edited by Jeffrey I. Seeman of the Philip Morris Research Center. Originally solicited as chapters for a single book intended to document the development of contemporary organic chemistry, the length of the contributions soon caused the project to mushroom into the present series. Seeman not only conceived the original project but also obtained corporate funding to help subsidize the final version. On all counts he is to be commended, as he has not only single-handedly doubled the number of known chemical autobiographies, but has provided future historians of organic chemistry with a veritable treasure trove.

As for the autobiographies themselves, they are as variable as the authors. From the standpoint of human interest and anecdote, the most successful of the three under review is doubtlessly the volume by John Roberts, with Eliel's contribution not far behind. The least successful is the volume by Cram, who, after confessing to a middle-age angst of dwelling on the past, proceeds to write a review article on his current research (indeed one of my colleagues borrowed the book to use as a reference in writing a grant proposal).

What is most interesting, however, is what all three accounts have in common. All are written for chemists rather than for the general public and the reader is plunged into the details of the author's research with little or no preliminary preparation. Indeed, so focused are the accounts, that even non-organic chemists may find themselves a bit lost at times. This apparent inability to place one's work in a larger historical perspective, and even to spell out its ramifications for the structure of chemistry as a whole, is not, I suspect, a failing of the authors alone, but is typical of chemists in general. This view is reinforced by the fact that all three authors became involved in the conceptual issues which later made them famous as a result of much more limited experimental projects, chosen either because they were manageable in terms of the equipment and chemicals available at the time or because they were simple extrapolations of projects assigned them as students or postdocs. There are no tales of reading the great literature of chemistry, identifying key conceptual issues and explicitly setting out to resolve them. Rather these larger issues evolved gradually out of the more mundane and more limited experimental projects. This observation is not intended as a criticism of the authors, but rather to draw attention to the fact that they are telling us (albeit indirectly) something very important about the way chemistry is done - something of which philosophers of science, who continue to use theoretical physics as their model of the scientific method, should take note.

Finally, all three authors express a certain nostalgia for the excitement of the 1950's and 1960's which seems to have vanished in this decade of declining chemistry enrollments, dwindling research funding, and increasing emphasis on applied rather than fundamental research - a nostalgia best expressed in Roberts' title "The Right Place at the Right Time". *William B. Jensen, University of Cincinnati, Cincinnati, OH 45221.*

LETTERS

Kasimir Fajans

Today I received a copy of the Spring 1990 issue of the *Bulletin for the History of Chemistry*. This issue is particularly interesting to me for the second part of the biography of Professor Kasimir Fajans because I knew him since the 1920's when he was Professor at the University of Munich and I was a scientific research associate at the Kaiser-Wilhelm-Institut in Berlin-Dahlem. Evidently all the other articles in the issue of the *Bulletin* have been and, in fact, always are of great interest and satisfaction to me.

Herman Mark, University of Texas-Austin

The Hofmann Sodium Spoon

Two days after reading your interesting little end-piece on the Hofmann sodium spoon, I came across the following in Edward Frankland's *How to Teach Chemistry. Hints to Sci-*