The Matter Factory: A History of the Chemical Laboratory, Peter J. T. Morris, Reaktion Books, London, 2015, 416 pp, ISBN 978-1-78023-442-7, $45.00 (distributed in the Americas by University of Chicago Press).

Even more than most historical narratives, *The Matter Factory* is rooted in the concrete—in particular places and particular objects. Of course histories of all kinds abound in particularities, in contingencies, and in events that could easily have happened differently if circumstances had been different—and history of chemistry is no exception. But such concrete considerations as locality and apparatus are rarely the organizing principle of such narratives, especially by comparison to more conventional foci such as biography, institution, or development of a particular theory or subfield.

To chemists across the discipline, lab fixtures and glassware are as iconic as the periodic table: even theoretical and computational chemists spend hours in laboratories during their training! The concentration of *The Matter Factory* on the chemistry lab and its equipment makes it a history that has the potential to appeal to chemists and chemistry students of any subdiscipline and at any stage of career. That potential appeal is realized in a highly engaging volume full of interesting facts, photos, insights, and connections to the broader history of chemistry.

Chemists were certainly part of the audience Peter Morris, longtime curator at London's Science Museum, had in mind when he wrote the book. To be sure, as an accomplished historian of chemistry (recipient of the 2006 Sidney M. Edelstein Award in History of Chemistry), Morris had his fellow scholars in that field in mind as well. He set out to describe how laboratories and the buildings that they occupy developed, alongside the practices and theories of chemistry, over four centuries. By focusing on selected manifestations of the infrastructure of the chemical enterprise, Morris also sheds light on the societies and economies in which chemistry was and is practiced.

Each of the book's twelve chapters, which are arranged in roughly chronological order, features one laboratory—although several are replete with many supporting examples. In each chapter, Morris intertwines a biographical sketch of a prominent chemist closely associated with the featured laboratory and a description of the development of an important chemical technique with the story of the chapter's featured laboratory. Each chapter is largely self-contained, so that the book as a whole constitutes a series of connected vignettes rather than a comprehensive or continuous narrative. This structure thus would repay both systematic readers and browsers. The wealth of illustration also rewards browsers and casual: there are 139 numbered images, mainly of buildings, labs, or equipment.

Alchemical and metallurgical practices are front and center in the first chapter, in which Morris looks for the origins of specialized chemical workspaces. Several striking depictions of alchemists at work, including paintings by Pieter Breugel the Elder and David Teniers the Younger are viewed with a healthy dose of historical skepticism. The central laboratory of the first chapter is the chemical workshop of Wolfgang von Hohenlohe at Schloss Weikersheim shortly before the turn of the 17th century. It was not depicted by a recognized artist, though, but through a sketch that depicts a scholarly reconstruction by Jost Weyer of that workshop. Furnaces of various sorts are the chapter's featured apparatus.

The second chapter jumps ahead nearly two centuries to the late 18th century. Antoine Lavoisier is the featured chemist and his laboratory at the Paris Arsenal the focal laboratory. Several of the images included in this chapter were prepared by Marie-Anne Lavoisier (née Paulze) in order to illustrate her husband's work. Pneumatic chemistry was the hot research area of the time, and the chapter depicts and discusses apparatus that facilitated experiments on gases. But the humble work table also receives attention as the substrate required for table-top equipment like pneumatic troughs.

Chapter three is the first of eight chapters on 19th-century chemical laboratories and the first of six that have a considerable pedagogical or educational aspect. Its protagonists are Michael Faraday and the Royal Institution of Great Britain. At the Royal Institution, chemical researchers at the pinnacle of their fields—Faraday and Humphry Davy before him—engaged in public outreach to crowds of fashionable and curious spectators in a large lecture theater. The lecture hall included space for demonstrations, connected to and supplied by laboratories where the demonstrations were prepared. The design feature of prep room connected to lecture hall became common in university laboratory buildings erected in the 19th century.

University education moves to the forefront in chapter four, which features Justus Liebig's laboratory at the University of Giessen. Morris summarizes Liebig's major research accomplishments before alluding to Liebig's justly famous innovative methods for training chemists. He points readers to other works that describe and ana-

lyze those methods in detail. Morris's focus, though, is on descriptions and illustrations of the laboratory where this training occurred, concentrating on its state in the 1840s after a major expansion. An 1842 illustration of the Giessen laboratory depicts fume cupboards (better known to American chemists as fume hoods). This piece of safety equipment spread in new or renovated university laboratories in the second half of the 19th century, appearing most often on the inside of the lab's exterior walls, especially on the interior of the building's exterior walls. The 1842 illustration of the Giessen lab also shows cabinets for equipment storage built under the work surface; it shows patterns of drawers and doors that would still be recognizable today as belonging to a chemistry laboratory.

Robert Bunsen and his new laboratory at the University of Heidelberg, opened in 1855, are the stars of chapter five. That lab serves as the focal point of a treatment of utilities that 20th- and 21st-century chemists take for granted: gas, water, and electricity were "modern conveniences" in the mid 19th century. The laboratory building had water and gas supplied from municipal services, and that could only happen in localities which made such services available. Every chemist—indeed, every student of introductory chemistry—knows the name Bunsen from the eponymous burner that produces a hot and stable flame of low luminosity. So Bunsen's lab is an obvious touchstone to discuss the innovation of gas utilities in chemical labs. It is also appropriate for water utilities, for Bunsen also invented the water aspirator widely used in vacuum filtration. That apparatus is hardly less widespread than the Bunsen burner, but its connection to Bunsen is much less well known.

Chapter six focuses on chemical palaces, monumental buildings that housed large lecture halls, laboratories and specialized accessory rooms (for balances or polarimeters, for example), museum-like displays, and often residential quarters for the professor and his family. Wilhelm Hofmann is the chief figure of the chapter, and the new chemistry building he designed as part of his move to accept the chair of chemistry at the University of Berlin in the 1860s is the chief edifice. Chemical palaces such as this reflected the wealth and prestige of chemistry as a discipline, of the chemists who directed them, and of the states that constructed them. Indeed, the promise of a new chemistry building was often an incentive for attracting a prominent chemist to accept move to a chair at a different university. By the last third of the 19th century, the laboratory spaces inside a university chemistry laboratory building would be recognizable as such by any early 21st-century chemist. Benches, aisles, and bottle racks were by then common.

The diffusion of the "German model" academic laboratory building throughout Europe and North America in the late 19th century is the subject of chapter seven. Henry Enfield Roscoe and his laboratory at Owens College, Manchester, England, are the featured chemist and institution, but this chapter intentionally casts a wide net to examine the spread of buildings like Hofmann's Berlin and Bonn palaces. Indeed, Hofmann continues as an important figure in this chapter because of his openness in publishing relevant details of those palaces.

Chapter eight closes this run of chapters on academic chemistry laboratories by scrutinizing a feature of such buildings that arose in Germany and proved particularly popular in the United States: the chemical museum. Chemical museums were collections of artifacts used in teaching—objects such as products of chemical industry, minerals, chemical specimens, and the like. Chemical museums flourished around the turn of the 20th century, and they disappeared over the course of that century and were largely forgotten. For the most part, historians of chemistry have not written about this type of chemical museum, with the exception of the one featured in this chapter, Charles Frederick Chandler's chemical museum at Columbia University in New York. This chapter, like the previous one, ranges over much of Europe and North America to show many examples of this peculiar kind of chemical space.

Chapter nine leaves the palaces of academe for laboratories in chemical industry. Late 19th-century research labs in industry were often similar in appearance to the German-style academic laboratory, though usually less opulent. Here the exemplar was the pharmaceutical lab at Bayer's facility in Elberfeld, Germany, and the featured chemist is Bayer's Carl Duisberg. Morris reminds readers that chemical industries needed labs for more than research and development. Analytical labs devoted to quality assurance and process control were typically much more basic than their academic counterparts.

Morris treats government laboratories in chapter ten. Their principal task in the late 19th century was analytical work in support of enforcing regulations for revenue and safety. The Government Chemist's Laboratory in London, and its first principal chemist, Thomas Edward Thorpe, are the chief examples of this chapter.

Morris returns to academic laboratories in the book's final two chapters, bringing the subject into the present

century after a stop in the 1960s. Chapter 11 concentrates on the Stauffer Chemistry Building at Stanford and the department chair who presided over it, William Summer Johnson. The Stauffer building was one of the first designed for the "instrumental revolution" in chemistry research (NMR in particular). It segregated many of the electronic instruments that supported chemical research, along with their specialized operators, from the laboratory spaces where wet chemistry was done. Both the architectural features of the exterior and the interior arrangement of instrument rooms were departures from the monumental style of the chemical palace and its laboratories of aisles and benches.

Oxford University's Chemistry Research Laboratory (CRL), opened in 2004, is the focus of Chapter 12. In several ways, this building extends trends first mentioned in the previous chapter: instrumentation and specialization are taken still further in the CRL. Even the less specialized workspaces there have "clean" and "dirty" areas physically separated but visually connected by glass partitions. Even more prominent than form and function in Morris's account of the CRL is its financing, which relied heavily on commercial companies spun off from Oxford. This too is a continuation of a trend noted in the previous chapter. Graham Richards was chair of Oxford's recently unified chemistry department when the new building was planned and constructed; Richards had previously served as chairman of the University and Industry Committee at Oxford and was an important figure in setting up some of the university's commercial spin-offs.

Morris is an expert and congenial guide in this tour of twelve sites of chemistry highlighted in the book (and of countless additional ones) over four centuries. Many of the sights are familiar to chemists, especially the humble equipment practicing chemists see nearly every day and take for granted. Morris provides insights of context and origin into those material artifacts. Chemists may look a little differently at their water aspirator, fume hood, or instrument room after reading *The Matter Factory*.

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- Councilor (2018-2020 term): Mary Virginia Orna
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- Alternate Councilor (2018-2020 term): Arthur Greenberg