

crowded and flapped its wings every hour and was deemed such an important symbol of the clock itself that it was refurbished and included in the renovated sixteenth-century clock.

Oestmann's study, which is published in Brill's series on scientific instruments and collections, takes as its main focus the sixteenth-century iteration of the clock, although it begins with the first instantiation, built between 1352 and 1354. After a brief discussion of the automata of that fourteenth-century mechanical clock, the author moves into the initial attempts in the first decades of the sixteenth century to renovate the clock, which was finally carried out under the leadership of mathematics professor Conrad Dasypodius between 1571 and 1574. Then Oestmann moves on to a consideration of the artistic embellishments on the clock (which have received attention from art historians interested in the work of painter Tobias Stimmer) and the technical elements, before exploring the relationship between Dasypodius's design and his interest in ancient architecture (Vitruvian) and engineering (Alexandrine). Finally, the volume contains a number of useful appendixes, including several excerpts of Dasypodius's writing; a description of the design of an astronomical clock (now lost), designed by Isaac Habrecht (responsible for the technical execution of the Strasbourg clock designed by Dasypodius) in 1583; and dozens of illustrations, diagrams, and images. Because Dasypodius's writings about the clock survive (alongside his commentary on Ptolemy and his text on the importance of mathematics), as do contemporary accounts from the university and town leadership, as well as from artisanal archives, Oestmann has a rich body of sources to contextualize this important artifact and reveal its meanings to the people who devised, built, and installed it. The result is a volume that should find readers among scholars interested in the history of science and technology, early modern studies, the Reformation, urban studies, and the relationship between engineering, art, and design.

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Thrifty Science: Making the Most of Materials in the History of Experiment.
Simon Werrett.

Chicago: University of Chicago Press, 2019. x + 304 pp. \$45.

As a member of the last generation of Brownie Girl Guides to earn a Thrift badge (discontinued in 2003), I was raised to associate thrift with a particularly gendered form of postwar make do and mend homemaking. To gain the small triangular Thrift badge, embroidered with a piggy bank, for my Brownie uniform, I had to darn a sock, make something out of secondhand material, and have my mother confirm that I kept my uniform clean and tidy. Simon Werrett's monograph *Thrifty Science* makes clear that the skills of keeping one's belongings neat and in good repair, and making something

new out of old material, should not be restricted to early twentieth-century female domestic labor. Rather, he shows through a wide range of evidence drawn from the Royal Society's *Philosophical Transactions*, manuscript receipt books, diaries, wills, and letters, that thrift was considered an ideal way of interacting with the early modern material world. Advice books on household economy placed thrift as the Aristotelian mean between extravagance and miserliness, suggesting that being able to make use of one's material goods by taking care of possessions and choosing objects that could be put to multiple purposes was a skill valued by men and women in seventeenth- and eighteenth-century Britain. To be thrifty was to thrive.

Werrett focuses on the practice of thrift by early modern scientific experimenters, who often worked from home and used household pipkins, linen cloths, and tobacco pipes for their experiments, taking notes on scrap paper and even old playing cards while working in their bedchambers or up on the roof. We hear how Benjamin Franklin (unsuccessfully) asked his family to catch lightning in electrical phials using rods attached to the side of the house, and learn how he improvised a kite to catch it from the sky with hemp twine, a silk handkerchief, and a door key. Thrift, Werrett is clear to point out, did not entail simple frugality, but rather the ingenious or inventive use of objects to hand, combined with purpose-built tools when necessary. Robert Symmer's two-fluid theory of electricity was inspired by witnessing his silk stockings crackle and spark when he removed them in a dark room, and he experimented with how they were attracted to his wallpaper and looking glass. Fine silk stockings, when put to use in an electrical experiment, could be just as thrifty as my darned Girl Guide sock.

Specialized purpose-built equipment could be used thriftily, through careful repair, adaptation, and sharing. Werrett shows how instruments were often bequeathed to collaborators and friends, or sold through secondhand dealers and auctions. By the nineteenth century, auctions were an important means to circulate natural-philosophical goods, and contributed to the dismantling of aristocratic science as private collections were shown and then dispersed into the emerging public sphere. The book ends with a chapter on the development of what Werrett terms *economic science*—that is, the shift of experimental science out of the home with its values of thrifty balance, and into the national sphere of industrial progress and profit, requiring dedicated teaching laboratories and specialized scientific equipment. Werrett's account is nuanced, and he uses language carefully, teasing out early modern concepts of shift, frugality, and refuse from more modern vocabularies of reuse, zero waste, and recycling. *Thrifty Science* is a timely reminder that science does not have to be purpose-built, expensive, and environmentally unsustainable.

Of evident import for historians of science, *Thrifty Science* should also be read by social, cultural, and economic historians, and particularly those who work on material culture, for what it tells us about the culture of making use of things. While the book does draw on surviving objects and depictions of early modern experimenters, evidence of thrifty practices and their cultural associations could be further teased out through case studies of instruments, tools, and visual accounts of early modern science. Cornelis

Bega's compelling 1663 painting of an alchemist, used as the book's jacket image, is not examined by Werrett, but its depiction of a man in tattered clothing hunched over an alembic and surrounded by broken pots and curled papers suggests that there was a fine line between thrifty ingenuity and cluttered folly. By prompting such investigations, Werrett's clear and compelling account will then be made even more useful through its own thrifty application by scholars of visual and material culture.

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Balkan Wars: Habsburg Croatia, Ottoman Bosnia, and Venetian Dalmatia, 1499–1617. James D. Tracy.

Lanham, MD: Rowman and Littlefield, 2016. viii + 448 pp. \$85.

With *Balkan Wars*, James D. Tracy undertook a bold and massive endeavor: to write a synthesis of the first phase (1527–1606) of the confrontation between the Habsburg monarchy and the Ottoman Empire, two early modern mega-states. In order to get the full picture, the author also skillfully integrated into the narrative the actions of the third mega-state, the Republic of Venice. Tracy presents to his readers a rather complex narrative of how, in the end, the two profoundly different Christian states, with often conflicting agendas in the region, managed to stop the seemingly unstoppable Ottoman advance. Tracy argues that, in its essence, this long confrontation represented a clash between two fundamentally different types of government: on the one hand, a highly centralized state in which the government rules by decree (the Ottoman Empire), and, on the other, a decentralized composite state (Austrian Habsburg domains) in which the central government was forced constantly to negotiate and renegotiate both the formulation and the execution of its defensive policies.

Relying on the vast amount of published primary sources and rich secondary literature, Tracy meticulously reconstructs the distinctive phases of this conflict. Starting with the disintegration of the Hungarian kingdom (chapter 1), Tracy analyzes the swift Ottoman advances and consolidation of Habsburg rule over newly acquired territories (chapters 2–3), and then the critical phase of the confrontation in which the Austrian Habsburgs managed to establish the border defensive system capable of stopping the Ottomans (chapters 4–5). Tracy concludes his narrative with an analysis of the events of the Long Turkish War (chapter 6), during which a stalemate between the two empires was finally reached. In sum, the author has created probably the most comprehensive textbook available in English dealing with the military and political aspects of the Christian-Ottoman confrontation in the region that can be loosely identified as the Western Balkans. Sections that provide wider political context for the events taking place along the Croatian-Slavonian-Dalmatian-Bosnian frontier represent, in terms of