important clarifications, although what he finds clear and obscure does not always match my own intuitions. For example, he complains that Hobbes conceives 'rather obscurely' of space as 'the phantasm of a thing existing without the mind simply' (p. 653). But Hobbes' point is not obscure (although his archaic English is, at least on first reading). Space, Hobbes argued, is just a subjective frame of reference, not real in its own right. It is our awareness of body 'simply', that is, of body having no other attribute except that it is located somewhere. Body certainly exists outside our minds, but the space which body occupies is a purely mental construction: it is the system of coordinates or external locations which the mind constructs out of its experience of real extended things. Having labelled Hobbes' account obscure, Gabbey then quotes Descartes' idea that motion is a mode, 'just as a shape is a mode of a thing' (p. 655) without further explanation: but that seems to me one of Descartes' most obscure ideas.

Finally, Mahoney's chapter on 'the mathematical realm of nature' is to be particularly welcomed, partly because so much discussion of seventeenth-century mathematics makes so few concessions to the reader, whereas this is an excellent clear introduction to the mutual relations between mathematics and mechanics in the seventeenth century, as well as to some of the philosophical problems that developments in mathematics generated, especially around the idea of infinity. There are exemplary discussions of optics, free fall, pendulum motion, and of the theory of curves and the theory of equations. Mahoney's account is just the kind of thing needed in this area, giving readers a taste of the depth and complexity of the problems without losing many of them on the way.

The *Cambridge History of Seventeenth-Century Philosophy* is the most ambitious and comprehensive of the Cambridge histories to date. It has faced logistical problems which the earlier histories have not faced because of the sheer amount of relevant material in the seventeenth century, and it has taken fourteen years to complete. It is a magnificent achievement and will be of as much interest to historians of science as it is to historians of philosophy.

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Nachum Dershowitz and Edward M. Reingold, **Calendrical Calculations**. Cambridge: Cambridge University Press, 1997. Pp. xxi + 307. ISBN 0-521-56413-1, £40, $64.95 (hardback); 0-521-56474-3, £14.95, $22.95 (paperback).

What a wizard wheeze! A set of computer programs to calculate any date in any calendar and convert between them. Praise, first, for Dershowitz and Reingold, computational calendricologists, who have devoted a large part of their joint lives to a task which anyone in their right mind will be glad someone else did.

Calendrical Calculations is presented by its publishers as 'definitive', 'accurate', 'useful', 'easy' and 'a must', which coming from CUP immediately arouses interest. Its purpose is 'to present, in a unified, completely algorithmic form, a description of fourteen calendars and how they relate to one another'. The world's main calendars are all here: Christian (both Gregorian and Julian), Hebrew, Hindu (both old and modern), Islamic, modern Persian, Coptic, Mayan and Chinese. There are also three modern reformed calendars, all of them effectively defunct: the Baha'i calendar, the French revolutionary calendar, and the ISO (International Standards Organization) calendar, an excessively sensible Swedish invention. Brief explanations are given of each, and there are valuable overview chapters on calendars in general and on time and astronomy. The bulk of the book, however, is given over to an explication of the algorithms into which the calendars are translated, in a computer language called LISP. These are set out in an appendix. The book comes complete with a license (yes, you are allowed to use it) and an associated website, bristling with errata.

As the millennium approaches, books purporting to explain the calendar are appearing like cactus flowers after a storm, full of second-hand errors, third-order simplifications and outright myths. Dershowitz and Reingold, by contrast, have worked at source and confronted every difficulty. Their book can be recommended as a pithy and reliable distillation of all the world's main calendars. As a bare work of reference, it leads the market. Its corresponding weakness is the need to fix upon one version of each calendar as definitive, whereas all major

https://doi.org/10.1017/S0007087498243524

calendars have in fact been modified and adjusted over the centuries. This robs it of historical value, and makes long-range projections and comparisons unreliable.

The authors indeed point out (p. 28) that their method produces answers which are 'mathematically sensible, but culturally wrong'. Some examples will illustrate this point. The Julian and Gregorian calendars are treated as two distinct entities, even though the Gregorian was in fact a minor correction to the Julian. Its adoption in different states at various stages over the four centuries since 1582 is not tracked; we are offered instead two timeless and unreal paradigms, hypothesizing Easters which never in fact existed. The computer cannot cope with Gregorian countries which observe a Julian Easter (such as Greece), or an astronomical Easter (as with some eighteenth-century Protestant states). It is thrown by the Julian hop from AD 1 to 1 BC, and invents a Gregorian year 0, giving out-of-synch BC dates for the two versions of the Christian calendar. The Islamic calendar given is the civil version only, whereas the Islamic calendar is religious; its holy days are determined by observation and announced annually by the religious authorities; they cannot simply be extracted from the civil framework. The existence of a theological divide in the Islamic world between those who measure time by local observation of the new moon and those who accept pips from Mecca is not recognized.

Oblivious to such incalculables, the computer races serenely on, generating absurdities such as Mayan equivalents for 39 December and the Gregorian Easter for the year zero. Curiously, it follows American cultural convention in recording dates in the mathematically illogical form of month-day-year. Finally, there is the little problem of the time of the day. The computer has to cope with different conventions of starting the day at sunrise, midnight, noon and sunset, with local time (general until the mid-nineteenth century), with different time zones, with daylight saving time (which is explicitly ignored) and with events such as Easter, Passover and lunar months which rely on exact observation of the phases of the moon and which can differ by a month depending upon how and where the measurement is done. The solution is to take the day as beginning at midnight but make conversions at noon, Julian time. So, we can give or take a day throughout.

Such problems are generated by the very nature of the enterprise, and Dershowitz and Reingold are well aware of the limitations of the digital approach to calendars. They readily admit (p. 28) that 'the astronomical code we use is not the best available, but it works quite well in practice, especially for dates around the present time, around which it is approximately centred. More precise code would be time-consuming and complex and would not necessarily result in more accurate calendars.' No matter, for the computer program on which the book is based will soon be as obsolete as the punch card. Here and there, there are hints that the authors (understandably) favour simplified calendars such as the French revolutionary and ISO calendars, from whose short and troubled histories there are surely lessons to be drawn.

The calendar, any calendar, is by its very nature an analogue device, designed to track the incommensurable movements of the earth, moon and sun, to accommodate feasts and holy days governed by arbitrary human rules, and to reconcile conflicts with reference variously to civil, theological or astronomical criteria. No formula can express all that. It is precisely because calendars cannot attain regularity that civil and religious conventions have evolved to govern them. To attempt to reduce these to digital uniformity is sheer hubris. Computers can *mimic* the calendar, just as they can mimic thought, but a computer program will not *be* the calendar, and cannot be interrogated as if it were; we are talking to the monkey, not the organ-grinder. At best, matching calendars is as delicate as mating pandas. At worst, it is as vain as trying to adapt Australian railway trains to run on tramways in Manchester, or trying to find the date of the world cup in pre-conquest America. The history of western attempts, since the Enlightenment, to reduce the complex cycles of the human and natural calendars to astronomical or digital perfection is in itself an episode in the history of science whose history, perhaps fortunately, remains to be written.

https://doi.org/10.1017/S0007087498243524

We can be grateful that so useful a work of reference has been created from a project of such awe-inspiring futility.

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William H. Brock, **Justus von Liebig: The Chemical Gatekeeper**. Cambridge: Cambridge University Press, 1997. Pp. xiv + 374. ISBN 0-521-56224-4. £50.00, $79.95.

One of the founders of organic chemistry, Liebig (1803–73) was also an important figure in the development of the laboratory-based research school, the popularization of chemistry, the application of chemistry to industrial, medical and agricultural projects and in a range of other spheres which were a focus of concern in the nineteenth century. If only for this reason, a biographical study of Liebig demands the attention of all historians of the nineteenth century. That this is the first English langauge biography of Liebig to appear this century just adds to the urgency.

In chapter 1, we see Liebig make the transition from the 'bucket chemistry' (p. 2) practised in his father's workshop to the academic, though still very utility centred, chemistry of the universities of Bonn and Erlangen. At Erlangen in 1823, and in less than scrupulous circumstances, Liebig 'earned' his doctorate. From here he went to Paris and emerged as a promising young chemist familiar with the politicking that a career in science would necessitate. The chapter closes with Liebig installed as extraordinary professor of chemistry at Giessen.

Chapters 2 and 3 deal with Liebig's early Giessen career and this is supplemented by the two appendixes. Giessen, the principal town of Upper Hessen, was an economic and intellectual backwater when Liebig arrived. It is against this background that Brock convincingly contextualizes Liebig's appointment: it was part of a broader modernizing initiative which included the appointment of other young and energetic individuals in an attempt to break down the scholastic organization which still dominated the university. Perhaps inevitably this strategy led to disputes with the established order, a political backdrop which Brock skilfully deploys as the narrative hook for chapter 3. At the end of the third chapter Liebig has established an international reputation as an organic chemist, an area that, in the 1840s, he was to retreat from.

Chapter 4 starts to examine the other possibilities that Liebig's international renown had opened up by looking at his relationship with Great Britain, a relationship that was to prove rich and fruitful for both Liebig and his British friends and acquaintances. During a whirlwind tour of the British Isles in 1837, Liebig consolidated existing friendships and cultivated new ones. In particular he used the visit to impress the council of the British Association for the Advancement of Science, engineering a commission to write for them a report on the progress of organic chemistry. This commission materialized as the first edition of his *Agricultural Chemistry*. Brock emphasizes the importance of Liebig's flirtation with Britain, suggesting that the attraction was mutual. While Britain represented a largely sympathetic audience, although with occasional heated controversy, Liebig was also an effective figurehead for the generation of young chemists, engineers and doctors emerging in Britain as distinct professional groups. Although Brock himself does not explore the issue, the argument is richly suggestive. Professionalization of science is usually connected to the late nineteenth and early twentieth centuries and to the debates arising out of evolutionary theory and allied discourses. More research needs to be done on the role of non-Darwinian debates in the professionalization of science.

The central and best parts of the book, chapters 5–11, offer a fresh perspective on Liebig's life and work. Paying particular attention to his place and placing in British science and focusing on the ways in which Liebig located science in social, economic and political arenas, these chapters offer a much needed counterbalance to our understanding of Liebig as an esoteric theorist and laboratory recluse. Chapter 5 deals with the commercial possibilities of science, showing that Liebig was at least as concerned with the utilitarian and humanitarian applications of science as he was with analytic procedures and theoretical intricacies. Chapter 6 turns to Liebig's agricultural chemistry and especially its reception in Britain. The publication in 1840 of *Chemistry in its Applications to Agriculture* made Liebig an international

https://doi.org/10.1017/S0007087498243524