Pluralité de l'algèbre à la Renaissance edited by Sabine Rommevaux, Maryvonne Spiesser, and Maria Rosa Massa Esteve

Le Savoir de Mantice 21. Paris: Honoré Champion, 2012. Pp. 352. ISBN 978–2–7453–2398–9. Paper €85.00

Reviewed by
Richard J. Oosterhoff
University of Notre Dame
richard.oosterhoff@gmail.com

One central narrative in the history of science addresses how we came to use letters, lines, and squiggles to compress dramatic mathematical and physical stories into compact, digestible phrases of algebra. For historians of mathematics, the issue is doubly pressing. First, algebraic language is simply how modern mathematics works, so its emergence is worth knowing about. The second reason follows. For easier comprehension, historians tend to translate old texts into modern algebraic notation and then deal with ancient mathematics through this algebraic translation.

Thus, the calls to respect original formulations in the history of algebra are especially crucial if we hope to understand how change came about (and not just what emerged). Reviel Netz sharpened Sabetai Unguru's charge to respect the original texture of mathematical language in his *Transformation of Mathematics in the Early Mediterranean World* [2004] by focusing on a shift from problems to equations. He argued that the genres, vocabulary, and diagrams of mathematics are not mere vestments on an algebraic skeleton but reshape the very structure of mathematics. He ended where the story of algebra begins, in Baghdad with the equations of Omar al-Khayyām and al-Khwārizmī. Students of Medieval and Renaissance mathematics are accustomed to picking up the history of algebra at this juncture, pointing to the vernacular traditions of Italy, Germany, and France (to a lesser degree), before landing in the algebra of François Viète and René Descartes around 1600. Though some scholars such as the late Michael Mahoney argued that more attention must be paid to the diversity of Renaissance algebra and its variety of genres and aims, in practice the story still tends to be told as a way to uncover the sources of Viète or Descartes, who finally disclose the 'unity of algebra'.

ISSN 1549–4497 (online)
ISSN 1549–4470 (print)

In this new volume, Sabine Rommevaux, Maryvonne Spiesser, and Maria Rosa Massa Esteve have gathered together studies that demonstrate the plurality of algebra in the Renaissance. The immediate occasion for this book was their conference, 'Unity or Plurality of Algebra (12th–16th centuries)' held at Tours in May 2009 as part of a CESR project begun in 2006 under Rommevaux's direction. As a whole, the volume should reorient the study of Renaissance algebra to consider a broader range of texts and to bring the specific diversity of algebraic practices into focus.

Chronologically, these studies range across the rise of 'algebra' as a basic feature of mathematical culture in Western Europe, notably through the evolution of textbook traditions: the first essay deals with the medieval Latin translations of al-Khwārizmī and the last examines the demise of the oral culture of the *Rechenmeister* in the generation before Descartes' *Géométrie* (1637). The structure of the book reflects an interest in the diverse textures of the operations and practices that were given the name 'algebra' during this period. This specificity is balanced by attention to the big questions that have often occupied students of Renaissance algebra, such as the relationship between arithmetic and geometry vis-à-vis algebra, and the candidacy of algebra to be a 'universal' or 'great' art.

The volume is organized into four sections on:

- (A) the medieval European reception of Arabic texts,
- (B) the regional styles of algebra in Renaissance Europe,
- (C) the relation of algebra to arithmetic and geometry, and the last and largest on
- (D) the variety of Renaissance definitions of algebra.

A volume of this sort is bound to energize the study of algebra by refocusing our attention on the details, since it consciously eschews grand statements or simplifications. In keeping with this approach, I will in this review restrict myself chiefly to supplying a survey of the book's individual chapters, followed with a couple of thoughts about fruitful directions for research.

A. The medieval European reception of Arabic texts

The two chapters on the Arabic traditions offer lessons on the limits of current scholarship. Max Lejbowicz focuses on the genealogy of Arabic algebra in the European context in the light of Gerard of Cremona's Latin translation of the *Kitāb al-jabr wa l'muqābala* of al-Khwārizmī. We all know this genealogy. Or do we? Lejbowicz tells a cautionary tale in recounting modern scholarship on Latin translations of al-Khwārizmī, showing how tenuous our grasp on that history is. Early 19th-century Europeans were only passingly interested in medieval Arabic scholarship and relied largely on faulty descriptions of manuscripts instead of directly examining them. The illustrious 19th-century historians of mathematics Guillaume Libri and Baldassarre Boncompagni each edited different Latin translations of the *Kitāb al-jabr*. But Lejbowicz, retracing their steps, shows how each managed to miss correct attribution by careless editing. Libri did not recognize that the translation had been by Gerard because he did not examine the other treatises in the manuscript that indicated Gerard's authorship, so he identified the translation as by 'Anonymous'. And Boncampagni, despite codicological counter-evidence, believed that the work which he edited to be by Gerard. And then the Latin reception of al-Khwārizmī grew even more complicated with the discovery of Robert of Chester's translation. (Robert of Chester's translation has become standard, especially in an English version; yet Karpinsky's modern edition is in fact based on a 16th-century manuscript that had been corrected for Johannes Scheubel's *editio princeps*, only a distant witness to the medieval manuscripts.) Lejbowicz's chapter suggests at least three tasks for future work. First, the Renaissance manuscript, still the standard image of medieval Latin translations of the *Kitāb al-jabr*, should be recognized as a late witness. Second, the treatise which Libri edited and assigned to 'Anonymous' should be known as that by Gerard of Cremona. Finally, since the authorship of Boncampagni's edition is now uncertain, we need studies of its true authorship. (Lejbowicz wonders whether yet another author might be responsible, i.e., Guillaume de Lunis.)

In a different way, Marc Moyon's chapter suggests that algebra had a limited role in Latin mathematics, at least in the Middle Ages. Surveying three practical mathematical treatises by Abū Bakr, Fibonacci, and Jean de Murs, Moyon considers the point of such mathematics. In Latin mathematics, did algebra serve primarily theoretical or practical purposes? All three authors were familiar with the rules of algebra. Did they use such operations to solve problems in the 'science of measurement'? Moyon finds that his three authors indicate an evolution in the uses of algebra: while Abū Bakr used algebraic rules as a mere alternative to traditional geometry, after him Fibonacci and Jean de Murs increasingly used algebra as its own method of solving certain problems. To be sure, neither later author leans on algebra too far: neither turns to algebra to analyze solids, for example, and the problems that they solved by algebra alone are 'marginal' to the practical geometry in question [55]. Moyon thus raises the intriguing possibility that algebraic rules were not used out of practical necessity. Rather, even in the middle of medieval *practical* geometry, algebra was seen as an alternative to traditional methods for *theoretical* reasons.

By showing algebra as not wholly necessary to practical mathematics—at least at first—Moyon's account nuances the usual story of algebra's origins in the late medieval Italian *abaco* tradition, where local teachers in mercantile towns passed on mainly practical texts and practices, which slowly filtered into the rest of early modern Europe. For example, in 15th-century Germany, the counterpart to *abaco* was the art of *Coss* which addressed old problems of currency exchange, measurement, and distance within a new vernacular tradition.

B. The regional styles of algebra in Renaissance Europe

For France, the story often begins with the 15th-century algebraic master of southern France Nicholas Chuquet, cast in the role of a vernacular receptor of the Italian tradition. Then, the spotlight usually shifts to humanist Paris, in particular, to the court-based, literary circles of Jacques Peletier du Mans. Giovanna Cifoletti [1992] described this rhetorical project as institutionalized in university Latin by Guillaume Gosselin, working in the 1570s. The second part of the book offers an opportunity to see whether this story holds.

François Loget opens this second part by brilliantly remapping the landscape of algebra in 16th-century France. He focuses on the 1550s, when a flurry of Latin algebras issued from Parisian presses. Thus, Loget moves away from Peletier and Gosselin's court-based algebra, instead putting the university in the foreground. In particular, the market for new Latin algebras in the 1550s suggests that the charismatic pedagogue Peter Ramus was especially responsible for making algebra a standard part of the science of numbers: it is Ramus who turns out to have especially modified algebraic expressions, shortening the cossist abbreviations of his German source, Johannes Scheubel, to mere letters. Here algebra enters Latin university handbooks.

But in Spain, as Maria Rosa Massa Esteve shows, algebra was more commonly found in vernacular practical arithmetics (with the exception of Pedro

Nuñes' work of 1567, which is discussed in later chapters). Practical arithmetics by Marco Aurel, Juan Pérez de Moya, and Antic Roca share simple language aimed at solving mercantile problems—Esteve reports no proofs or geometrical constructions. But she nonetheless thinks that these three works share two distinctive practices that contribute to the development of algebra. First, these algebras try to simplify rules for solving such problems by setting unknowns ('characters') in a series of continuous proportion. Second, they have an analytical approach to the 'Rule of the Thing'. That is, these vernacular works present this algebraic rule as the construction of an equation to check problems that have been 'imagined as solved'.[1] Esteve's close reading helps one sense the distinctive mathematical texture of the Spanish *arte mayor*, seeing it as a possible source of the analytic method so often tied to Viète and his reading of Pappus. In the *arte mayor*, analysis could become an explicitly shared algebraic method in the generation before Viète.

What then of Nicholas Chuquet? He brilliantly expanded on the most sophisticated parts of the Italian tradition. At the same time, because he never published in print, it has been hard to see whom he influenced, if anyone except Estienne de la Roche, whose *Arismetique* (1520) lifted many problems straight out of Chuquet's manuscript. Albert Heefer supplies a partial answer to this puzzle. Arguing that historians have missed de la Roche's innovation (though he used Chuquet's problems, he frequently offered new solutions), Heeffer intervenes in the historiography of algebra in two ways. The first has to do with algebraic objects themselves, a point that he has aired elsewhere. That is, Heeffer suggests that our understanding of early modern algebra has been confused by different kinds of 'unknowns'. Laboring under this confusion, historians have sometimes sometimes mistakenly identified problems as dealing with *multiple* algebraic unknowns when some of the 'unknowns' were just placeholders for knowns—they were not, for example, actually operated upon to solve the problem. By clarifying this point, Heeffer isolates a tradition of problems that actually deploy two unknowns. In 1474, Chuquet began to use a second unknown, an annotation calls this 'the rule of quantity'. This terminology also shows up in de la Roche. But then Christoff Rudolff, author of the first German algebra textbook, deploys a similar phrase. Did he learn from the French tradition? Heefer compares Rudolff's use of the phrase to de la Roche's. As a result, it seems possible

[1] See Kouteynikoff's account of Gosselin in a later chapter.

that Rudolff encountered Chuquet's problems through de la Roche's work or, Heeffer suggests, that by comparing the order of problems, the German *Rechenmeister* somehow had access to Chuquet's manuscript.

Heeffer's second methodological intervention is the database of 2000 algebraic problems from before 1600, which enables him to trace influences such as these accurately. Interested readers should investigate this database at http://logica.ugent.be/albrecht/math.php.

A mere three chapters, two mostly on France, cannot offer a comprehensive picture of the transmission of the medieval algebraic heritage. But they do suggest that the traditional story needs considerable work. Latin textbooks turn out to be as important as vernacular manuals; furthermore, all three chapters show that certain styles of mathematics are only partly explained by regional traditions.

C. The relation of algebra to arithmetic and geometry

In the third part of the book, Odile Kouteynikoff and Marie-Hélène Labarthe consider one of the oldest questions concerning Renaissance algebra: 'Is it actually an arithmetical tool or rather an application of geometry? Or is it instead a more fundamental mode of mathematical reasoning prior to both arithmetic and geometry?' To answer this question, they consider the works of the Paris humanist Guillaume Gosselin (died *ca* 1590) and Pedro Nuñes (1502–1578), professor of mathematics at Coimbra, both conceptually adept and widely learned in earlier algebraic traditions.

In Paris, after Estienne de la Roche in the 1520s and after the Latin revitalization of algebra in the 1550s, there was Guillaume Gosselin. His significance lies first in his *De arte magna* (1577) and then in his French translation of Tartaglia's treatise on number and measure (1578). Gosselin is of special interest because, on the one hand, he was deeply read in the tradition of vernacular problem-solving, a tradition that includes Stifel, Cardano, the Spanish *arte mayor*, and of course the earlier French authors. On the other hand, he also was a careful reader of the new editions of ancient Greek mathematics, notably Diophantus. The result all this reading, Odile Kouteynikoff shows, was a commitment to developing better theoretical tools.

Gosselin was especially attentive to Diophantus' use of 'fictions', replacing unknowns with 'false' values to approximate a solution systematically: the

Rule of False Position (or Hypothesis). Using this case study, Kouteynikoff shows us where Gosselin fits algebra in the hierarchy of arithmetic and geometry. At times, Gosselin made algebra a sub-discipline of arithmetic: algebra was practical arithmetic, he emphasized in his translation of Tartaglia. But at other times, he alerts the reader to how algebraic rules can be applied outside of numbers to geometrical objects. For example, Gosselin first formalized the Rule of False Position in an algebraic context and then used the ancient problem of duplicating the cube to reveal the rule's geometrical use. By working in different disciplines, algebra appears to be more fundamental than either of them. On balance, Gosselin seems to have seen the Rule of False Position as a more general, even universal, tool.

That was hardly the only option. Scholars such as Henk Bos have suggested that algebra depended on the geometrical tradition for methodological respectability [e.g., 2001]. Marie-Hélène Labarthe leads us in the same direction, tracing a path through the *Libro de álgebra en arithmetica y geometria* (1567) of Pedro Nuñes. She focuses on proofs for two of the six canonical rules inherited from al-Khwārizmī. To prove these rules, Nuñes thoroughly depended on geometrical constructions. His language makes clear that his algebraic reasoning about 'sides' and 'squares' is indeed about geometrical magnitudes—*cosas*, for example, are explicitly the sides of surfaces (*centos*). At the same time, Nuñes insists that the 'numbers' marking such magnitudes are subject to arithmetic. In particular, he follows the ancient prohibition of irrational fractions. As a result, the objects of algebra are defined by the combination of the ancient rules for both disciplines. Labarthe points out that her account vindicates Jens Høyrup's account [2002] of Nuñes, in which Nuñes' potential for innovation is limited by his assumptions from classical arithmetic and geometry. But Labarthe suggests that this very limitation is valuable in reconstructing precisely how arithmetic and geometry fit together in the history of algebra [213]. Here is one of the places in the volume where the authors might have passed a little further beyond careful textual analysis. The point needs explicit unfolding. I am ready to believe that Nuñes' exposition of algebra was enriched, not bounded, by the blend of traditional arithmetic and geometry. But how, exactly?

Gosselin and Nuñes make a fascinating comparison. Gosselin apparently was stimulated by ancient arithmetic to simplify through general, abstract rules, eventually breaking the traditional rules. In contrast, Nuñes may have been limited by the tradition but he built up a more systematic account of it. In both cases, however, the exposition of algebra depends on both arithmetic and geometry but it conceptually slips back and forth between the older disciplines.

D. The variety of Renaissance definitions of algebra

The last and longest group of chapters aims more directly at the question that distinguishes this collection from older histories of Renaissance algebra: 'What is, or was, algebra?' The question is important because historians of mathematics have often thought the answer obvious: just go back to the period and check whether a given figure had achieved a passing grade on a particular algebraic concept. This collection signals an effort to dig more deeply, with greater historical sensitivity.

This sensitivity shows first by attending to the account of algebra's origins that Renaissance practitioners themselves gave. In a chapter on 'Narratives of Algebra in Early Printed European Texts', Jacqueline Stedall points out that algebra was justified to the reading public by either reputable genealogies or promises of utility. Her account of genealogies is most developed. From Pacioli to Peletier, in the first half of the century, authors often reported that algebra was founded by a shadowy Arabic figure named 'Geber'. Høyrup [1996] and Cifoletti [1996] have argued that Renaissance mathematicians systematically obscured the Arabic roots of algebra in the 16th century. Stedall pinpoints the shift to 1550, when Johannes Scheubel observed that Regiomontanus had connected Diophantus to algebra (in an oration first printed in 1537). By the 1550s—the same decade that Loget highlights as a turning point—the Greek origins of algebra threatened to eclipse the vague Arabic attribution to 'Geber'. So did this changing attribution match a different definition of algebra? Stedall suggests that with Stifel and the generation of the 1550s, algebra was 'no longer to be seen as a collection of specific techniques (i.e., as inherited from al-Khwārizmī) but as a general method encapsulated in a single rule' to be applied anywhere in arithmetic, an account that fit nicely with its new origins in the *Arithmetica* of Diophantus [234]. The new account of algebra's classical origins fit new priorities, mathematical as much as political.

Stedall finds only one author advertising algebra for its own sake, Recorde in his *Whetstone of Witte* (1557). Her authors addressed a public who needed to be convinced that algebra was worth investment; within the more restricted republic of mathematicians, however, there were lovers of algebra such as Girolamo Cardano. To measure their lack of practical interest, one must dig past public images to private obsessions, as Veronica Gavagna reveals. Gavagna reconstructs the editorial history of a text that is often overshadowed by Cardano's *Ars magna*: his *Arithmetica*. Historians have mostly ignored the *Arithmetica*. Those who have not, have simply thought it a novelty that Cardano composed after his masterpiece, around 1545. But Gavagna finds earlier vestiges of the work. In 1539, Cardano sent a letter to Tartaglia with a copy of his newly published *Practica arithmetica*, mentioning his account of book 10 of Euclid's *Elements*. He explained that it resolved a new type of algebraic equation but was too long to publish with the *Practica*. Gavagna hypothesizes—in part on the basis of Cardano's autographs—that in fact Cardano was referring to the *Arithmetica*. But if it was written in 1539, why wait until 1545 to publish it? Tracing changes in Cardano's use of specific equations, Gavagna suggests that he was reluctant to publish it because he hoped to clarify parts of the work—some clarified bits were published in the *Ars magna*. Perhaps he meant to work out the remainder (specifically the sections on Euclid) at more leisure but he may have published what he had in 1545 in a hurry to establish priority. Meanwhile, if Gavagna's reconstruction holds, the *Arithmetica* now provides a snapshot of a key stage in the earlier development of Cardano's *Ars magna*. The implication would be that Cardano developed his algebra as commentary on Euclid's *Elements*, thus bringing algebra into the realm of learned reflection on classical problems for their own sake.

The same tension between practical and theoretical uses of algebra returns in Pedro Nuñes' algebra. Maryvonne Spiesser first shows that even though it was published in the vernacular, Nuñes' work based itself not on a local, Iberian practical tradition but instead on the Italian works of Pacioli, Cardano, and Tartaglia. Furthermore, he turned to sources such as Regiomontanus' *De triangulis omnimodus* (1464, printed 1533) for problems. In other words, the problems that he posed for algebra came from the developing canon of classicizing geometry. Speisser leads the reader through several examples of how algebra served to resolve such classical problems. Interestingly, Nuñes' commitment to the rigor of algebra is somewhat ambivalent. To be sure, it serves as a kind of master discipline, a 'scientific' method for all parts of mathematics. But Nuñes does not insist that his reader follow every proof: those are just for doubters. As Spiesser elegantly sums it up:

> The nature of algebra oscillates constantly between two poles: a science, coming out of geometry and which surpasses it; an art, a technique superior for resolving mathematical problems. [285]

One of Nuñes' most accomplished mathematical readers, the Jesuit mathematician Christoph Clavius, would collapse the poles of algebra as art and science. In a chapter that addresses Clavius' definition of algebra head on, Rommevaux reveals an aged, consummate pedagogue integrating some of the previous centuries' progress in algebra—he refers to Bombelli, Cardano, Tartaglia, Maurolyco, Viète, and the medieval arithmetic of Jordanus. Chiefly, however, he uses Stifel and Nuñes. Rommevaux demonstrates in particular that Clavius mentions algebra chiefly as an 'art' for resolving problems of every kind in mathematics. This puts him in the tradition of seeing algebra as a 'great art', like Cardano and Nuñes. But Rommevaux implies that, in reordering Nuñes, Clavius shifts the conceptual foundations of algebra. Instead of setting algebra off with geometrical proofs as Nuñes does, Clavius expresses algebraic rules as a 'continuation of the rules of elementary arithmetic' [308].

The final chapter of the volume brings out a theme that lies mostly latent in this volume: the social place of mathematics and the shape that it impressed on algebra. Do, in fact, the roots of the elite advances in Viète and Descartes' algebras lie in the practical soil of merchant maths? Ivo Schneider uses the German *Rechenmeister* Johannes Faulhaber to consider how the masters of German *Coss* shaped the concept of algebra in the decades around 1600. Such masters seem to have been mostly architects and mercantile teachers—not university masters—whose livelihood depended on an oral pedagogy. Schneider evokes the world of practical 'secrets', which teachers advertised to would-be students: Faulhaber claimed that *Coss* was an 'art and science' which would lead its practitioner to all other mathematical disciplines. This context helps explain why *Rechenmeister*, wary of sharing their wares too freely, circulated new results very slowly. For example, even though Cardano's solution of cubic equations was appeared in 1545, it was not available to a German public until 1608.

Schneider's account is most fascinating for what it says about the end of this oral, practical, craft-oriented culture of mathematics. Critics such as Descartes derided the *Rechenmeister* for not only their secretiveness but also the variety of 'tricks' that they invented to solve the same, simple problem, each master patenting his own 'methods'. This criticism partly reflects the disdain of Descartes, an academically-trained amateur, for Faulhaber's status as a practitioner with economic interests. The practical algebraist was undone by print culture, Schneider implies. After a fellow *Rechenmeister* divulged Faulhaber's algebraic secrets in print, he was compelled to make his name in other mathematical domains such as surveying and architecture. Not until 1622 did he publish in algebra. What he published that year, however, belies Descartes' dismissive judgment, for it included a solution to the quartic equation (equivalent to the solution in Descartes' *Géométrie* of 1637). In narrating this exchange, Schneider reveals a striking moment in the history of algebra. With printed algebras, readers could puzzle out their own solutions to problems instead of hiring a specialist to teach them—a fascinating glimpse of the tensions between professionals and the amateur without economic interests [e.g., 326].

E. Conclusion

At the beginning of this review, I mentioned Reviel Netz' large-scale account of the development of mathematics from problems to equations. This volume suggests that this mathematical story, far from becoming easier and neater between 12th-century Baghdad and the 17th-century Dutch Republic, first becomes much messier. One reason was the very rediscovery of classical mathematics, which forms an uncertain theme throughout this volume. Netz's analysis of ancient mathematics might provide a historical analogy to help understand what this rediscovery meant for Renaissance mathematics. Netz claims that late antique authors founded new (systematic) second-order reflections on mathematics by organizing the first-order works of classical geometers such as Archimedes, thus giving rise to systematic collections of problems and eventually new techniques (such as those by al-Khayyām and al-Khwārizmī) for dealing with those problems. This sounds a bit like an old story about Renaissance mathematics. In 1975, Paul Lawrence Rose suggested that the key contribution of humanist mathematicians was to make the store of classical mathematics available in new editions, translations, and commentaries, a necessary first step towards new creative answers to old problems. Rommevaux, Spiesser, and Esteve's volume suggests that the circle could be made larger: Renaissance mathematicians such as Stifel and Nuñes synthesized and built on the earlier classical, Arabic, and vernacular traditions all together. Thus, the key insight is that both scholarly and practical traditions need to be taken into account for algebra. It is foolish to exclude one or the other. The 'humanizing' Gosselin is a fascinating instance. Certainly, Gosselin's Rule of False Position is a practical analytic tool of the sort surely deployed by masters of *Coss* and *abaco*. Yet, to generalize the rule, Gosselin turned to Diophantus and the ancients.

This brings us to the social and material contexts of these books. Syntheses were achieved in textbooks. Several chapters focus explicitly on textbooks and, as a whole, this volume offers evidence of a momentous shift away from the *abaco* and *Coss* books for merchants towards algebra within a liberal arts education. While the works of Cardano and Stifel were meant to shore up a reputation among dueling practitioners, their Latinate, scholarly trappings put them into the world of liberal learning. With the flood of Latin textbooks published in the 1550s, we see algebra inserted into the liberal studies of the upper college and the university arts course. The very debate over whether algebra is chiefly an arithmetical or geometrical art is not only conceptual but was given special urgency by the social prestige of those disciplines as parts of the (disintegrating) quadrivium. Faulhaber's published work (his oral teaching notwithstanding) can hardly be called pedagogical. But Nuñes, Clavius, and Descartes all wrestle with the problem of presenting advanced material for students of the arts.

The shift towards liberal arts textbooks raises a number of unanswered questions about social uses of these works (a concern nearly explicit in Stedall's chapter). If Clavius' algebra, for example, serviced the hundreds of new *studia* and universities throughout Europe, did it also help merchants? Did this textbook revolution entirely pass by the clientele of the *Rechenmeister* and *maestri d'abaco*? Or did those demographics now attend city schools, where mathematics teachers could belong to the university world? What needs more work is the intended and actual readership of these works. Curiously, *Pluralité de l'algèbre à la Renaissance* expends hardly a word on the material apparatus or page layout of these mathematical books of the new age of print. Typography, diagrams, and physical descriptions of books say a great deal about authorship as well as readership (as one might infer from the mistakes of Libri and Boncampagni that Lejbowicz details). Yet, not a single image is reproduced, though some are imitated in modern typography.

To think about the broader significance of algebra in this period, we might reflect on Latin. Here *Pluralité de l'algèbre à la Renaissance* offers a helpful corrective. Often historians have mathematics have generalized about the social implications of mathematics from the language in which it was published, differentiating for example, between classicists and cossists. This is an especially fascinating question with regard to algebra, since it has often been identified with the cossist mathematics of the German *Rechenmeister* or the *abaco* tradition of Italy. Clearly, the vernacular often includes some of the most practical—and operationally sophisticated—forms of algebra. Likewise, the more theoretically rigorous efforts to prove algebra, to link it especially to geometry and arithmetic, occur in Latin treatises: the turn in Paris to Latin algebras of the 1550s and Clusius' algebra (1608). But there are plenty of exceptions to the polarity of vernacular/practical and Latin/theoretical: I only mention Stifel's *Arithmetica integra* and Nuñes' *Libro de algebra*. To see the larger topography of algebra in the 16th century, then, we need to do the kind of work that Schneider undertakes, linking the content of mathematical texts with the people, communal practices, and institutions that made such texts worth publishing. That is, the greater significance of the 'Latin turn' in Renaissance algebra is in the audience. Latin brought algebra into the arts classroom—which brings us back to the question of social utility of mathematics. Few contributors to this volume dwell on the larger audiences and the social contexts of algebra, with the exception of Schneider and Loget. That is hardly a criticism: to do the history of mathematics, we first need to get straight what the texts say. But what the texts meant and did in early modern Europe requires us to take another step, one that this volume now invites.

Acknowledgements Thanks to Robert Goulding for reading this review in draft.

BIBLIOGRAPHY

Bos, H. J. M. 2001. *Redefining Geometrical Exactness: Descartes' Transformation of the Early Modern Concept of Construction*. New York.

Cifoletti, G. 1992. 'Mathematics and Rhetoric: Peletier and Gosselin and the Making of the French Algebraic Tradition'. PhD dissertation, Princeton University. Princeton, NJ.

Cifoletti, G. 1996. 'La création de l'histoire de l'algèbre au XVIe siècle'. Pp. 121–142 in Goldstein, Gray, and Ritter 1996.

Goldstein, C.; Gray, J.; and Ritter, J. 1996. edd. *L'Europe mathématique/ Mathematical Europe. Histoires, mythes, identités*. Paris.

Høyrup, J. 1996. 'The Formation of a Myth: Greek Mathematics—Our Mathematics'. Pp. 103–110 in Goldstein, Gray, and Ritter 1996.

—— 2002. 'Pedro Nuñez. Innovateur bloqué et dernier témoin d'une tradition millénaire'. *Gazeta de Matemática* 143:52–59.

Netz, R. 2004. *The Transformation of Mathematics in the Early Mediterranean World: From Problems to Equations*. Cambridge.

Rose, P. L. 1975. *The Italian Renaissance of Mathematics*. Geneva.