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Shaping the Sciences of the Ancient and Medieval World: An Introduction

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Abstract: This introductory chapter gives an overview of the research question raised in the book as much for historians of science as for anyone working with, or producing editions of, ancient scholarly texts. It highlights the benefits that flow from a worldwide history of textual criticism and editions as well as from a focus on texts dealing with science—two key options that are taken in this book. Following the book’s scheme, the introduction first concentrates on ancient editorial practices, in particular examining their potential impact on modern editions. We then highlight how, through time, perceptions changed concerning what a text is, and how this influenced in turn how scholarly texts were made accessible. We offer an analysis of the ways historical, political and social contexts shaped editions and translations of ancient scientific works and documents, using the case studies offered in this book, before turning to an analysis of the specifics of editions and translations that bear on scholarly documents rather than on literary or religious sources. Finally, this introduction looks at how some elements specific to texts dealing with science—such as diagrams and numbers—have been edited and the specific work that has been done editing mathematical and astronomical texts of the past. All these threads help us reflect on how editorial practices have heavily mediated the way we have access to ancient sources dealing with science. The scholarship displayed here lays the foundation for further studies on the history of critical editions. It also raises questions for those who make scholarly translations and critical editions today.

Key words

History of critical editions, History of philology, History of translations, World history, History of science, philology of number, philology of diagrams

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1.1. Outlining the project of the book

1.1.1 *Historical Remarks about Textual Criticism*

In 1996, shortly before his untimely death, the historian of mathematics in ancient Greece Wilbur Knorr (1945-1997) published an article that bore a striking title: ‘The Wrong Text of Euclid: On Heiberg's Text and its Alternatives’. The title was referring to the critical edition of one of the major works of Greek antiquity—Euclid’s *Elements*—by Johan Ludvig Heiberg (1854-1928), the philologist who brought out editions of virtually all the ancient Greek mathematical texts.¹ To this day, Heiberg’s critical edition of the *Elements* (as well as most of his other editions) remains the authoritative reference. It has served as the basis for all the modern translations of the *Elements*, from the classic English translation published by Thomas Heath (1861-1940) in the first decades of the twentieth century (Heath 1908, second edition: 1926, reprinted as Heath 1956) to the most recent Italian translation (Acerbi 2007), including the French translation published at the end of the twentieth century (Vitrac 1990-2001). In other words, virtually all the historical works on Euclid’s *Elements* that have appeared since the publication of this critical edition have built upon it. Yet, Knorr (1996) expresses doubts about the capacity of this critical edition to represent the oldest state of Euclid’s *Elements* that could be reached with philological work. One could not explain more clearly how important it is for modern scholarship to reflect critically upon the critical editions of ancient writings that lie at the basis of today’s historical and philosophical work. This is precisely the goal of this book.

The thrust of Knorr’s argument is disturbing: In his view, because of the way Heiberg worked on his critical edition, he could concretely restore only a state of the text posterior to — and incorporating elements of — Theon of Alexandria’s fourth-century recension of the *Elements*. However, Knorr continues, in theory, the available documents allow us to shed light on states of Euclid’s *Elements* prior to Theon’s work, and hence closer to Euclid’s original text. The details of Knorr’s analysis are important: For Knorr, Heiberg had *a priori* ideas about the way Euclid had written the *Elements*. In particular, in Heiberg’s view, Euclid avoided logical gaps in proofs. This *a priori* assumption led Heiberg to discard medieval Arabic and Latin manuscripts of the *Elements*, on the sole ground that they did not fit with his expectations concerning this Greek work. Indeed, they had logical gaps that the earliest extant Greek witnesses (some of which were more recent than these medieval editions) did not have. Accordingly, Heiberg based his editorial work on these Greek witnesses, thereby carving his own assumptions into the corpus at the basis of his philological work, and, accordingly, into the critical edition that we now all use in our research on the *Elements*. How can research on Euclid’s proofs rely on Heiberg’s edition? This is the key issue that Knorr’s critical remarks raise.

By contrast, Knorr puts forward the thesis that these Latin and Arabic manuscripts themselves might be considered more faithful witnesses to a state of Euclid’s *Elements* prior to Theon’s edition and commentary than the Greek editions used by Heiberg, which represented a state of the text dependent on this later editorial work. Knorr further points out that this was precisely the hypothesis defended by the specialist of Arabic studies and history of mathematics Martin Klamroth (1855-1890), who during the same decades suggested basing a critical edition of Euclid’s *Elements* on the Arabic witnesses from the Middle Ages. The key point is that, as we will see, this case illustrates the general rule with respect to critical editions of ancient works rather than a marginal phenomenon.

¹ Heiberg’s edition of the *Elements* (1883-1888) was published as part of that of Euclid’s complete works by Heiberg and Heinrich Menge (1838-1904) (Heiberg and Menge 1883-1916). (Knorr 2001), published posthumously, returns to the same issue.

In fact, in the wake of Knorr's seminal article, doubts have also been raised about Heiberg's critical edition of the works of another major scholar of Greek antiquity, Archimedes. Heiberg's assumptions about Archimedes as a mathematician contrasted sharply with his hypotheses about the Euclid of the *Elements*. At variance with the idea that in the *Elements* the original text avoided logical gaps, in Archimedes' case Heiberg advanced the thesis that the mathematician did not bother with obvious arguments. This assumption led Heiberg to suspect a significant number of passages in the received text as 'interpolations', which he accordingly placed between square brackets in both the Greek text and the Latin translation (Chemla 1999). This holds true for Heiberg's first edition of *Archimedis Opera Omnia* (Heiberg 1880-1881) as well as for the second edition (Heiberg 1910-1915), which he published after new Archimedean writings had resurfaced (Netz 2004: 2).² As has been the case with Euclid's *Elements*, subsequent translations have drawn on Heiberg's critical editions. However, these translations dealt with Heiberg's suspicions of interpolations in quite different ways, as can be shown from taking a quick look at an example. We have chosen for this the second proposition of Archimedes' *On the Sphere and the Cylinder*. In his first edition, for this proposition, Heiberg (1880 (vol. 1): 14, Greek text) puts between square brackets two expressions, as he does in the translation into Latin (Heiberg (1880 (vol. 1): 14, Latin text). Consequently, in the translation, the bracketed expressions feature as having a status similar to the additions that Heiberg introduces into the text for the sake of explanation. In the second edition, the number of passages suspect of being interpolation increased (Heiberg (1910 (vol. 1): 12, Greek text). If we keep the example of the proposition 2, Heiberg added square brackets around another suspected term. Heath (1897), which offers a free English translation in which Archimedes' text is heavily modernized, relies on Heiberg's first edition: in the aforementioned second proposition, the passages suspect of being interpolations do not feature. In the twentieth century, two French translations of Archimedes' works appeared (Ver Eecke 1921, Mugler 1970-1972). For the same proposition 2, Paul Ver Eecke (1921: 8) silently translates the larger passage bracketed by Heiberg, but not the other two, without making his choices explicit, let alone what motivated them. However, in a footnote inserted in proposition 10, Ver Eecke makes clear that he does not translate a long passage suspected by Heiberg to be spurious (Ver Eecke 1921: 20). Mugler (1970 (vol. 1): 13-14) does for proposition 2 what he does everywhere: he reproduces Heiberg's brackets in the Greek text but translates the whole text into French without any indication—including the passages suspected of being interpolations. Finally, in the most recent English translation, Netz (2004: 43-45) translates the Greek text of proposition 2 according to Heiberg's second edition, including its square brackets, and he discusses their appropriateness as well as other editorial issues in the 'Textual Comments'. There, for proposition 2 of *On the Sphere and the Cylinder*, Netz expresses doubts about the validity of one of Heiberg's bracketing choices. Moreover, he argues in favor of another one, and introduces a new suspicion of interpolation that Heiberg had not pointed out. Netz's comment about the last and most important of Heiberg's bracketed passages (step 16 in the 2004 segmentation of the text) is worth reading for our purpose:

Step 16 belongs to an important class: pieces of text which may be authentic (and then must shape accordingly our understanding of Archimedes' practices) or may be interpolated. How to tell? Only by our general understanding of Archimedes' practice – an understanding which is itself dependent upon such textual decisions! Heiberg imagined a purist, minimalist Archimedes. In this, he may have been right: my sense, too, is that Step 16 is by a later scholiast. But we should keep our minds open.

² Decorps's chapter in this book outlines a history of editions of Greek mathematical texts of antiquity. She points out that Friedrich Hultsch's critical edition of Pappus' *Collection* (1876-1878) likewise considered several passages as spurious 'on the grounds of an ideal representation of what a Greek mathematical treatise should be' (see note 92).

One could hardly better formulate how critical editions and translations shape texts of the past according to the image editors and translators had of them, and therefore surreptitiously communicate these actors' assumptions to the readers. With respect to Greek mathematical texts of antiquity, we still need to assess fully the consequences of Heiberg's editorial practices and assumptions for subsequent historiography.³ More basically and more broadly, the above observations raise complex questions about the critical editions of ancient texts available today. We will not solve these specific questions here. Rather, this book aims to address general issues that these case studies point out and that can be summarized as follows:

As we have already underlined, our work on the history of ancient science depends in an essential way on critical editions that were prepared in modern times in contexts sometimes far removed from our own. The problem is that, on the one hand, we cannot redo these critical editions for each new investigation into the texts that we undertake. On the other hand, the extant editions cannot be used lightly and indiscriminately. This dilemma raises a simple question: How then can we equip ourselves with the appropriate critical tools to use these editions today? The examples of Heiberg's editions of Euclid's *Elements* and Archimedes' works highlight how the authors of editions draw on documents that were in turn produced in contexts different from their own. These authors put into play criteria to select the source material to be used to prepare their editions. They carry out textual criticism according to methods and values that depend not only on their personal choices, but also on the context in which they operate and the goals they assign to their editorial work. Highlighting these criteria, methods and values and analyzing them might enable us to use the results of these philological endeavors with the necessary critical distance. Our project for this book derives from these remarks. It appeared to us that an essential manner for the historian of science in the ancient world to acquire a critical distance of this kind was to develop a historical approach to the modern critical editions that we use daily in our research. This is one of the main aims pursued in this book.

1.1.2 Critical Editions and the Erasure of Clues about Practices

The full deployment of our project requires that analysis such as Knorr's be first expanded. Indeed, Knorr focused primarily on Heiberg's editorial work on the *discursive part* of the *Elements*. His remarks thus have a crucial impact in estimating, for example, the extent to which we can rely on Heiberg's edition to conduct a historical investigation about Euclid's mathematical ideas or about his proofs. More recent work by Saito (2006) has further suggested that Heiberg's edition could also be an obstacle for us to work on Euclid's mathematical *practices*, more specifically in this case, his practices with diagrams. For Saito (2006) has shown that the geometrical diagrams of Heiberg's edition diverged quite dramatically from those of the ancient editions of Euclid's *Elements* on which Heiberg's philological work rested (see **Fig. 1.1**). These diagrams thus also call for critical analysis. Saito and Sidoli (2012) have actually established that in this case Heiberg seems to have ignored the evidence about diagrams found in the manuscripts and that he simply included into his edition the diagrams from an early nineteenth century edition of the *Elements* by Ernst Ferdinand August (1795-1870).

³ For the case of Archimedes, Netz (2012) offers a reflection on this issue.

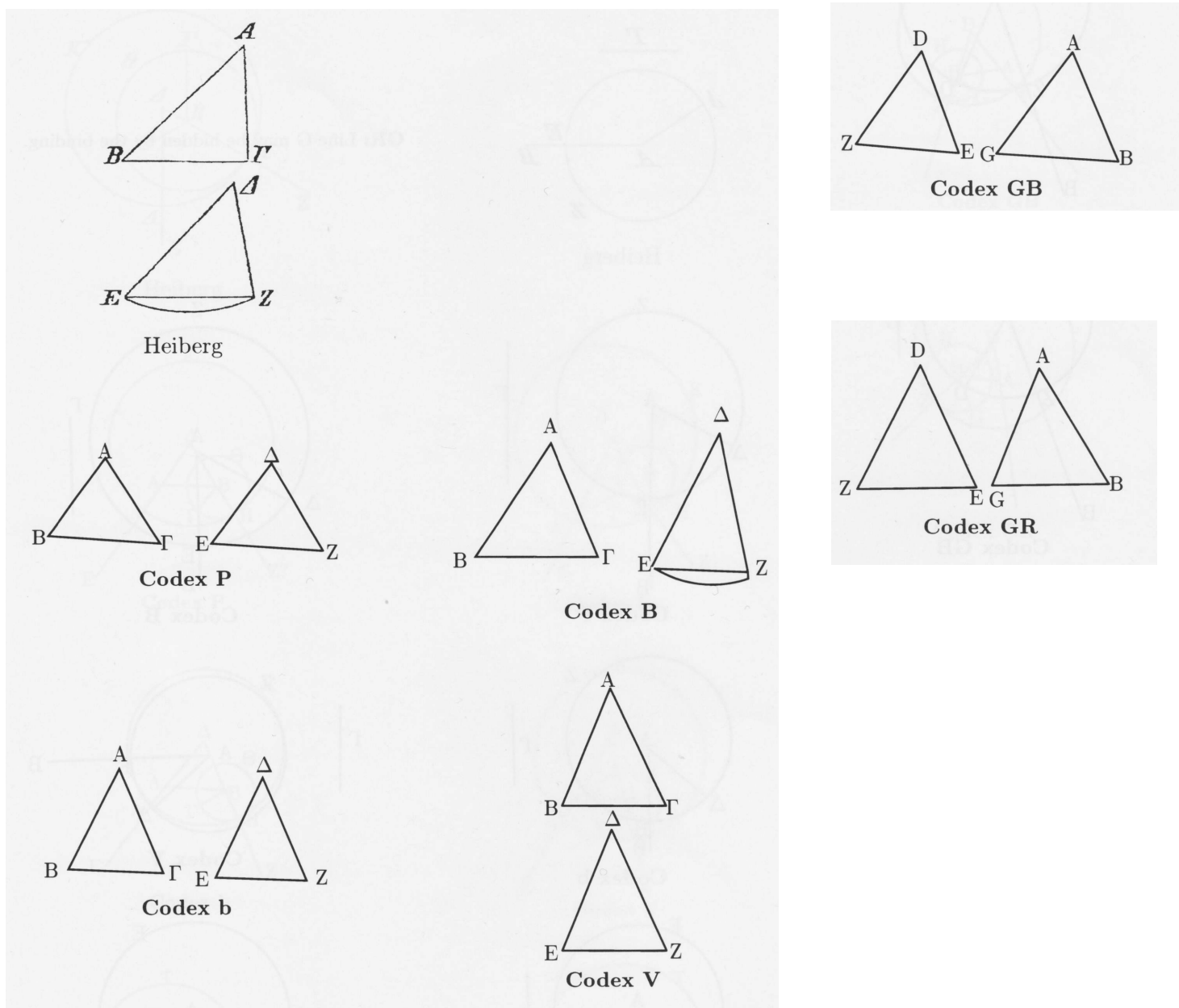


Figure 1.1: This figure is taken from (Saito 2006: 100). For Proposition 4 of Book I of the *Elements*, it shows the diagram found in Heiberg’s edition (top left) as well as a set of diagrams contained in ancient editions. Under Heiberg’s diagram, to the left, the reader can see the diagrams of the various Greek editions on which Heiberg relies. **Codex P**, **Vaticanus graecus 190**, was copied between 830 and 850; **Codex B**, **Bodleianus Dorvillianus 301**, was copied in 888; **Codex b**, **Codex Bononiensis, Bologna**, biblioteca comunale, 18-19, dates from the eleventh century, and **Codex V**, **Vindobonensis phil.gr. 31**, from the twelfth century. To the right, we reproduce the diagrams of two ancient Latin editions that Saito also provided: **GB: Bruges 521** and **GR, Vat. Rossiano 579**, which are two fourteenth-century copies of the Latin translation by Gerard of Cremona (1114 – 1187).

It is true that some facets of Euclid’s practice with diagrams, like those studied by Reviel Netz (1999), can be approached using clues that are found in the discursive part of the text of the *Elements*. Arguably, these facets might, at least partly, be captured using Heiberg’s edition. However, Saito highlights other facets of that practice whose study depends in an essential way on material features of the diagrams themselves. The ‘overspecification’ of the diagrams is a case in point (Saito 2006: 82). By this term, Saito refers to the fact that ancient editions feature diagrams that are more specific than the proposition requires. Let us illustrate this phenomenon with the example of Proposition I.4 of the *Elements*, which is precisely the topic of **Figure 1.1**. This proposition concerns two equal triangles and **Fig. 1.1** brings together the diagrams for it included in

the main ancient editions as well as in Heiberg's critical edition (Saito 2006: 100). Heiberg's diagram depicts these triangles as generic, whereas in Codex P the two triangles are equilateral and in Codex b and V they are isosceles. Are these witnesses outliers whose testimony should be disregarded, or do they reflect diagrams of a type Euclid used in his mathematical practice? The key point is that the oldest extant papyri also show diagrams that are overspecified, thus inviting us not to discard right away the hypothesis that the singular diagrams found in ancient editions might reflect those used by Euclid.

Figure 1.2 (a)

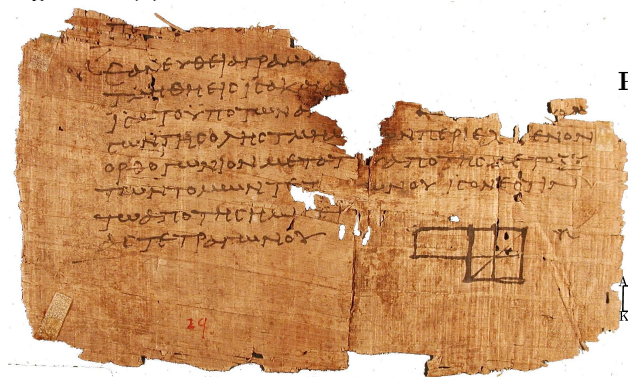


Figure 1.2 (c)

Proposition II.5

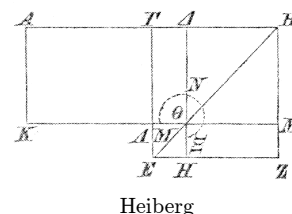


Figure 1.2 (b)

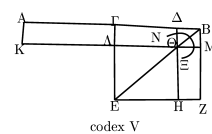
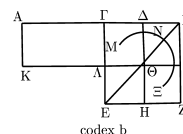
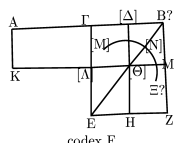
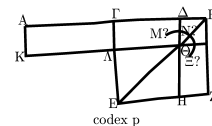
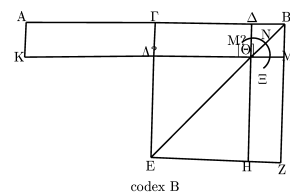
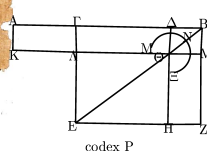


Figure 1.2:

Figure 1.2 (a): Papyrus *Oxyrhynchus* I 29, University of Pennsylvania. Downloaded from https://en.wikipedia.org/wiki/Papyrus_Oxyrhynchus_29#/media/File:P._Oxy._I_29.jpg (accessed February 16, 2021). According to Grenfell and Hunt (1898: 58), who provided the first edition of this papyrus, it shows 'the enunciation, with diagrams' of Proposition 5 from Book II of the *Elements*, and it was copied between the end of the third century and the beginning of the fourth century. Fowler (1987: 210-212) considers the copy was made between 75 and 125. **Figure 1.2 (b):** The edition of the diagram provided by Grenfell and Hunt (1898: 58). **Figure 1.2 (c):** Saito (2011: 47) reproduces Heiberg's diagram (on top) and (below) those of the manuscripts he used in his critical edition.

Figure 1.2 (a) reproduces one of these papyri, *Oxyrhynchus* I 29, edited by Bernard P. Grenfell, and Arthur S. Hunt (1898). The editors identified this papyrus as containing the enunciation and diagram of Proposition 5 of Book II of the *Elements*. Clearly, the diagram borne by the papyrus shows, on the right hand side, the square dealt with in Proposition II.5 cut into four identical squares. However, the text of the proposition and its proof more generally put into play a division of this square into two different squares and two rectangles. The diagram of the papyrus is thus overspecified, since it transforms shapes that in the general case are different from each other into four identical squares. Grenfell and Hunt's 1898 edition draws the diagram as shown in **Figure 1.2 (b)**. Like Heiberg's philological practice for diagrams, their edition thus erases the overspecification of the papyrus' diagram and substitutes it for a diagram that is closer to modern standards regarding the way the figure relates to the text of the proposition. The same remark holds true for Heiberg's treatment of the diagram for the related proposition in the *Elements*, which **Figure 1.2 (c)** reproduces along with the diagrams of the main ancient editions (Saito 2011: 47). Heiberg's diagram is lettered like those in the ancient editions of the *Elements*. However, as far as

the shapes are concerned, he discarded the evidence of the overspecified diagrams to redraw a diagram similar to the witnesses that were closer to a modern practice of diagrams. In other words, Heiberg drew the diagrams according to his own modern representation.

Recently, the study of Euclid's diagrammatic practices has become a hot topic in the history and philosophy of mathematics. These remarks imply that Heiberg's edition cannot without any further reflection serve as a basis for an approach to Euclid's practice of diagrams. Knorr's analysis thus needs to be extended beyond the discursive part of the *Elements*. In fact, as Netz (2012) further showed, the same conclusions hold true for Heiberg's edition of Archimedes' writings. We have seen that they also apply to Grenfell and Hunt's edition of the Oxyrhynchus papyrus.

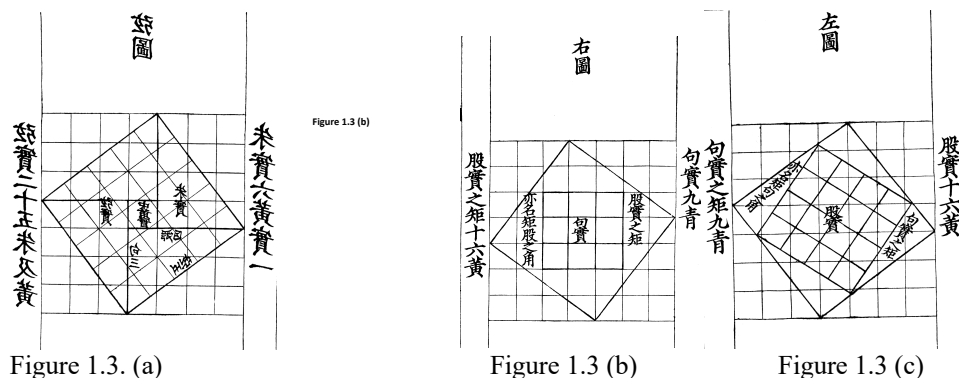


Figure 1.3. (a)

Figure 1.3 (b)

Figure 1.3 (c)

Figure 1.3 Bao Huanzhi's 鮑澣之 1213 edition of *The Gnomon of the Zhou [Dynasty]* (*Zhoubi* 周髀, first century BCE or CE): The three diagrams open a section of Zhao Shuang's 趙爽 commentary (third century) entitled:

'Figures of the base (*gou*) and of the height (*gu*), of the square and of the circle.'

Translation of the textual indications on the diagram:

Figure 1.3 (a)

The two characters at the top:

'Figure of the hypotenuse'.

Then, from top to bottom, from right to left:

'The square (*shi*) of the hypotenuse, twenty-five, is vermilion and yellow.// The square of the hypotenuse//The base is three.//Central yellow area (*shi*).//(in horizontal characters) The height is four.//Vermillion area (*shi*).//(slantwise) The hypotenuse is five.//The vermilion areas are six. The yellow area is one.//'

Figure 1.3 (b)

The two characters at the top:

'Right Figure'.

Then, from top to bottom, from right to left:

'The square of the base, nine, is blue-green.//The gnomon of the square of the height//The square of the base//Is also called the angle of the height as gnomon//The gnomon of the square of the height, sixteen, is yellow.'

Figure 1.3 (c)

The two characters at the top:

'Left Figure'

Then, from top to bottom, from right to left:

'The square of the height, sixteen, is yellow.//The gnomon of the square of the base//The square of the height //Is also called the angle of the base as gnomon//The gnomon of the square of the base, nine, is blue-green.'

Figure 1.4 (a-c)

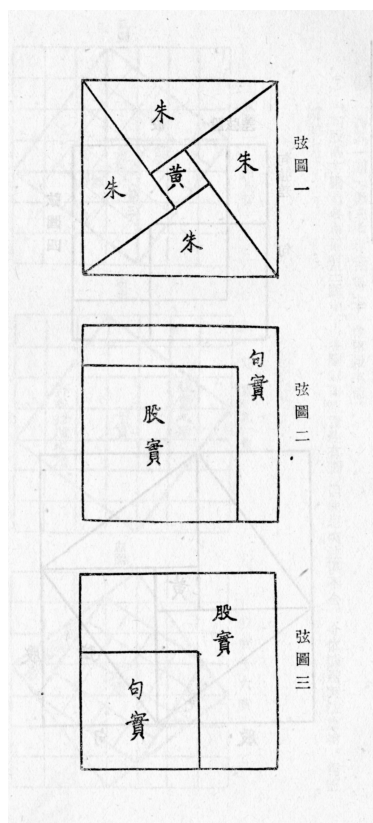


Figure 1.4 (d-e)

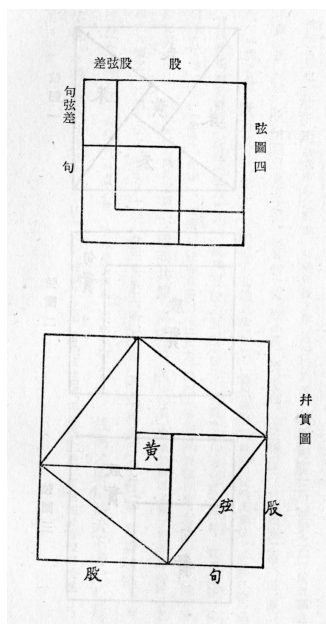


Figure 1.4: Critical edition by Qian Baocong 錢寶琮 (1963: 15-16) of Zhao Shuang’s diagrams. Translation of the textual indications on the diagrams:

Figure 1.4 (a)

From top to bottom, from right to left:
‘Figure of the hypotenuse 1:
Vermillion/Vermillion/Yellow/Vermillion/Vermillion’

Figure 1.4 (b)

From top to bottom, from right to left:
‘Figure of the hypotenuse 2:
Square of the base/Square of the height.’

Figure 1.4 (c)

From top to bottom, from right to left:
‘Figure of the hypotenuse 3:
Square of the height/Square of the base.’

Figure 1.4 (d)

From top to bottom, from right to left:
‘Figure of the hypotenuse 4:
Height/Difference between the hypotenuse and the height/Difference between the base and the hypotenuse/Base.’

Figure 1.4 (e)

From top to bottom, from right to left:
‘Figure of the square of the sum (of the base and the height):
Height/Hypotenuse/Base/Yellow/Height.’

Two remarks are important here. To begin with, the editorial practices for diagrams that we have described have an impact on the historiography. Indeed, in redrawing the diagrams of ancient Greek mathematical texts in this way, Grenfell and Hunt as well as Heiberg do not merely ‘modernize’ them. They further increase their distance from the diagrams found in other ancient

mathematical sources, e.g., in ancient Chinese mathematical texts that have come down to us. Let us illustrate this point with *The Gnomon of the Zhou [Dynasty]* (*Zhoubi* 周髀, completed in the first century BCE or CE)—this is the oldest extant Chinese mathematical classic handed down with ancient commentaries through the written tradition—and, more precisely, with diagrams used by the third century commentator Zhao Shuang 趙爽. **Figure 1.3 (a-b-c)** shows these diagrams as they are found in the earliest extant edition of this work, published by Bao Huanzhi 鮑澣之 in 1213. The other ancient editions share the same diagrammatic features as those illustrated by Figure 1.3. Zhao Shuang refers to these diagrams to discuss the correctness of algorithms that can be associated with right triangles. The use of square units in the diagrams indicates clearly that the figures are drawn for the right triangle whose three sides are, respectively, 3, 4 and 5. Zhao Shuang’s text also mentions these particular dimensions. Using Saito’s words, these diagrams are overspecified, in the same way as those found in ancient Greek mathematical documents.⁴ This remark underlines a similarity between practices with diagrams to which ancient Greek and ancient Chinese sources attest. However—and this is the key point—the similarity can be seen only if we rely on ancient editions. It is hidden if we compare Chinese sources with Grenfell and Hunt’s as well as Heiberg’s critical editions.

This is where the second remark comes into play. Indeed, the editorial practices concerning diagrams that we have highlighted in Grenfell and Hunt’s edition as well as in Heiberg’s are by no means an exception. Modern editions of ancient scientific texts exhibit phenomena of this kind much more broadly. We can illustrate this remark using precisely the way modern critical editions have dealt with the diagrams contained in Zhao Shuang’s commentary on *The Gnomon of the Zhou [Dynasty]* that we have mentioned above. Let us take, as an example, the first modern critical edition of *The Gnomon of the Zhou [Dynasty]*, which Qian Baocong 錢寶琮 published in 1963. As we have seen, **Figure 1.3 (a-b-c)** reproduces the diagrams as they occur in the earliest extant edition from 1213, whereas, as has already been mentioned, the diagrams found in the other extant ancient editions all share the features that this 1213 edition exhibits. In addition to showing that the shapes displayed bear unit squares, these ancient editions all contain diagrams with the same textual indications. These indications refer to colors (yellow, vermilion, blue-green), to shapes (e.g., gnomon), to places (e.g., center) and to specific dimensions, which echo those shown using the unit squares. Finally, the three figures seem to constitute a set of fundamental figures, from which the correction of all the algorithms Zhao Shuang gives about the right triangle can be established (Chemla 2005). **Figure 1.4** reproduces the diagrams that Qian (1963: 15-16) drew for his critical edition in order to feature Zhao Shuang’s diagrams. Clearly, the diagrams in the 1963 edition delete salient features of the witnesses. For instance, Qian’s diagrams do not make use of unit squares and, in correlation with this point, the textual indications in the modern diagrams do not refer to any particular value. Moreover, Qian replaces the set of three diagrams, as shown in all the ancient editions, by five diagrams, thereby modifying the nature of the relationship between the diagrams and the text. We argue that these changes delete key clues about ancient actors’ practice with diagrams, in exactly the same way as Grenfell and Hunt as well as Heiberg did for Greek mathematical texts of Antiquity. Moreover, Qian’s substitution of diagrams has had a clear impact on the later transmission of the text of *The Gnomon of the Zhou [Dynasty]*. Indeed, in the same way as Heiberg’s diagrams were reproduced in all the translations based on his edition, subsequent critical editions of *The Gnomon of the Zhou [Dynasty]* also used the diagrams that Qian (1963) inserted into the text and that differed radically from those of the ancient editions on which he drew.⁵

⁴ Chemla (2005) argues that Zhao uses these diagrams as paradigms.

⁵ See, e.g., for the *Elements*, (Vitrac 1990, volume I: 200-202) and, for *The Gnomon of the Zhou [Dynasty]*, the critical edition by Guo Shuchun 郭書春 and Liu Dun 劉鈍 (1998: 2). Note that, in the latter edition, the vertical presentation of the sequence of diagrams given by Qian was transformed into a horizontal one.

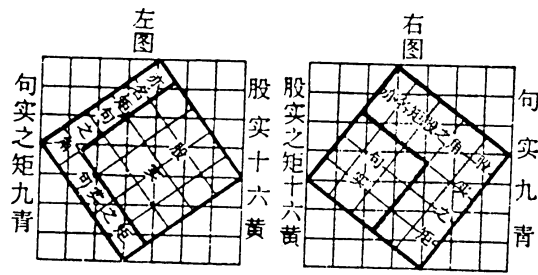


Figure 1.5: Li Jimin's 李繼閔 (1990: 371) reconstruction of Zhao Shuang's left and right diagrams.

Translation of the textual indications on the diagram:

To the left, on top:

'Left Figure'

Then, from top to bottom, from right to left:

'The square of the height, sixteen, is yellow.//The gnomon of the square of the base//The square of the height //Is also called the angle of the base as gnomon//The gnomon of the square of the base, nine, is blue-green.'

To the right, on top:

'Right Figure'

Then, from top to bottom, from right to left:

'The square of the base, nine, is blue-green.//The gnomon of the square of the height//The square of the base//Is also called the angle of the height as gnomon//The gnomon of the square of the height, sixteen, is yellow.'

One might argue that **Figures 1.3.b** and **1.3.c** as displayed in the ancient editions were erroneous and hence that in his critical edition, Qian tried to restore correct figures, as they might have been drawn before mistakes were introduced in the course of the written transmission. Li Jimin (1990: 371) clearly thought along these lines, since he too suggested replacing the diagrams in the ancient editions with correct ones. However, his way of restoring the same diagrams, which is reproduced in **Figure 1.5**, clearly follows principles different from Qian's. Li Jimin's diagrams might seem to us closer to those in the ancient editions than Qian's, and we might be tempted to conclude that they are thus more faithful to those that once occurred in the original text. However, we should not jump to conclusions too quickly here: Chemla (2004) argues that the *way* in which the diagrams in the ancient editions are erroneous gives clues on the nature of the original diagrams that are essential for a historical inquiry into the practices with diagrams—clues that are precisely erased in Li Jimin's edition.

This remark illustrates clearly the dilemma that an editor faces: each solution for the diagrams has its merits and its drawbacks. More importantly, exactly as noted above concerning the discursive part of a text, we see here the latitude that editors have in their negotiation between the different criteria by which they could abide in their shaping of diagrams. Here too, the solutions they adopt depend, among other things, on the context in which they operate and the goals they assign to the edition, as much as on their personal assumptions regarding the edited text. The examples concerning diagrams given above highlight what is at issue in the variety of editorial practices that have been put into play in the making of critical editions. These practices have led to quite different ways of presenting editions of the same text to the reader. Depending on the editorial choices, historical work about diagrammatic practices can rely more or less on the editions and thus unfold more or less fully.

This book is predicated upon the conviction that a historical approach to modern editorial work can enhance our understanding of the features of ancient texts to which critical editions have applied (often tacitly) changes. Such a historical approach can further help assess the impact of these changes on the historical work based on these editions. Indeed, as previous historians have sometimes noted, other elements and features of ancient texts underwent reshaping in the course of editorial endeavors. We need to identify them. This book intends to shed light on changes of this kind that have received less attention and on their bearing upon the historiography. However, before

we set out to tackle these issues, let us explain why we need, once again, to broaden our perspective.

1.1.3 Historicizing the Modernization of Ancient Texts in Editions and Translations

Modernizing diagrams, albeit in different ways, suppresses clues with which we could have addressed the issue of ancient actors' mathematical practices with their figures. However, discourse and diagrams are not the only parts of ancient scientific texts that have undergone modernization — or, more generally, changes — in the successive editions, thereby making it more difficult and even sometimes impossible to use these editions to describe ancient actors' knowledge and practices. The same conclusion has been drawn about another facet of ancient scientific texts whose importance for the history of science can hardly be denied, that is, the numbers and quantities that they contain. Another historian of Greek mathematics who also passed away all too early, David Fowler (1937-2004) drew our attention to this issue, offering remarks that will prove useful in defining more precisely the project of this book. Writing about the notation and uses of fractions in early Greek mathematical texts, Fowler (1992: 134) observed:

Almost all of our written evidence about Greek culture has passed via Egypt, and almost all of it has been later rewritten, from the ninth century AD onwards, in a modernised Byzantine script. Numerical material in these Byzantine manuscripts is liable to have been modernised and uniformised in what might then have been considered to be unimportant ways—this applies, in particular, to the treatment of numbers and fractions (One needs only to look at modern editions and translations, even by the most scrupulous of scholars, to see similar processes at work today.)

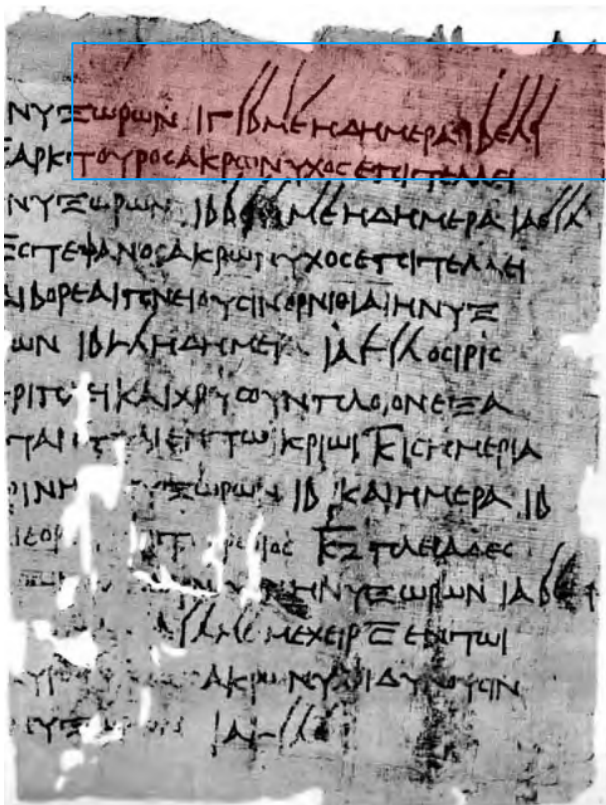
Two remarks are essential for us in Fowler's observations. To begin with, Fowler notes that the Greek manuscripts on which modern philologists have relied to produce their critical editions are for the most part posterior to the transliteration of texts from antiquity into the minuscule script, which took place in the Byzantine world starting between the end of the eighth and the ninth centuries. Fowler thus raises the question of the transformations that the notation of numbers and quantities might have undergone in the latter context as well as that of the impact of these changes on subsequent editions and more broadly on the work of historians of science.

This first remark highlights a general and essential issue: a historical and critical approach to modern editions of scientific texts, for the development of which this book pleads, must also take into consideration the contexts and circumstances in which the source material on which the philological work is based was produced as well as the possible changes to the original features that these old materials may have already incorporated. Research of this kind would not only provide crucial tools to exercise our critical acumen, but it would also allow us to examine how the modern philologists whom we study have dealt with the same question. This constitutes an important facet in the description and the contextualization of their philological practice. Several chapters in this book offer reflections on these issues, notably the two specific case studies presented in Part I.

Fowler points out a concrete example. He emphasizes that changes in the notation of divisions in a few papyri and in later Byzantine manuscripts have led historians to conclude that the concept of fraction that we commonly use today already existed in ancient Greece (Fowler 1992: 137). However, for him, such was not the case, and this gives a distorted view of numbers and arithmetic in ancient Greece. In particular, this creates a gap between hieratic and Greek mathematical documents, where in fact ancient documents point to a great continuity with respect to the nature and the concept of fraction used.⁶ Exactly as we had seen above for the diagrams displayed in the critical editions, which create the illusion of a greater distance between Greek and Chinese ancient mathematical texts and a smaller distance between Greek ancient texts and modern

⁶ Fowler (1992) upholds this thesis. In an earlier publication, Knorr (1982) had also highlighted this point.

mathematics texts, we see here the shaping of a divide between ancient Greek and hieratic texts and that of a similarity between fractions in Greek texts and modern fractions.



Fr. (δ), 2nd hand.

Col. iv. PLATE VIII.

- 55 [η] νύξ ὥρων ιγίβ'μέ', η δ' ἡμέρα ιβ'έ'λ'γ.
 [ι]ζ Ἄρκτουρος ἀκρόνυχος ἐπιτέλλει,
 [η] νύξ ὥρων ιββ'ί'έ'μέ', η δ' ἡμέρα ιαθ'ί'λ'.
 [κ]ζ Στέφανος ἀκρόνυχος ἐπιτέλλει
 [κ]αὶ βορέαι πνεύουσιν ὄρνιθλαι, η νύξ
 60 [ὦρ]ῶν ιβλ', η δ' ἡμέρα ιαγ'ί'λ'. Ὅσιρις
 [π]εριπλεῖ καὶ χρυσοῦν πλοῖον ἐξά-
 [γ]εται. Τῦβι (ε) ἐν τῶι Κριῶι. κ ἰσημερία
 [έα]ρινῆ, [η] νύξ ὥρων ιβ καὶ ἡμέρα ιβ,
 [κ]αὶ ἐορ[τ]ῆ Φιτωροῖος. κζ Πλειάδες
 65 [ἀκ]ρόνυχ[οι] δύνου[σιν], η νύξ ὥρων ιαβ'ς'γ',
 [η] δ' ἡμέρα [ι]βί'λ'μέ'. Μεχειρ ε ἐν τῶι
 [Τ]αύροι. Ἐάδες ἀκρόνυχου δύνουσιν,
 [η] νύξ ὥρων ιαλ'ί'λ',

55. l. ι'ε' for ιβ.

57. ι'ε' corr. from ι.

65. ε' corr.

68. l. λ'γ' for λ'ε'.

55-205. '(Choiak 1st:) . . . The night is $13\frac{4}{5}$ hours, the day $10\frac{1}{5}$. 16th, Arcturus rises in the evening. The night is $12\frac{2}{5}$ hours, the day $11\frac{1}{5}$. 26th, Corona rises in the evening, and the north winds blow which bring the birds. The night is $12\frac{3}{5}$ hours and the day $11\frac{2}{5}$. Osiris circumnavigates, and the golden boat is brought out. 'Tubi 5th, the sun enters Aries. 20th, spring equinox. The night is 12 hours and the day 12 hours. Feast of Phitorois. 27th, Pleiades set in the evening. The night is $11\frac{3}{5}$ hours, the day $12\frac{2}{5}$.

Figure 1.6: Fowler's first document: Papyrus Hibeh I 27, edited with translations and notes by Bernard P. Grenfell, and Arthur S. Hunt in 1906. These three pieces (Figure 1.6 (a): Facsimile; Figure 1.6 (b): Transcription; Figure 1.6 (c): Translation) are reproduced from Grenfell and Hunt (1906: Plate VIII, 146, and 152, resp.). They were brought together in (Fowler 1992: 139).

In fact, Fowler continues, the same type of modernization recurs in modern translations of ancient source material. This is the second remark which Fowler's quotation above highlights and which is equally important to widen adequately the perspective adopted in this book. Indeed, Fowler notes that, just as ancient editions do, modern editions as well as translations—both crucial tools for historians of science—tacitly modernize in ways that look innocuous but in effect have significant consequences. Fowler's argument relies on two documents (Fowler 1992: 138-140 and 140-141, respectively). Figure 1.6 reproduces the plate with which Fowler illustrates the first document. To the left (Fig. 1.6 (a)), the plate displays part of the papyrus Hibeh I 27 written in ca. 300 BCE. The first line shows the notation of a fraction as a sequence—the juxtaposition means a sum—of what we would call 'unit fractions'. Each of these 'unit fractions' is not written as a pair of a numerator and a denominator, but as a number topped by a stroke.⁷ These two features indicate

⁷ Fowler and Turner (1983) provide a systematic description of the notation of integers and fractions in the papyrus Hibeh I 27.

that the notation of said quantity in the Greek papyrus is essentially the same as the way of writing fractions attested by hieratic mathematical texts. The edition of the papyrus published by Bernard P. Grenfell, and Arthur S. Hunt (1906: 146) is faithful to the notation as it appears in the original document (Fig. 1.6 (b)). However, beneath the photo of the papyrus and the 1906 edition, Fowler reproduces the English translation given by Grenfell and Hunt (1906: 152) (Fig. 1.6 (c)). Just as noted above about the edition of the diagram occurring on a papyrus, the translation by Grenfell and Hunt transforms the fractions of the original document into a completely different concept: a single fraction with a numerator and a denominator. Interestingly, this transformation also precisely echoes the troubling problem in the historiography of fractions that Fowler exposes: an ancient notation, which indicated the use of a specific concept of fraction, is replaced with another—more modern—notation that might induce the reader to assume that the papyrus makes use of a modern notion of fraction. Note that in this case, modernization takes place in the translation. As several examples analyzed in this book suggest, modern editorial work on ancient source material has sometimes been inseparable from the production of translations into modern languages, to the point that sometimes the editorial work takes the form of a translation. This remark will appear to be all the more significant for our book as we adopt a world-wide view on the problems presented above, and at this global level, translations into languages foreign to that of the base text often incorporate editorial work. As a result, the historical inquiry presented in this book has taken both modern editions and translations of ancient scholarly texts into its focus.

1.1.4 Our project

Clearly, ancient and modern editions, translations and, more generally, publications of texts from the past are crucial moments in the multiple processes by which ancient and medieval works as well as other types of documents are made available to us. As we have recalled above, since the 1980s, an awareness has gradually emerged that historians of science ought to scrutinize the changes undergone by ancient scholarly texts, when said texts are presented or represented in editions and translations that are used in historical work. However, these reflections have remained scattered and punctual. We now need to adopt a more systematic approach to this issue. This book aims to take a step in this direction. More importantly, we cannot just expose the problematic character of what until recently was often taken unquestioningly as a direct access to source-texts. It is true that, if pressed, nobody would claim that Heiberg's edition allows us to read Euclid's text of the *Elements*, in an immediate and transparent way, even though, in practice, scholars have behaved as if they believed this. In fact, we also need to analyze *how* editions and translations have tacitly transformed the sources on which they relied, and how these changes left their imprint on the historiography of science, when it was based on these editions and translations.

In a sense, this book belongs to a recently renewed approach to histories of text criticism, philology, and translations, including new perspectives on histories of the book and of critical editions.⁸ In this context, it is nevertheless characterized by two key features.

To begin with, we adopt a worldwide perspective on the issues addressed. In contrast, whether we think of Knorr, Fowler or Saito, the first forays into the topic under consideration typically focused on Greek geometrical texts of antiquity. The fact of taking a wider perspective brings to the fore general questions that might otherwise have been overlooked.⁹

For instance, from a world-wide viewpoint, it becomes crystal-clear that scholarly texts of the past were edited and translated in ways that, in particular, made them understandable in new environments and comparable with texts produced in other contexts. This phenomenon is all the more conspicuous if we think that from the eighteenth century onwards, editions and translations of

⁸ See notably (Judet de La Combe 1990), (Cerquiglini 1999), (Chartier 2021).

⁹ Here again, we are not alone in striving to broaden the discipline in this way. See, notably, (Suarez and Woudhuysen (eds.) 2013), (Pollock and al. (eds.) 2015), (Grafton and Most (eds.) 2016) as well as the contributions to the journal *Philological Encounters*, for instance (Dayeh and al. 2018) and (Pecchia and al. 2021).

Chinese and Sanskrit scholarly texts were produced in Europe, while since the seventeenth century, Persian and Arabic texts had been translated into Sanskrit, and Latin editions of Greek texts of antiquity translated into Chinese. To the issue of anachronism, which appears to characterize the aforementioned treatments of diagrams and numbers, we thus need to add what Kim Plofker (2021) has referred to as ‘anachorism,’ that is, in our terms, the problem of overlooking that the texts dealt with were produced not only in different times, but also in places and scholarly cultures far removed from those of the editors and the translators. When the evidence has been reshaped, which features of this reshaping can be associated with the fact that texts circulated in places and times in which their original languages, their textual genres, and also the practice of mathematics to which they adhered were unfamiliar? How did editions and translations tacitly make ancient “exotic” texts either more “exotic” or, conversely, comparable in bits and pieces to texts that would have been familiar to the readers? It is precisely on such issues that a world-wide perspective sheds interesting light.

From another angle, poring over sources from different parts of the world raises another key question, that of the methods by which the texts attested by these sources were edited and translated. As a first approximation, the world-wide perspective we adopt suggests distinguishing between two types of situation—which are the two poles of a spectrum of possibilities.

Sometimes, ancient works were edited by scholars whose working language was intimately related to the language of the original works in question, and who were using methods that had been fashioned to deal with sources in cognate textual traditions. We can think of the example of the Chinese mathematical work *The Gnomon of the Zhou [Dynasty]*—which we mentioned above—as it was edited by Dai Zhen 戴震 (1724-1777) in the context of the preparation of the great encyclopedic compilation the *Complete Library of the Four Branches* (四庫全書 *Siku quanshu*) at the end of the eighteenth century. Dai Zhen had access to several ancient editions of the work—which he compared to establish the text—as well as editorial tools and methods that had been developed in the context of the movement of ‘evidential research’ (*Kaozheng* 考證).¹⁰

In contrast, Edouard Biot’s French translation of *The Gnomon of the Zhou [Dynasty]*, which was the first ever translation of the work into a European language, could only rely on the single edition, which he found in the collection of the Royal Library.¹¹ Moreover, for his approach to the text, which Biot endeavored to render literally, he could rely only on the ancient commentaries with which the work has been handed down as well as on the first Chinese dictionaries in foreign languages published, and, to begin with, that published by Chrétien-Louis-Joseph De Guignes (1759-1845) in 1813.¹² This example illustrates the second type of situation for a translation.

As shown in, e.g., chapter 10, in which Cooper studies how Sumerian texts were edited in the past, this book also exemplifies situations of this kind not only for translations but also for editions. Indeed, sometimes, editorial work was carried out adopting assumptions that had been shaped for sources produced by different scriptural acts and attesting to texts that derived from different conceptions of authorship. The backdrop for the example is this: In nineteenth century Europe, philological techniques had been devised, in particular in the context of editing ancient Greek and Latin sources, or biblical Hebrew. For sources of this kind, a philological method imposed itself, which consisted of organizing written evidence using a stemma and then of focusing

¹⁰ See this book, chapter 4, to which we return below. (Chu 2010: 147-151) outlines more generally Dai Zhen’s restoring of the Chinese mathematical ‘canon’ in the context of his work for the *Complete Library of the Four Branches*.

¹¹ Biot had access to *The Gnomon of the Zhou [Dynasty]* by means of the Ming edition included in the *Jindai mishu* 津逮祕書 (Biot 1841: 596-597). On this edition, see (Chemla 2020: 286). (Biot 1841) gives a translation of the text, and is complemented by (Biot 1842), which relies on astronomical data and computation to analyze *The Gnomon of the Zhou [Dynasty]* further.

¹² On Biot’s literal approach, see (Chemla 2021: 49-57). (Martija-Ochoa 2001-2002) has analyzed Biot’s translation more broadly.

on only part of the sources in relation to the structure of the stemma. Note that, just as we have seen above for Heiberg's edition of Euclid's *Elements*, the method led to carving an assumption about the history of the sources in the corpus on the basis of which editorial work was performed. In this context, in the first decades of Assyriology, some European scholars applied this philological method directly when dealing with cuneiform sources, despite the fact that these sources were the outcome of wholly different stories and processes. Was it appropriate to believe that this method was suited for all types of ancient documents worldwide? Chapter 10 explains why there are reasons to doubt the validity of the operation for contexts in which the sources available derive from scriptural acts other than copying.¹³ Which assumptions about the sources and which related editorial practices were more generally transferred from one context to another, and what consequences did this have on the editions and translations produced? These are thus other key questions that a world-wide perspective highlights as promising.

For us, this global approach to the issues addressed is all the more needed that, from the outset, the history of ancient and medieval science has adopted an international perspective, comparing writings produced in different parts of the world through the editions and translations available. It is thus essential to examine in a critical way the material foundations on the basis of which these comparisons were carried out. What is at issue here is the historical study of the fashioning of an estrangement or, conversely, of a homogeneity of texts of science.

The latter remarks bring us to the second key feature that characterizes our book in the wider context of an interest for the histories of philological endeavors: we focus on scholarly texts, with a special emphasis on documents that attest to activities in mathematics, astral sciences, and medicine. One might doubt that this fact has any bearing on the questions on which we focus. However, it clearly does. One example will suffice to illustrate this point. For the German philologist Georg Friedrich Wilhelm Thibaut (1848–1914), who prepared, with the Indian scholar Sudhākara Dvivedin (1855–ca. 1910), a critical edition of Varāhamihira's *Pañcasiddhāntikā* (a sixth century work on astronomy),

texts of purely mathematical or astronomical contents may, without great disadvantages, be submitted to a much rougher and bolder treatment than texts of other kinds. What interests us in these works, is almost exclusively their matter, not either their general style or the particular words employed, and the peculiar nature of the subject often enables us to restore with nearly absolute certainty the general meaning of passages the single words of which are past trustworthy emendation.¹⁴

Thibaut's declaration illustrates one way in which the editing of mathematical or astronomical texts was done in a specific fashion, compared to other types of texts. In this book, we will be interested in understanding how, in the nineteenth century, and sometimes well into the twentieth century, different editors and translators perceived scientific documents as specific and separate in their study from other scholarly and literary texts. We also question how that perception may have affected their editing practices.

Clearly, scientific documents raise specific editorial issues. Scientific practices sometimes put into play textual practices that are not purely discursive, like interacting with diagrams and images, and carrying out computations. Some of these practices leave specific traces in the texts in

¹³ On the genesis of the philological method associated with the name of Karl Lachmann (1793–1851), see (Timpanaro 2005). Interestingly, the history of the production of sources that Timpanaro assumes in his reflections shows a clear bias due to the type of works to which philological endeavor was first applied in Europe. Indeed, sources are assumed to have been produced by copying, and copyists are assumed either to have made mistakes or to have produced copies following specific types of scenario.

¹⁴ The assertions, taken from Thibaut's preface (p. v) to (Thibaut and Dvivedin 1889), were quoted in (Keller 2012: 265).

the form of non-discursive components, like drawings and tables, while others—no less specific, like computations carried out materially — leave only clues. The fact of attending to the edition of scientific texts thus commonly requires that editors deal with several kinds of specific non-discursive elements, and all the more so that, as we have pointed out, all these textual facets have historically been subject to many editorial manipulations. How they have attended to this task, and also how they have dealt with traces and clues are questions that are central for us, in particular because of the potential impact of the result on the historiography of science. Indeed, as has already been emphasized, in the past decades, non-discursive elements of scientific practices and texts have become a key issue in the history and philosophy of science. This has led to question how these elements have been passed down, edited, and translated in what until then was often taken unquestioningly as a direct access to source-texts. Addressing this issue in a systematic way can certainly benefit these discussions.

However, the example from Thibaut quoted above shows that these issues are also worth addressing with respect to the discursive parts of these texts, which might have been perceived as less specific. Indeed, for Thibaut, because of the nature of the subjects treated in texts of this kind, the discursive part of a scholarly work allows for a specific type of editing. This is in line with the argument that what counts for scientific texts is their content not their form, thus inducing specific text criticism, modes of translation and editing for them. In fact, the two examples of Heiberg's editions of Euclid's *Elements* and Archimedes's works that we have sketched above show two strikingly different illustrations of how in the editions of scientific texts, the discursive parts were molded in relation to the philologist's assumptions about these two practitioners' mathematical activities. Here too, thus, Heiberg's philological practice for these discursive parts was intimately correlated with his perception of these texts as scientific writings. However, the assumptions he adopted and how they were brought to bear on his editorial practice differed for both cases, and in both cases, they differed from those in Thibaut's edition. Both philologists valued authenticity and faithfulness. However, they understood these values differently and they also translated them into different editorial practices. The general issues of the values prized by editors and translators and also of how they shaped their practices in response to their respective values appear as meaningful for our project.

Much is thus at issue for historians and philosophers of mathematics in deconstructing the appearance of immediacy and transparency that readers focusing essentially on the contents sometimes attach to editions and scholarly translations.

The specificity of scientific works and documents in these respects should nevertheless not obscure the fact that, to a certain extent, practitioners of editorial work and translation have applied to such texts operations that they would have applied to any other text. Seen from this angle, we may still benefit from considering the ancient and modern production of editions and translations from the broader perspective of a more general history of texts, translations and books. Conversely, precisely because of the singularity of their subject matter, editions and translations of scholarly works and documents could allow us to better perceive transformations undergone in the course of philological and translation work that would be difficult to apprehend for other types of writing. This is a conclusion that can be drawn from Part I of this book, which is devoted to ancient editorial practices.

1.2 Ancient and Modern Actors and Institutions at Work in the Manufacturing of Sources for Ancient and Medieval Texts

As we have argued in Section 1.1.3, inquiring into editions and translations of ancient and medieval scholarly texts implies that we begin with a reflection on editorial practices before early modern and modern times. Indeed, we have seen that the documents upon which early modern and modern actors relied for their philological endeavors already incorporated the results of operations carried out by ancient actors in the context of their editorial activities and that these operations had significant consequences on the historiography of science. We have encountered above the impact,

on modern scholarship, of the edition of the *Elements* made by Theon of Alexandria, who operated in a context upon which historical work has already been devoted. We have also encountered the potential impact, on the inscription of numbers contained in our sources, of the transliteration of ancient Greek sources from majuscule to minuscule script, which began in the Byzantine world at the end of the eighth century. To deal with this issue more broadly, in this book, we have concentrated on ancient editors from other parts of the world.

1.2.1 Ancient Editorial and Cross-Linguistic Practices

Interestingly, these other ancient actors broaden our views on the types of editorial intervention that were carried out, whether texts were worked upon, copied or translated. These actors also give us clues as to how we can detect such interventions in the documents that came down to us. This is what Piotr Michalowski argues in chapter 2 of the book. In fact, he holds a radical view. Indeed, for him, the oldest written documents we know—that is, the first accounting texts from the fourth millennium BCE, which attest to the birth of writing—are already edited texts. The crucial remark is that these texts are quite uniform and thus seem to reflect the intention to shape an organized accounting system, using standardized writings.

In Michalowski's view, the same holds true for another basic type of text that was crucial in elementary scribal education: lexical lists. These texts were inventories of nouns in Sumerian, probably composed at the same time as the accounting documents mentioned above. However, the first material testimonies of these texts are the standardized lists that are associated with the expansion of the Ur III state (ca. 2112-2004 BCE), its languages and institutions—schools in particular—throughout much of the Middle East. Piotr Michalowski's chapter argues that the lists borne by these earliest surviving tablets should also be considered as already shaped by editorial practices. To highlight operations ancient actors carried out as they were editing these lists, Piotr Michalowski concentrates on a widespread professions list, which travelled all over Mesopotamia, from South to North and beyond, notably to Ebla in today's Syria. For the unique palace archive of Ebla reveals the manner in which the lists were copied. Some of the professions lists were copied from tablets coming directly from southern Babylonia, while others were produced from copies. At times, features of these copies testify to the scribes' intention to preserve formal textual properties of the original. Indeed, the first copies respected the norm of nineteen lines per column, while the copies of copies did not. The former copies added a double line after each nineteenth line, showing again that the scribes—although adopting a new format—wanted to keep traces of the old ones as well. Michalowski interprets these often imperceptible acts as clues of philological activity. Indeed, they reveal that ancient actors not only reflected on how to preserve the original but also created textual acts with this aim in mind. On the other hand, Ebla's palace archive provides evidence that scribes also adapted these lists. This is another facet of their editorial work. Here language is important. In southern Babylonia we know that texts were read in Sumerian while in the north they were probably read in semitic languages. Michalowski shows that the migration of lists involved all sorts of 'interlanguage procedures': lists were sometimes translated or gave birth to new lexical lists in regional languages. These operations were also editorial in nature: they aimed to re-actualize the list to make it readable for new audiences. In some cases, the antiquated professions list was adapted by listing regional professions. In others, the professions list was made into a bilingual list, serving then as a translating tool or an indicator on how to pronounce some Sumerian words.

In short, Piotr Michalowski argues that these ancient tablets testify to processes of standardization and acculturation, while at the same time providing evidence of ancient actors' reflection on how to preserve features of the original. All these acts have left clues that only indirectly tell us how texts were shaped and reshaped so that new audiences could read them. The argument highlights how challenging it is, for ancient contexts of this kind, to characterize what past editorial work consisted of. This is true because this work bears on textual aspects that we do not always consider important, such as the diagrammatic features of texts seen above. And yet features of this kind might yield crucial pieces of evidence for the historiography of science

(Chemla 2020). This is also true because we only have traces of this work. What are the operations observable today that testify to the fact that in the past actors reflected on how to preserve and transmit a given text? This is a key question for our endeavor. To this question, Sheldon Pollock can give another kind of answer, because of the nature of the writings on which he relies. Indeed, he focuses on different types of commentaries on ancient Sanskrit works, which enable him to deploy a contextual approach to modes of edition in a wide range of sources in this corpus.

In comparison with the pieces of evidence discussed by Michalowski, Sanskrit commentaries attest to other types of additions to a base text, which meant to offer their readers a new form of approach to the text. Each of them reflects modalities that actors shaped in order to transmit the base text. Moreover, commentaries quote the root text, and hence they are compositions in which editions are carried out and conceptions of original texts are discussed. In this context, Pollock sheds light on another phenomenon worth contemplating. For his contextual approach allows him to establish that, depending on the genre, ancient commentators wanted to preserve and transmit different aspects of a Sanskrit text. Indeed, Pollock first underlines how little information we obtain directly. Nevertheless, he highlights that commentators put into play, in their discussions, key editorial notions such as that of ‘interpolation’ (*prakṣipta*, *kṣepaka*). This is the case of Haradatta Mīśra, a ninth century commentator of the work of the grammarian Pāṇini, who uses precisely a term to qualify the ‘original’ text—the term *sāṃpradāyika* (‘traditional’ or ‘original’) being employed in opposition with that of ‘interpolated’. The use of such notions allows historians to approach actors’ varying representations of the genuine base text.

Moreover, Pollock sets forth clues indicating the principles by which actors determined what was interpolated, and which variant represented the original composition. The essential point for us is that the criteria used by classical, medieval and early modern editor-commentators of Sanskrit works, as they opposed original and interpolated texts, reveal two main types of editorial approaches. Indeed, Pollock suggests distinguishing between commentaries that gave pride of place to content and those that mainly relied on stylistic features, to decide over issues of interpolation. Pollock further suggests that commentators adopted one or the other approach in relation to the types of works commented upon.

For him, commentaries to knowledge forms (*vidyasthānas*) belong to the first category, as do scriptures—an intermediate textual form between scholarly texts and poetry. Pollock illustrates the case of the edition of scriptures using the example of Buddhist texts and analyzing how the editors aim to establish what for them is ‘word of the Buddha’ (*buddhavacana*). Commentators on these scriptures, Pollock shows, judge the issue of the authenticity of a received text through a discussion of the quality of the truth enunciated, rather than through historical or textual considerations. Thus, in contrast to the examples given above by Michalowski, what counts in the transmission of the text in such cases has to do with its knowledge claims, rather than with formal elements. This stands also in contrast with the commentaries on epic literature and court poetry of the second millennium, for which Pollock argues that a diversity of criteria becomes explicit. For example, Vallabhedava, a tenth century commentator/editor of poetry, compares diverging readings from various recensions and gives insights into his values as an editor when he puts forward arguments to support judgments that a given reading can be considered as ‘correct’, ‘authoritative’, ‘false’, ‘unmetrical’, ‘interpolated’ or ‘beautiful’. The yardstick by which elements of a text would be considered worth preserving would, in this case, be less the evaluation of their claims than the consideration of their conformity with what was expected from a specific genre of text.

As Pollock further underlines, in their editorial practice, commentators were aware of characteristic features of the preservation and transmission of texts in South Asia, since they might have taken into account the key role played by orality. In particular, they show an awareness of how oral instantiations may have contaminated the original wording in specific ways, as when literary texts were affected by memorization and performance. Assumptions of this kind seem to have left an impact on the concepts with which they approached textual variations. For instance, Pollock suggests that the term *pāṭha*, ‘variant’, should be understood as also taking into account variants in the recitation of a text. In other words, for medieval Sanskrit commentators, the notion of corruption

did not only refer to an accident occurring when copying manuscripts by tracing words on a given medium but extended to the transformations that might occur in oral transmission. To put it in more general terms, the materiality and modalities of reproduction of the word and their impact on transmission do have a bearing on the philological concepts that ancient actors form to describe the events affecting the various witnesses on which they rely to produce an edition.

To summarize what this foray into ancient sources tells us, we see that we detect editorial work being performed as soon as we perceive ancient actors striving to preserve features of a text they reproduce. Should we straightforwardly consider that these actors conceived of said text as a master text? A conclusion of this kind might derive from a projection of an understanding of philological work that became dominant in nineteenth century Europe. However, we will see below that ancient sources have compelled editors to widen their understanding of editorial practices and accordingly their approach to the sources to which these were applied.

The reflections mentioned above have moreover shown that the way in which editorial work is performed depends on ancient—and modern—actors' representation of the source to be preserved and, in case variants are considered, the principles by which they are judged. It also depends on how these actors imagined the transmission process, and on the values they upheld. Adopting this perspective has already required that we diversify our own representations of editorial acts. Clearly, in these processes, scholarly texts may have been treated differently from other types of documents. How were texts dealing with mathematics, astral sciences, and medicine edited? This issue lies at the center of our interests in this book.

Our earlier considerations have highlighted how and why the contexts in which editions and translations were produced are important elements for our understanding of these textual productions. In particular, it appears as essential to note that editorial work is carried out—and editions are handed down—by different types of institutions.

Contexts of the ancient world are notably difficult to address with precision, even though this general statement might need to be nuanced depending on the regions of the world dealt with and on the ways in which access to the ancient sources was fashioned. However, when we turn to early modern and modern actors—as we do in the subsequent part of the book—, things change radically, and in these cases, we can observe in greater detail the historical and social contexts within which a person—or a group of people—could find it meaningful to embark in editions and translations of ancient scientific texts. We can moreover shed light on motivations that presided over the launching of editorial work, the types of actors who embarked on these endeavors and their social backgrounds, as well as the technologies they put into play. These are precisely the issues dealt with in Part II of the book, which concentrates on the historical and social contexts of the early modern and modern work on ancient scientific texts.

1.2.2 What was at issue when returning to ancient texts in early modern and modern times?

In a first case study, Han Qi examines the reasons why, and the circumstances in which, a significant interest in one of the oldest mathematical texts from antiquity, *The Gnomon of the Zhou [Dynasty]* (*Zhoubi* 周髀), grew in seventeenth- and eighteenth-century China. Why did early modern actors find this work important to the point that the book became one of the major works for the historiography of mathematics in China in subsequent centuries? Han Qi argues that this resulted from opportunity and specific political contexts — a combination that we will see recurring in several other cases. The value that through this process came to be attached to *The Gnomon of the Zhou [Dynasty]* finds its clearest expression in the fact that an edition of the book was given pride of place in the imperially-commissioned encyclopedic work *Complete Library of the Four Branches* (*Siku quanshu* 四庫全書) at the end of the eighteenth century. Han analyzes the different factors that entered into the increasing value attached to the book. Moreover, he sheds light on the process through which this edition came into being.

What circumstances allowed seventeenth- and eighteenth-century scholars to develop an interest in *The Gnomon of the Zhou [Dynasty]*? This ancient mathematical treatise— which included elements of mathematical knowledge required for cosmography and the calendar —was

the only mathematical work of antiquity that had been edited by Ming scholars at the beginning of the seventeenth century. In contrast with any other ancient mathematical work, it was thus more readily available at the time. Han shows that what first sparked a new interest for *The Gnomon of the Zhou [Dynasty]* was the translation into Chinese, in 1607, of part of Clavius' (1538-1612) Latin commentary on Euclid's *Elements*, and more broadly the translation and dissemination of writings of 'European' mathematics, as early modern actors in China perceived them. The translation of the *Elements* was carried out by the Jesuit Matteo Ricci (1552-1610) and the Chinese convert Xu Guangqi 徐光啓 (1562-1633). Xu understood the potential of 'Western knowledge' to reform the imperial calendar which was a very political affair. This development triggered a reaction by scholars who refused what they called 'Western knowledge'. In this context, Xu used reference to *The Gnomon of the Zhou [Dynasty]* as a strategic move to convince his Chinese opponents that knowledge in China and knowledge brought from the West were identical, and that hence there was nothing wrong in using the latter. Reference to this ancient Chinese work was thus instrumental to legitimize the study of 'Western knowledge'. This first set of circumstances thus illustrate what was at issue for early modern actors in returning to mathematical works of antiquity. Interestingly, this occurs in a context in which various struggles for power hinged on the belief that the bodies of knowledge introduced from Europe and translated by Jesuit missionaries were "Western."

More than fifty years later, the Manchus having conquered China and ruling the Middle Kingdom, court politics entered the stage more decisively. This derived from the complex strategy of the Manchu emperor Kangxi (康熙 reign: 1662-1711), faced with Han scholars questioning his legitimacy as a Chinese emperor. To avoid Han scholars' opposition to 'Western science' being used in court institutions, and to show off his knowledge of ancient 'Chinese science', Kangxi, among other moves, referred to *The Gnomon of the Zhou [Dynasty]* to put forward the thesis of a 'Chinese origin of western knowledge *xixue zhongyuan* 西學中源', especially that of calendars and of right-triangles. The most important practitioner of mathematics and astral sciences at the time in China, Mei Wending (梅文鼎, 1633-1721), embraced the emperor's thesis and subsequently drew on *The Gnomon of the Zhou [Dynasty]* to further expand this view. Therefore, it was a complex situation at court that gave voice to specific discourses on the origins of mathematics and astronomy which in turn triggered interest in an ancient Chinese text of Antiquity.

The presence at the time of many Jesuits at Kangxi's court gave this phenomenon an international dimension. Indeed, European correspondents of the Jesuits— among whom Leibniz — were curious of the history of geometry in China. In particular, they were interested in knowledge and proofs of the 'Pythagorean Theorem' and this is how *The Gnomon of the Zhou [Dynasty]* entered a more global conversation. In return, this interest would resonate back to China, and have a new echo. Leibniz' questions on the nature and antiquity of 'Chinese mathematics' would find their way to Kangxi's court. Accordingly, in *The Basic Mathematical Principles (Shuli jingyun 數理精蘊)*—the synthetic work on mathematics that had been commissioned by Kangxi and completed in 1722 by imperial compilers among whom Mei Wendings's grandson, Mei Juecheng (梅穀成, 1681–1763)—, the Chinese origin of astronomy and geometry is presented as being endorsed by Jesuits at Kangxi's court. Whatever the case may be, J. F. Fouquet (1665-1741), a Jesuit at Kangxi's court, did bring back to Europe precisely the Ming annotated edition of the text thanks to which *The Gnomon of the Zhou [Dynasty]* was available in China at the time. This sheds light on the processes through which evidence for ancient scholarly activity outside Europe was being gradually gathered in Europe, creating the conditions for editions and translations of works such as *The Gnomon of the Zhou [Dynasty]* to be carried out there. It was precisely on the basis of a reprint of this same Ming edition—which he found in the collections of the Bibliothèque Royale—that, about a century later, Edouard Biot would carry out his translation of the work into French. Biot's introduction to his publication shows his awareness of the fact that in China, *The Gnomon of the Zhou [Dynasty]* was considered 'the fundamental basis of the mathematical and astronomical knowledge of all peoples' (Biot 1841: 597). In particular, at the Bibliothèque Royale, Biot also had access to *The Basic Mathematical Principles*, in which this view was expounded. He treated the

latter theory with irony, but he had his own antiquarian agenda for embarking in a translation of *The Gnomon of the Zhou [Dynasty]*. He seeks out the earliest extant books that testify to the knowledge in mathematics and astronomy available ‘in the Orient’ in ancient times—which he would use notably to assess the relative value of peoples. From this perspective, given the antiquity that Biot lends to *The Gnomon of the Zhou [Dynasty]* (for him, the book goes back, at least partly, to the eleventh century BCE), to his eyes the work is unique, thereby justifying a translation (Biot 1841: 593-594, 598). Developments of this kind—e.g., the constitution of libraries with “Oriental” sources, the emergence of training in “Oriental” languages in Europe—thus illustrate the circumstances in which European publication projects provided access to an international past of sciences.

If we turn back in time and to China, the 1722 work on mathematics that was mentioned above—*The Basic Mathematical Principles*—had the aim of offering a synthesis of mathematical knowledge East and West. The fact that, in it, *The Gnomon of the Zhou [Dynasty]* was given a central place expressed, in the very structure of the work, that this ancient book was the foundation of all mathematical sciences. The claim was instrumental in the fact that half a century later, in 1772, Dai Zhen (1724-1777) would undertake a crucial critical edition of the work—along with that of all Chinese mathematical canons used as textbooks in the Imperial University—for publication in the encyclopedic work *Complete Library of the Four Branches*. Thanks to this editorial work, for the first time since the thirteenth century, the entire corpus of Chinese canonical works in the field of mathematical sciences was re-constituted, hence becoming available for historical inquiry (Chu 2010). More generally, the imperially-commissioned *Complete Library of the Four Branches* offered editions of all the Chinese writings of the past that, in the eyes of the imperial institutions, were deemed worth preserving—including works brought from Europe and translated into Chinese. The enterprise of the *Complete Library* thereby fashioned a Chinese written heritage, on the editions of which most present-day editions of the same works depend. What is more, in line with the theory that had emerged during Kangxi’s reign, in the section that contained astronomical works, *The Gnomon of the Zhou [Dynasty]* was given the highest status, as the first book. Texts speak not only through their words, but also through their positioning in a textual structure.

Han’s contribution illustrates how, in fact, various types of context need to be taken into account to understand the different meanings early modern actors attach to a mathematical work of antiquity like *The Gnomon of the Zhou [Dynasty]*. As a result, the late 18th century imperially commissioned re-edition of *The Gnomon of the Zhou [Dynasty]* is not a merely scholarly event: it echoes complex political debate that spanned two centuries and involved international networks of scholars. It was shaped in the midst of global debate on China’s scientific past, and in return then, once re-edited, contributed to shaping discourses on China’s mathematical past. The same type of intricate relations between international networks and projects of a political nature, albeit of a different kind, can be perceived in the case of the *Bibliotheca Indica* series of the Asiatic Society of Bengal, to which Alessandro Graheli devotes his chapter.

Graheli focuses on the *Editio Princeps* of a seminal work of dialectics, epistemology, logic and metaphysics that Jayanārāyaṇa Tarkapañcāna (1806-1872) published within the *Bibliotheca Indica* in 1864-1865: the commentary by Vātsyāyana Pākṣilasvāmin (ca. 5th century CE) called the *Nyāyabhāṣya*. This *Editio Princeps* is a case in point to show how the politics of scholarly publications in South Asian languages in the second half of the nineteenth century in Bengal shaped, in a significant manner, the printing of ancient Sanskrit works.

The *Bibliotheca Indica* was initially created by James Prinsep (1799-1840), the then secretary of the Asiatic Society of Bengal. Its establishment was prompted by a change in policy in Great Britain which favored English and more generally European texts for education in India over attempts to make bridges with scholarly texts from South Asia. To counter such policies, Prinsep encouraged the publication of important South Asian works of the past. At first then, in part at least, the aim of the series was to publish counter-manuals for the education of English and Indian employees of the East India Company. In other words, as in Han’s case study, politics—here,

specifically, the educational policies of a British colony—played a role in shaping the choice of texts published by the *Bibliotheca Indica*.

However, from the beginning, these publications seem also to have been motivated by an antiquarian and scholarly interest. Although progressively, the latter overtook the whole purpose of the collection, it nevertheless owed its creation to a mix of factors: a reaction to the colonial power's policies and the logic of scholarly endeavor, which were the initial goal of the Society. The aims of the institution funding the *Bibliotheca Indica* seem to have been an even more important factor in determining the kinds of works it specifically published. Indeed, other editorial projects in Calcutta at the time were undertaken in educational institutions such as the Fort William College (which trained British employees of the East India Company) and at the Calcutta Sanskrit College (which trained British-friendly pandits — traditional scholars of Sanskrit): these projects focused exclusively on textbooks. By contrast, as a systematic planned endeavor, the *Bibliotheca Indica* published much more—and more widely—concerning Sanskrit lore.

Graheli shows how the progressive shift in the targeted readership of the *Bibliotheca Indica* series was inscribed in the way the selected works were published. In the beginning, in 1847, the series required that a translation be made for each edited text so that it was accessible to any reader fluent in English. By 1853, in place of a translation an analysis could be supplied in the form of an introduction. In other words, at first, the text had to be made accessible to those unfamiliar with oriental languages but later, the texts seemed to be made for scholars who could read Sanskrit.

The edition of the *Nyāyabhāṣya* was also published in the *Bibliotheca Indica* for more specific reasons. Interest in *nyāya*, and in particular in the oldest possible texts of this philosophical school dealing with dialectics, epistemology, logic and metaphysics, had been sparked, in Europe, by a memoir issued in 1824 by the British Indologist H. T. Colebrooke (1765-1837). Colebrooke (1824) reported in particular on Sanskrit authors' description of a form of syllogism, which elicited the question of whether there existed a peculiar Hindu or Eastern logic, and also of whether *nyāya* had been influenced or had affected developments in Greek philosophy (Ganeri 1996). These issues inspired further work on Sanskrit texts dealing with logic. In Calcutta at the time there was an important school of 'new *nyāya*' (*navanyāya*). The interest in history shifted the focus of publications on *nyāya* during the 19th century from textbooks to teach 'the new *nyāya*' at the Calcutta Sanskrit College to an antiquarian search for the 'oldest text' of *nyāya*, which was fostered in the Asiatic Society of Bengal. It is precisely this antiquarian pursuit that contributed to rescuing a work, the *Nyāyabhāṣya*, that had been neglected with the development of 'the new *nyāya*' from 15th century onwards in Bengal. Consequently, the *Editio Princeps* of the *Nyāyabhāṣya* was based on a single recension of a quite marginal text. In other words, as in the case studied by Han, it is, in part, international conversations that contributed to attaching new values to an ancient work and hence the production of a modern edition for it.

Just as in the case discussed by Han, the foregoing remarks illustrate the variety of contexts that need to be taken into account to explain modern actors' interest in an old and almost forgotten work. Graheli goes one step further and examines the production of the edition itself. In the first place, he focuses on the modern edition *qua* material object. As D. McKenzie (1999) has long argued, the material features of books are not innocuous. Graheli argues that what such features convey in the case of this edition of the *Nyāyabhāṣya* is quite meaningful, thereby inviting us to take them into consideration in our general reflection on editions.

Indeed, in this case, to begin with, just as for any other edited work, the *Nyāyabhāṣya* underwent a major transformation, when, instead of being made available in manuscript form, it was printed. Printing may seem to be just another technology for reproducing a text. However, in nineteenth century South Asia, this technique of reproduction attached a modern and above all foreign flavor to past texts. Along with printing, the script used to produce the *Nyāyabhāṣya* was also changed for the edition. In scholarly circles in Bengal, Bengali script was used to transcribe Sanskrit. However, Devanagari rather than Bengali was used to print Sanskrit in the *Bibliotheca Indica* editions. This is still the case today, attesting to the enduring impact of the choices made in the printing *milieu* of Calcutta in the late 18th and early 19th century on indological publications to

this day. Furthermore, the font used was a trademark of the Baptist Mission Press— of which Graheli tells the story —which was responsible for printing the *Bibliotheca Indica* publications. It became a standard font type with an enduring impact on twentieth century Devanagari typography¹⁵. In other words, the *Bibliotheca Indica* project highlights the historical shaping of standards of publications for critical editions

The printing format represented another silent and yet meaningful modification that the *Nyāyabhāṣya* underwent: South Asian manuscripts were habitually written in landscape format—the shape of the traditional palm-leaves. Publications of the *Bibliotheca Indica*, however, were in book format—a choice made for cost purposes most probably. As a result, texts issued in the shape of a book might have had a similar appearance to other texts from elsewhere in the world—this is one facet of the manufacture of homogeneity that was discussed above—and hence more apt to be compared with them.

Finally, the *Bibliotheca Indica* publications, bought by subscriptions, were made in different fascicles bounded together once the last fascicle came out; provisional cardboard covers were used for the first fascicles while the last one had a cover which englobed all the others. In other words, the texts of the *Bibliotheca Indica* series were published as books in progress.

These remarks raise a key question, that of understanding the consequences of publishing texts in this way: What happens when a text hand-written in Bengali script on a landscape format manuscript becomes a set of fascicles printed in Devanagari later bound between two covers and turned into a book? How does this transformation shape the perception various readers have of it? What could appear as anecdotal changes in a modernization process that make ancient texts available to new publics might change in important ways the way these texts are received. In the case under consideration, altogether these transformations were formulating a discourse. For some actors at least, these new material features were tacitly recounting how the work had been uprooted from its primary contexts of emergence and use and now bore marks of foreignness. This case in point illustrates more generally what is at issue in examining the refashioning of a work or a document that takes place in the production of an edition.

In addition to examining the material reshaping of the work that occurred with its inclusion into the *Bibliotheca Indica* series, Graheli attends to the textual technologies put into play to prepare the edition. Indeed, for the *Nyāyabhāṣya* Jayanārāyaṇa created a new kind of edition which used practices and values inherited from Sanskrit textual critical traditions as well as others coming from the Asiatic Society milieu. For instance, the edition included editorial colophons after each section of the text, of a type standard in Sanskrit commentaries. It also systematically mentioned variant readings (*pathāntara*), as in the elaboration of a critical edition following the Asiatic Society style. In other words, critical works published in the *Bibliotheca Indica* series embody new, syncretic, conceptions of what a published text should be. How, more generally, were editions carried out in contexts in which different traditions of editorial scholarship were concurrently practiced? Attending to this issue, which is raised by the case of the *Nyāyabhāṣya*, might help us better perceive meaningful differences between ways of editing ancient works worldwide.

Han and Graheli's chapters likewise illustrate, in two completely different contexts, how scientific texts of the past that had become marginal, or even forgotten, all of a sudden turned out to be the object of a revived interest and how, accordingly, they were the object of modern editions—in Han's case, in the context of state institutions, and, in Graheli's case, in that of foreign institutions. By contrast, Karin Preisendanz's contribution deals with a wholly different case, for she discusses the modern editions of an ancient medical work that was still widely read and used by practitioners of medicine, among others, in nineteenth century India. Indeed, she focuses on *Caraka's compendium* (*Carakasamhitā*), one of the canonical ancient texts of *ayurveda*—the ancient scholarly discipline of medicine in South Asia. In relation to the active and persisting interest in the work, Preisendanz has identified more than fifty different nineteenth and twentieth

¹⁵ For the political implications behind this choice see (Singh 2018: 472-474) which also writes a larger international history of the printing of Devanagari in the 20th century.

century printed editions of the compendium — not to mention manuscripts owned privately — produced by types of actors and for kinds of uses wholly different from what Han and Graheli describe. Editions of *Caraka's compendium* are a far cry from the single and prestigious editions that were the outcome of the processes analyzed by Han and Graheli, offering to us another facet of the meaning and forms of the re-creation of ancient texts for all those who value them. As in Graheli's study, Preisendanz's corpus sheds light on how the different aims motivating each of these publications—which were influenced by different kinds of sponsors and fueled by international stakes related to the status of scholarly knowledge in colonial India—shaped in multiple but decisive ways the published editions and translations of *Caraka's compendium*.

The fact that this work, originally composed in Sanskrit, was part of a live dynamic tradition is strikingly embodied by the annotations in diverse languages and the complex textual apparatus that surround its publications. Indeed, the targeted readers of these editions were not supposed to be trained scholars in Sanskrit. As a result, most editions of *Caraka's compendium* did not include the sole text in Sanskrit, but involved commentaries, footnotes and translations. The text was vernacularized in many different ways, through scripts, translations and commentaries in the languages of the place where they were edited (e.g., in Marathi, Bengali, Tibetan, Hindi, etc.). From a different perspective, the languages of these publications also reflect the social milieu of the editors. Some editions of *Caraka's compendium* were made by traditional Sanskrit scholars. This is the case for the *editio princeps*, prepared by Gangadhar Ray in 1868, which for the first time turned *Caraka's compendium* into a printed book. However, the subsequent editions and translations were for the most part made not by philologists or pandits, but by practicing physicians of *ayurveda*. This would have a deep impact not only on the kinds of edition they would publish, but also on their concrete production and their availability. Indeed, by its very nature, this case study highlights another general issue about editions and translations: publishing, printing and selling printed matter requires many different resources, including the financial support of sponsors, a press, bookstores, etc. In fact, a great variety of networks entered into each printing of *Caraka's compendium*. Physician-editors were sometimes also press owners. More generally, to publish editors relied on intricate relations between students and teachers within close family ties, related to clinics, pharmacies, bookstores and printing presses. These facilities were often on the same streets. Sometimes these networks were pan-Indian, for instance involving editions relating to medical schools with actors circulating between Calcutta and Jaipur.

Preisendanz further argues that the type of funding available was also decisive in shaping printed texts. When sponsors made the printing of works possible in the first place, they also left their imprint on the kind of books published and the language chosen for them. For instance, Maharajas and lineages of wealthy scholars could promote Sanskrit editions or prestigious vernacular translations/commentaries. In other cases, prints were published in fascicles with advanced subscriptions or payments. Fascicle after fascicle, they could display their prestigious patrons but also, sometimes, their lack of decisive sponsorship. Preisendanz nevertheless shows that cheap vernacular publications were much more successful than prestigious scholarly Sanskrit ones—which were, just as in the *Bibliotheca Indica* series, printed in Devanagari script. Therefore, not only the material conditions of publication, as previously underlined by Graheli, but also the networks to which editors belonged, whether they were respected pandits or local practicing physicians, all participated in the making of the printed edition as well as in its popularity.

Why was printing *Caraka's compendium* important? As previously, these publications also reflected wider international issues. Just as in the cases treated by Han and Graheli, Preisendanz demonstrates that for editors, printing was part of a modernist project which involved integrating the Ayurvedic medical tradition into a world conversation and a world history. Accordingly, for the promotion of their agenda the editors took advantage of the new print media introduced by the colonial rulers. In their view, printing texts allowed them to promote knowledge they felt was despised by colonial rule, and to disseminate what they perceived to be neglected foundational

works of science.¹⁶ In other words, here too, editing ancient texts, and in particular fashioning the text in a certain way, is in and of itself a political statement.

In line with these concerns, the prefaces of these editions reflect how *ayurveda* slowly became part of a nationalist discourse. The issue for the editors, then, was not only to valorize what seemed to be a downplayed tradition, but also to prove that *ayurveda* was at the origin of all other medical traditions. As in the case described by Han, the point was to establish not only that European allopathic medicine originated from *ayurveda*, but also that it was the origin of all the medical traditions that were its direct competitor, namely ‘homeopathy’ or the Persian medical tradition known as *Unani*. Editions of scientific texts, therefore, belong to a discourse on the history of science that is worth documenting. Furthermore, we can study the impact of such a discourse on the way these editions are carried out: editions influence the writing of such histories, and, in return, these histories participate in giving shape to these editions.

Beyond the content of their prefaces, editions of *Caraka’s compendium* embody—and thus assert—these historical and genealogical points of view. In particular, some editors were ‘integrationists’ forging different types of hybrids out of their knowledge of *ayurveda* and what they perceived to be ‘foreign knowledge’. The synthetic character of the editions extended to the textual features of the books produced. Indeed, some editions mimicked scholarly Western editions noting variations of manuscripts in footnotes without, however, describing the manuscripts themselves. Another sign of this integration and accommodation of ‘foreign knowledge’ is the appearance—in the editions themselves—of illustrations, and notably of anatomical drawings. There seems to have been no such images earlier. The labels of these new images involve, to use Michalowski’s expression, ‘interlanguage procedures’. Indeed, these labels also display linguistically how these images establish dialogs between several scholarly worlds. For instance, the eminent scholar Shankar Daji Pade’s (1876-1909) Marathi translation and edition of *Caraka’s compendium* published in 1907 has anatomical drawings. They are labelled with numbers, and include names in Sanskrit, Marathi, English and Latin. To take another example illustrating both kinds of integration—that is, integration between bodies of knowledge as well as between textual practices—, Khemraj Shrikrishnada was one of those scholars who were at the same time merchants, publishers and press owners responsible for vernacular editions of the *Caraka’s Compendium*. His edition with Mihirchandra’s Hindi commentary, published in 1898, contains multilingual illustrations, notably of parts of the body not usually studied in *ayurveda*, such as the brain or the nervous system. Such illustrations sometimes included English terms transliterated in Devanagari. However, these anatomical drawings co-existed with mythological representations of diseases as demons, and the illustrations of the divine origin of *ayurveda*. Despite the similarity between the textual devices employed, the use of illustrations in these two editions may be interpreted as formulating opposite meanings: if Shankar Daji Pade displays how he is constructing a new hybrid knowledge, Khemraj Shrikrishnada and Mihirchandra’s point with their choice of illustrations might be to prove that European medicine was a later development of *ayurveda*.

In brief, as the case of *Caraka’s compendium* shows, publications of editions embody not only the social positions of the editors, but also the way they want to situate themselves within the world of what was perceived as ‘European knowledge’ with its critical editions and footnotes. Editions and within them a specific kind of object—the illustrations—reflected also the ways that *ayurveda* was being thought and adapted. They exhibit more broadly how these editions with translations exhibit their editor’s goal, and speak of the histories of science they wish to be integrated in: editions and translations are performative acts. More largely such a corpus offers rich evidence for the issue of how past texts were accommodated for present uses.

¹⁶ Preisendanz notes that to this day, the edition and publication of ancient works are deemed important and relevant to readers and editors in India. The sheer number of published books runs contrary to the feelings expressed by editors that *Caraka’s compendium* would be a forgotten, neglected, text.

Taking a world-wide view on editions and translations of ancient scholarly texts in early modern and modern times hence sheds lights on how international networks, political considerations and all sorts of material constraints have had an impact in inspiring interest in ancient texts and shaping the outcomes of these endeavors. But there is more. The anatomical illustrations evoked in Preisendanz's contribution invite another range of questions. Indeed, they display the diversity of factors that enter more generally into the shaping of specific elements making up editions and translations. More importantly, fashioned as they are, these elements will have a bearing upon how subsequent readers interpret the ancient scientific works to which these elements belong. As we have suggested in Section 1.1 of this introduction, this is a key general issue. How have editions and translations reshaped the various components specific to ancient scientific documents? How have these transformations left their imprint on interpretations and also, more broadly, on the historiography of science? These are the important questions that the book addresses next. Accordingly, in what follows, in contrast with a global, macroscopic point of view, we turn to micro-case studies focusing on how editions and translations showcase the components of ancient scientific sources and how this approach enables us to historicize the treatment of these specific elements, which form Part III of the book.

1.2.3 Shaping Specific Features of Scientific Texts

The first two chapters of Part III return to the issue of the edition and, more broadly, of the representation of numbers and quantities, which we touched upon in Section 1.1.3. They do so, by concentrating on cuneiform documents. Indeed, modern editions of sources from Mesopotamia reveal important facets of the treatment of numbers and quantities, as well as, more generally, of the shaping of editions and translations.¹⁷ However, to understand these aspects, we must first add a few words about these documents themselves.

Mesopotamian clay-tablets are witnesses of scientific knowledge and practice in ways that differ from most of the other sources mentioned in this book. First, these tablets are excavated objects, which, for the most part, were found close to the places where they had been inscribed and used, rather than texts transmitted through a continuous process of copying and willful preservation in libraries and archives. Second, these tablets are written in scripts that can be read in Sumerian or in Akkadian. A little explanation is in order here, since much is at issue in this point. Sumerian was inscribed using a logographic writing (Sumerograms), while Akkadian can be written using a syllabary, that is, in a phonetic fashion. However—and this is a crucial point for us—, sometimes the inscription of Akkadian does not make use of the Akkadian syllabary, but of Sumerian characters, which are accordingly read in Akkadian.

These two features—the very nature of these sources and the language in which they were composed (presumably, since it is not always easy to determine the actual language lying behind the script)—have led modern actors to shape, for their editions, specific kinds of textual device. Indeed, the nature of the material evidence and the possible disjunction between the script and the language are correlated with the fact that an edition of cuneiform source material consists standardly of several of the following components: a photograph, a hand-drawn copy, and several types of representation of the text inscribed on the tablet with a modern Latin alphabet. The latter include: transliterations (which encode graphemes and thus represent the written form of the signs) and transcriptions (which encode phonemes and thus focus on how the text was pronounced).¹⁸ In

¹⁷ In the three annexes appended to (Chemla, Keller and Proust (eds.) 2022), the reader will find information on the conventions used in this volume to deal with numbers, measurement units and measurement values in, respectively, cuneiform, Chinese and Sanskrit sources.


¹⁸ Proust notes that transliterations and transcriptions are historical constructions. She uses here the definitions used by the Cuneiform Digital Library Initiative (CDLI), which itself relies on the definitions of these categories given at the twenty-first congress of Orientalists in Paris in 1948. For instance, Neugebauer's 'transcription' corresponds to what is now for the CDLI a 'transliteration'.

addition, these Latin-alphabet representations of cuneiform texts are often accompanied by translations and followed by a commentary which provides an interpretation of the sources' content. Such editions therefore represent the witnesses with textual *dispositifs* that mirror the sources in different ways, depending on the editor's choice. The case of clay tablets displays immediately why editions do not provide a direct access to the documents they rely on. It also clearly sheds light on the artificial character of the text of these editorial works *qua* text. What is more, this example highlights right away various aspects of the historicity of the text of editions: the printed output depends, for example, on the material resources available to reproduce the tablet (drawings, photographs in black and white or in color, 3D images, etc.).

Mathematical tablets give noteworthy illustrations of how editors' decisions fashion the edition of a text—in particular with respect to the languages in which sources were composed and read. Indeed, Proust provides stunning examples of how different editors gave wholly different transcriptions of the same Old Babylonian mathematical cuneiform tablets (2000 BCE-1600 BCE), thereby shaping different editions for the same source.

With the example of Tablet YBC 4710#1, she shows how the different transcriptions given by Neugebauer and Thureau-Dangin derive from the fact that they understood differently the function of Sumerograms used to write down the text, in ways that have a significant impact for the history of mathematics. Indeed, for Thureau-Dangin, when Sumerograms were used in an Akkadian context, they were merely employed to write the Akkadian language. Accordingly, Thureau-Dangin transcribes them in Akkadian. For instance, his transcription of the Sumerogram meaning 'field'—which he transliterates as *a-ša*—is *eqlum*. By contrast, for Neugebauer, Sumerograms in Akkadian texts were to be understood as mathematical symbols, and should thus be preserved as Sumerograms in the transcribed text—note that Neugebauer thereby gives another meaning to what a "transcription" is. The kinds of texts used for an edition are a flexible matter that is adapted to the scientific work carried out with them.

These diverging choices seem to derive from a fundamental disagreement between the two Assyriologists about how they understand the function of a mathematical inscription, and this entails deep historiographic consequences: contrary to Thureau-Dangin, for whom a mathematical text simply writes down oral utterances, Neugebauer's practice might reflect the assumption that mathematical work is primarily written and that the inscription represents the traces of this engagement with the written word. From the viewpoint of the editions, in a spectacular way, a same witness then will give rise to the publication of different transcriptions and translations. Furthermore, obviously, if signs are interpreted as being mathematical symbols, this has bearing on their relevance for the history of mathematics. The tablet containing them would then be eligible as a source to be included in the rich and somewhat prestigious field of the history of mathematical symbolism.

Let us leave here the issue of the language corresponding to the written word—and the different functions that accordingly different editors lend to the inscription—to focus on our main topic in the first two chapters of Part III: the edition and translation of signs denoting numbers and quantities. The observation of these signs sheds light on another phenomenon. Indeed, we might believe that transliterations straightforwardly reflect the written word. However, Proust shows that even signs of this kind highlight that interpretation has an impact on transliteration.¹⁹ The tablet that we have just mentioned illustrates this remark: the same sign (for instance, ) might be

In practice, Assyriologists have also used other modes (hybrids of both notably) of representation of the tablet in Latin script. For the sake of simplicity, in what follows we will stick to the CDLI definitions.

¹⁹ As Proust also notes, these remarks further extend to the treatment of computations. After all, transliterations cannot always convey the fact that the addition of quantities of goods to which some tablets attest could have been obtained by bringing together and regrouping the numerical signs representing the addends. The use of Arabic numerals in transliterations might even at times encourage artificial interpretations of numerical relations.

thought, by some, as being an un-pronounced graphical indicator and be accordingly transliterated in superscript, whereas it might be interpreted by others as a surface unit (in our example, this is, for instance, the case for the young Neugebauer), or as a lexical word meaning ‘field’ (this is the option chosen by Friberg). Here, thus, as above, but for different reasons, a same witness is given three distinct transliterations and widely diverging translations in relation to three editors’ different interpretations. This example clearly illustrates that the way numbers are transcribed, transliterated and translated does not only depend on the language in which editors think texts were composed (although this factors in, as we have seen above), but it also rests on how the function of the numerical sign, and the information given by a quantitative sign are understood. These remarks extend more generally to numerical and quantitative signs: a sign can elicit different transliterations, transcriptions and translations. The reader of an edition and a translation will therefore have an access to the source material that is heavily loaded by the editor’s choices.

On the other hand, the signs used to write down numbers also illustrate a converse phenomenon, which highlights the complexity of the issue. Proust makes this point in her historical remarks about the interpretation of sexagesimal place-value notations. The analysis is developed in two steps, both of which are important to us.

To begin with, Proust argues that the interpretation put forward by Neugebauer in a seminal article published in 1932-1933 deeply shaped the historiography of the sexagesimal place-value numeration system, in particular because his choices were inscribed in his translations of the sources. The crucial point is this: Although Neugebauer observes that, in Old-Babylonian mathematical tablets, many notations using a sexagesimal place-value numeration system are inscribed without any indication of an order of magnitude, in his translations he specifies the orders of magnitude, as he understands them. This is precisely the operation through which he inserts his interpretation—which is that ancient actors tacitly associated an order of magnitude with the numerical signs—into his translation of the original text. This historiographic practice durably shaped the understanding subsequent historians—and more generally readers—will have of these texts and their numerical component. However, Proust argues, one can interpret these numerical signs as they feature in the sources, without assuming that ancient actors added a layer of meaning that they did not write down: it suffices to imagine that ancient actors employed numerals written using the sexagesimal place-value notation only to compute and not to express quantities. In this case, although Neugebauer and Proust transliterate the same signs in comparable ways, given that their interpretations of these signs differ, they translate in quite different ways. In line with the remarks above, this example again clearly illustrates the potential impact of decisions taken in translations on the historiography of mathematical sciences.

But there is more, and this is where the converse phenomenon appears. Indeed, Proust attempts to identify the reasons behind Neugebauer’s choice in this respect. Much as Heiberg editing Archimedes homogenized a text to avoid its ‘interpolations’, Proust suggests that Neugebauer’s translation practice seems to have aimed to render in a uniform way all sexagesimal place-value notations found in cuneiform sources. Astronomical tablets written in the last centuries BCE, —that is, two thousand years after the mathematical tablets mentioned above— attest to the fact that at the time, actors apparently used the sexagesimal place-value notations as indicating orders of magnitude. Neugebauer seems to have assumed that similar notations in earlier mathematical texts were of the same nature as the latter, and he thus translated them accordingly. It is important to note that this amounted to assuming that over two thousand years the sexagesimal place-value system has not changed in meaning or use. What is more, translations tacitly conveyed this assumption of immutability to the reader. The historiographic impact of this assumption for the history of mathematics in Mesopotamia has been tremendous: the historical evolutions of the sexagesimal place-value notation have been overlooked. However, if we follow Proust’s interpretation, it appears that throughout these two millennia, there were deep transformations in the use of this notation, and these changes need to be attended to. The additional theoretical point for our purpose is this: we have observed above that sometimes the same sign in a document was the object of diverging interpretations and hence different transliterations. We now see that the same

numerical sign might have wrongly been assumed to have the same meaning, when different uses suggest that in different contexts it needed to be interpreted differently. Thus, use and also context might leave no trace on the sign itself, and yet they need to be attended to when carrying out editions and translations.

We will come back below to how the will to homogenize sources could tacitly engrave an assumption of uniformity into the edition of mathematical and astronomical sources themselves. For now, let us note that a decision to homogenize, in the translations, a numeration system found in sources shaped in crucial ways how non-Assyriologists could reflect on numerical signs.

What we have just seen suggests that cuneiform sources attest to a clear diversity in the ways of inscribing and using numerical signs. However, in order for this diversity to be attended to, it must be distinguished from and rid of another diversity, which stems from the diverging interpretations of editors and translators. This is where a historical reflection such as the one whose development this book intends to encourage might be helpful. In Proust's view, the diversity in representing numerical and quantitative signs springs from a lack of collective reflection, which is related to a deeper historical phenomenon. Historically, in the field of Assyriology, the scientific dimensions of the sources have not been a central concern—which shows a striking contrast with the field of classical studies in ways that call for further reflection. This phenomenon is reflected by the fact that the editorial conventions presiding over editorial work did not mention anything concerning numerical and quantitative signs. For instance, the conventions defined by Ignace J. Gelb at the twenty-first congress of Orientalists in Paris in 1948 are silent on this topic. At the time, for Orientalists, the most significant editions were those of literary and religious texts. Accordingly, editorial conventions focus on elements deemed relevant for the edition of these genres. On the other hand, historians of mathematics and astronomy concentrated only on what they thought relevant for their scientific analysis, neglecting what they considered to be less important elements of the context. Thus, in his conventions Neugebauer omits the complicated transcriptions of measurement values, probably because he believed they had no mathematical interest. More generally, in this no man's land, each author devised his or her own editorial conventions, focusing on the numerical signs and the features that he or she perceived as important. These remarks reveal a crucial phenomenon, touched upon also by Glenn Most in the postface of this book: they show the impact of the modern divide between disciplines on the editions of different types of source material and even on the different parts of a document.

For Proust, a study of the diversity artificially generated by the practices of modern actors should pay heed to an essential issue. Despite the variety of practices adopted by twentieth-century editors, their editorial conventions for the transcription, transliteration and translation of cuneiform numbers, measurement values and quantities generally share a common problem: they do not distinguish between the different types of signs contained in cuneiform sources. Indeed, ancient actors seem to have shaped distinct sets of signs for different uses—an issue of major importance for the history of science. Some of these signs incorporate both numerical and metrological information, while others are used specifically to count discrete items and yet others to carry out computations. The differences between such notations were quite stable in time, which explains why it is crucial to reflect them in transliteration and translation. However, editions often do not give us access to them in a faithful fashion, which severely limits the understanding that non-Assyriologists could acquire of these practices with numerical notations. The next chapter, by Cécile Michel, continues this line of analysis, by examining, from a historical viewpoint, the various problems elicited by modern transliterations and translations of the expression of quantities in the context of the edition of cuneiform source material. Michel thereby allows us to understand in greater detail the nature of the distortions that since the beginning of the twentieth century, various editors have applied to quantitative information. For this, she concentrates on tablets produced in contexts different from those evoked by Proust—that is, in economic and business milieus. These tablets abound in expressions of quantities—including measurement values—rather than numbers expressed using the sexagesimal place-value notation. Michel studies specifically how twentieth-century editors have transliterated the original notations, her aim being not only to show the

profound transformations undergone by the sources even in transliteration, but also to explore the historiographic consequences of the various solutions adopted.

The main thrust of her contribution is to highlight several ways in which, in the original documents, the expression of quantities has a structure in the cuneiform script that the transliterations and also the translations have replaced with another. An example given by Michel will suffice to explain what is at issue. A tablet inscribed in the first centuries of the second millennium BCE in Mari attests to the fact that the scribe used two different systems to write numbers. He first employs the sexagesimal system called system S to express the number resulting from a count of men and women. Then he uses a second numeration system, apparently decimal,²⁰ to express the sum of the numbers listed. In the transliteration of the tablet given by Jean Bottéro (1914-2007), the first result of the count of men is given as ‘60(+)16 *awilû*(meš)’, whereas a transliteration following the conventions of the CDLI would indicate that the 60, the 10 and the 6 are written using, respectively, three types of signs in a uniform way (one for 60, one for 10, and one for 6, which is repeated six times). In other words, the transliteration introduces a kind of opposition between the first sign (transliterated as 60) and the last two (transliterated together as 16), which structures the notation in a way different from what the source displays. Moreover, the transliteration renders the graphemes using the decimal place-value notation commonly employed today. Exactly the same remark holds true for the transliteration of the sum, in which the number of persons reads ‘1 ME 29’, which means ‘1 hundred 29 men’, while the use of the CDLI conventions gives ‘1 me 2(u) 9(diš)’.

The key point is this: by transliterating the separate counts of people in each line using a decimal place-value system, Bottéro makes the related numerical signs appear closer to those expressing the sum than they actually are. The transliteration thus fails to highlight the crucial change of numeration system that has taken place between the moment when the scribe determines the numbers to be added and the moment when the sum is computed. However, when we place this tablet in the context of contemporary Mari tablets, this detail appears essential: we now know that in this context, additions were carried out with a specific numeration system, into which the expression of the numbers to be added was first converted, before the sum was computed. This practice leaves a clue in the way the sum is expressed in the tablet under discussion. Consequently, the tablet bears witness to this practice, which can be perceived only if the transliteration faithfully reflects the numerical signs as they actually occur. The example illustrates what was at issue when ancient actors used different numerical signs to inscribe different quantities: the differences bespeak the distinct natures and meanings of the quantities expressed. In the case under consideration, some quantities derive from an operation of counting while the sum is yielded by a computation. What is more, against this backdrop, we see how misleading it is to add a sign ‘+’ between the sign transliterated as 60 and those transliterated as 16.

The other examples discussed by Michel show that these two issues—refashioning the structure of the expression as found in the original document and thereby deleting clues about the operations that produced this expression—are quite general. With the various systems of transliteration used for the expression of quantities, the structure and nature of the original signs were regularly misrepresented. Michel further argues that translations were also the site where major transformations took place.

Like in the cases studied by Fowler concerning the notation of numbers in ancient Greek texts, Michel notes how the specific signs for fractions that can be found in administrative texts—often respected in transliteration—might disappear in translations if authors, for instance translate a transaction involving $\frac{2}{3}$ *mana* and 4 *gin* as ‘44 *gin* of silver’. Notice that, in this case, the fraction occurs in an unexpected position in the expression of the measurement value. Indeed, as is commonly the case in these documents, the quantity is expressed using several measurement units in an order of decreasing magnitude. It is noteworthy that the fraction does not occur at the end of

²⁰ (Proust 2002) and (Chambon 2012) consider that this system is centesimal. See also (Chemla in dialogue with Keller and Proust 2022: 31, 42). What follows is based on these publications.

the expression, as a part of the smallest of all the measurement units used, but at the beginning. Why is that so, and what does this tell us about the practice of measurement or about that of computation? To our knowledge, these questions are not yet fully settled. It is clear that to address them, historians must rely on as faithful a representation of the original expression as possible.

In addition, Michel shows that, quite standardly it seems, translations convert the expression of all measurement values into a decimal number of the highest or the lowest measuring unit. François Thureau-Dangin (1872-1944) for instance, in an 1894 publication, converts all capacity measurement values contained in a document into quantities of *silā* (akkadian QA)—a measurement unit that is deemed to be equivalent to the liter. Thureau-Dangin does not give a transliteration of said tablet. Cecile Michel does, and she transliterates one of the quantities in question according to CDLI conventions as ‘3 (*bariga*) 2 (*ban*₂) 4 (*silā*₃) *kaš ús*’. Such a transliteration indicates that there are three *bariga* signs, 2 *ban*₂ signs and four *silā*₃ signs. Thus here, for each component of the measurement value, both numbers and measurement units are expressed with a same sign. Thureau-Dangin gives directly a translation of this expression as 204 QA (*silas*). In other words, what the original text formulates as an expansion with respect to a sequence of measurement units, whose relationship one to the next varies from one pair to the next—1 *bariga* is 6 *ban* and 1 *ban* is 10 *silā*—, becomes a number of *silas* expressed using a modern decimal place-value numeration system. What is more, the translation separates the number and the measurement unit in ways that do not reflect the original document. Michel suggests that Thureau-Dangin may have done so to make the text easy to read for those interested in economic history: Editions and translations in this case seem to have been shaped to enable readers to conveniently retrieve the quantitative data they contained, rather than to be faithful to an original. In this respect, Thureau-Dangin’s practice evokes what we have said about Thibaut’s conception of the editorial work in the case of scientific sources: for such documents, in editor-actors’ view, what matters appears to be the mere content, irrespective of the form it takes in the sources. However, whether converting into *silā*, or into the highest unit of the capacity system, the *gur*, such translations erase what was written on the tablet and suppress clues regarding how ancient actors computed with such measurement values. Moreover, consequently, by giving the illusion of a direct access to the source, translations also made possible assumptions on quantitative signs and numbers that had nothing to do with what actually was in the original text. In this way, such editions and translations subsequently provided a representation of source material on the basis of which was shaped a history of numerical notations and quantitative signs that could assume a uniform use of the sexagesimal place value notation or the absence of fractions.

Michel identifies a third type of transformation that was applied to the expressions of quantity in translation. Indeed, these expressions often make use of negative formulations. This is, for instance, the case of ‘1 *lá* 1/4 *gin*’, which refers to a quantity by indicating that it is one *gin* from which 1/4 *gin* was subtracted. Michel notes that Larsen and Møller translate ‘3/4 shekels’—in other words, ‘3/4 *gin*’—as do many Assyriologists in similar cases. Again, when do such quantities occur? Are they the results of measurement or of computation? What clues does their expression give about these questions? Questions of this kind can only be address on the basis of transliteration and translation that reproduce the main features of the original expression.

Michel’s chapter puts forward a last remark that raises important issues for the reflection on philological work in mathematics and that interestingly returns to the remarks we have made on diagrams, in Section 1.1.2. Indeed, she notes that the ways in which an ‘8’ or a ‘9’ are written on different tablets might present variations that, in practice, were not considered worth mentioning in transliterations. For instance, in a transliteration following the CDLI norms, these numerical signs might be rendered as ‘8(*diš*)’ or ‘9(*diš*)’, that is, by indicating that the signs are formed by the repetition of the sign ‘*diš*’ as many times as there are units. However, the way in which the ‘*diš*’ signs are arranged in the document is not indicated. Indeed, there is a standard way of placing them, in three rows, in the upper two of which three *diš* are placed, but Assyriologists also encounter non-standard ways. Why are there variations in the arrangement? What do they tell us about the scribes? For Michel, observing these variations systematically would be a meaningful task, not least because

it might open the way to a social history of numbers. However, to this day, these differences between the signs have been overlooked in transliterations: the signs were treated as the same, and hence concretely uniformized. Michel argues that this practice hides the diversity of actors, which implies that historians will have to return to the original documents anew, when and if they intend to address this issue.

What Proust and Michel have shown holds true much more generally: the expression of numbers and quantities—that is, mathematical objects that can be found in many different kinds of texts—has historically been subject to several sorts of rewritings in modern editions and translations. Their shapes were thereby often deeply transformed. They have been sometimes standardized, and sometimes modernized to meet the needs of imagined readers. These transformations have resulted in the erasure of the various contexts to which the notations of numerical and quantitative signs were attached, no matter how complex the editorial devices made to give access to original sources were. The coherence of different sets of notations as well as the various uses of different numerical and quantitative signs to which our sources attest then become inaccessible to the reader. These conclusions call for the deployment of a broader critical reflection on modern editions and translations of numbers and quantities in ancient documents. They also call for a systematic analysis of how editions and translations depend on a given historiography of numbers and of how, conversely, they also inform the historiographies that rely on them.

Reviel Netz's contribution continues this analysis of how specific elements of editions and translations were shaped, this time focusing on diagrams. His chapter deals with the history of the editions of mathematical diagrams in Greek geometrical texts from antiquity to modern critical editions, notably those published by Heiberg and Friedrich Hultsch (1833-1906). However, the issues Netz's chapter addresses differ from those dealt with for cuneiform documents for one fundamental reason: the witnesses available for the Greek works from antiquity considered by Netz are of a different nature and have a different history than the source material available in cuneiform. Accordingly, the history of editions and translations is also quite different. In particular, in this case the historian is confronted with what, by comparison, appears as an almost continuous series of attempts to recreate these works of the past for the present.

At first sight, Netz's study is in line with the historiography evoked at the beginning of this introduction. As we have seen in section 1.1.2, recent work has established that there are key differences between the diagrams preserved in the manuscripts and those found in the critical editions of the late nineteenth and early twentieth century. Some of these differences—relating to the supposed generality and the visual accuracy of these diagrams—have been the object of a collective effort in recent decades (De Young 2005; 2012; 2020; Saito 2006; 2011; 2019; Sidoli and Saito 2012; Netz 1999, 2012, 2013, 2020; Lee 2018, 2020...). However, Netz here, precisely by relying on the possibility of observing editorial work over the long term, aims to go beyond this and raise new questions: Noting the wide gap between manuscripts and modern editions with respect to diagrams, he seeks to establish how this divide occurred in history. The point is to understand the processes that produced the diagrams that feature in the editions commonly used today and thereby to interpret the meaning of these changes.

To this effect, Netz develops a historical inquiry into the transformations undergone by the diagrams in Greek geometrical texts from antiquity. More precisely, he focuses on diagrams in the context of proofs proceeding by *reductio ad absurdum*, which Netz identifies as particularly revealing of the processes he is interested in. To begin with, like any other diagram, these diagrams generally show striking differences when we compare their occurrences in the various manuscripts and standard printed editions. However, in their case, the differences take a specific form: ancient diagrams emphasize the absurdity of the situation assumed in the proof, while modern editions reduce the absurdity. For instance, where, in manuscripts of Archimedes' work *Spiral lines*, Proposition 13 has a diagram depicting a tangent line touching a spiral in two distinct points with a broken line, Heiberg's 1913 edition restores the drawing of a straight line. Such transformations naturally suffer exceptions. Thus, in the case of Proposition 35 of Book IV of Apollonius's work *Conics*—where the issue is the representation of the intersection of conic sections and the question

is raised whether the curves are tangent or not at these points—Heiberg’s 1893 edition remains quite faithful to the curves of the manuscript tradition (normalizing it only ‘slightly’) while Halley’s 1710 edition dramatizes the absurdity found in the manuscript diagrams. We return to the contrast between these two editions in Sect. 1.2.4.

In this context, Netz’s question is thus to identify when and why these breaks in the traditions of drawing diagram took place. Going beyond just noting the differences existing between the various occurrences of the same diagrams, his argument makes clear the benefits that can be drawn from writing a history of the diagrams and their transmissions in manuscript and print.

Looking at ancient sources, from ancient Greek papyri to medieval Byzantine manuscripts of works by Archimedes, Euclid and Apollonius, Netz argues first that, as a rule, diagrams there show very little variation. As a result, the diagram attached to a given proposition in the shared archetype can in general be reconstructed. This diagram is characterized notably by two features. First, it is overspecified—which we have discussed in Section 1.1.2. Second, it is schematic: the ancient figure represented the important traits of the situation under consideration without apparently giving any importance to it being iconic—that is, without attempting to imitate the object under consideration. Similarly, Netz shows that Heiberg’s editions contain diagrams often in keeping with those that appeared in early modern and modern editions, and quite different from the restored archetypes. Clearly, thus, these results allow us to measure in which respect a reader using today’s modern editions deals with diagrams utterly different from the original.

Netz goes one step further, when he asks how we can account for the amount of diagram variation we find between the ancient witnesses and the modern figures. He identifies the moment when, and the context in which, the ancient diagrams were simply replaced by the versions we find in modern editions. More precisely, Netz suggests that the break did not take place in the shift from manuscript to print cultures but that it was largely—though not always—carried out by humanist *milieus*. Indeed, these humanists felt the diagrams handed down in medieval manuscripts were corrupt, since these diagrams seemed absurd with respect to their own sense of what a correct diagram should look like. Striving more generally to retrieve the ‘Greek original’ behind what was perceived as the corruption of the ‘Middle Ages’, humanists thus discarded the extant manuscript evidence to replace it with diagrams that looked more reasonable to them and thus closer to what they imagined Greek scholars of antiquity would have drawn. Ironically, while they attempted to be faithful to the original, their editions betrayed the ancient texts, introducing more modern diagrams in their restoration. For instance, Memus’ (1537) *editio princeps* of the *Conics* seems to be the place where a reduction of the absurdity of *Conics* diagrams took place. These early modern diagrams left their imprint on Heiberg’s edition of the *Conics*. However, in this case, Heiberg seems to have also taken into account the diagrams of the single twelfth-century manuscript on which, in his eyes, all available manuscripts of the *Conics* eventually depended, thus eventually giving diagrams that present a mixture of both Memus’ and the manuscript’s. Commandino’s (1565) edition of Archimedes’ *Floating Bodies* and the Basel printed edition of Archimedes’ *Spiral lines* in 1544 would be other such moments where the transformation towards a reduction of diagram’s absurdity would have taken place—here maybe ultimately influencing Heiberg’s edition of these texts. Concerning *Spiral lines*, Netz further argues that the initial transformation may have taken place in certain manuscripts, notably William of Moerbeke’s (d. 1286) translation of it into Latin, before showing up in certain Renaissance printed editions.

Netz’s inquiry is an example of what a long-term reflection on the processes of copying, and making critical editions can contribute to the history of Greek geometrical texts of antiquity. Taking into account the complex processes through which ancient texts were given to read to new readerships enables him to go beyond the mere observation that modern editions hide ancient diagrammatic practices. Netz retraces the genealogy of these new types of diagrams, their history, and the forces at play in promoting a replacement of evidence by newly drawn figures. He identifies the ancient actors and the issues they attached to the diagrams, explaining *how* and *why* these actors produced the diagrams we are used to reading as belonging to the sources, although these diagrams might be, in some cases, quite different from the original ones. This of course has consequences.

The kind of history set forth by Netz shows that, in certain cases, humanist-produced ‘modern’ diagrams consequently helped in shaping what was understood as the ‘modernity’ of ‘the Greeks’.

Netz’s historical analysis of diagrams thus clearly points out some of the new insights that historians might more generally derive from the fulfilment of the following critical tasks: attending to the different transformations elements of a text might have undergone in various ancient testimonies as well as later editions and translations to then account for why some manuscripts present these elements in ways that differ considerably from others. Tasks of this kind are meaningful not only for diagrams, but also for any other element of a scholarly text. Yet, a history of the transformations of specific elements of texts such as numbers and diagrams still remains to be written, as underlined by Most in the postface.

The foregoing explorations have shown that the expression of quantities as well as the diagrams encountered in the sources are sometimes reproduced in editions and translations in ways that depend more on the representations forged by editors and translators than on the attempt to faithfully mirror those of witnesses. These remarks clearly highlight facets of the editorial and translation work specific to scientific sources. Cooper’s contribution, for his part, sheds light on another more general and more fundamental feature of editions which has not, to our knowledge, been the subject of reflection, despite the fact that it has undergone major changes: the textual devices that actor-editors shaped on the basis of their reflections on how best to represent the witnesses. This issue draws our attention to another facet of the production of editions, already touched upon by Graheli: editors operate in the context of philological cultures, which they contribute to shape in relation to the specificities of the source material they deal with. Here again, due to the nature of the cuneiform witnesses, Old-Babylonian documents will appear as offering precious pieces of evidence to approach this facet of the editorial work, which turns out to be of capital importance.

To deal with the phenomenon under consideration, Cooper has at hand a very telling kind of source: tablets attesting to Sumerian literary compositions. These compositions, whose editions Cooper—like Netz—examines from a historical perspective, were among the works taught in Old-Babylonian schools. Other works included royal panegyrics, epics, and mythological tales that were learned after word lists, advanced sign lists, metrology and mathematics. Pupils may have learned to write these texts, first producing excerpts found in single-column tablets, and then with larger portions in multi-column tablets. Consequently, most of the witnesses used for the editions of literary compositions of this kind were the innumerable discarded tablets of school education, dating from 1825 to 1725 BCE. In fact, quite concretely, no ‘master copy’ of a Sumerian literary composition exists. Nor do we know anything about authorship. As we now understand the nature of the evidence, each school, each archeological layer, enables the reconstruction of what could have been for a given teacher, in a given place and time, a correct rendering of the composition. As a result, recorded variants cannot be interpreted in the same way as they are when editing single author texts: variants do not arise by copying a document that was itself a copy of another document and so on. However, this awareness emerged precisely through a long struggle with the issue of how to represent the extant witnesses.

Cooper’s contribution considers the problems raised as Assyriologists strove to produce editions of these peculiar works with such specific witnesses, examining, to begin with, how editors understood the task to fulfil. First, editors tried to reconstruct a stable original text. Early scholars, trained in classics, imported editing techniques devised for ancient Greek and Latin sources, or biblical Hebrew, and attempted to apply such philological cultures to texts with different stories and, above all, with different types of witnesses. Consequently, published editions first reflected their editor’s desperate struggle in reconstructing an eclectic best text. For instance, S. N. Kramer’s (1897-1990) edition concentrated on the wording of the composition, line by line. The critical apparatus, displayed in his first 1937 publication, ordered tablets according, first, to the first line of text contained in a tablet and then—for tablets with the same first line—to their length, the manuscript sigla allowing the editor to list them in alphabetical order. Footnotes indicated when a tablet did not contain a given passage. The reader had to reconstruct from a set of dispersed

footnotes and the sigla what text a given witness contained. This way of proceeding was standard until the mid-seventies of the twentieth century. Cooper notes that such editions appeared essentially as line-by-line texts ‘in a forest of footnotes.’ The work itself seemed to become meaningful only if and when it was put in visual relation with a facing page translation, enabling the reader to grasp that the Sumerian composition was indeed a piece of literature. Translation and edition were thus deeply intertwined. In the mid-seventies, the impossibility of grasping such a fragmented text led to the creation of a new kind of textual *dispositif*. Editors experimented with ways of making editions that could visually display witnesses and their variants, still aiming to reconstruct a standard best text. In this vein, in 1974, D. Edzard introduced a new textual device inspired by an edition of ‘scores’, providing line after line all the contents of all the witnesses, furnishing full-fledged data on the text contained in each tablet. This had the advantage, over the previous style of edition, of being very clear as to what exactly the text contained in each tablet was—the reader was not required to reconstruct it any more.

These changes were not of pure form. As is often the case, new textual representations led to seeing the documents in a different light and to questioning the goal that should be ascribed to editorial work. Indeed, new features of the sources were progressively deemed meaningful for editions. Previously unrepresented, they were now included in publications: editors concentrated on different types of visual display and various kinds of *varia*. Editors also began paying attention to provenance to organize the complexity of the source material, which allowed them to identify the existence of groups of texts. From another perspective, to make their editions they could make use of new text-editing tools. Thus, in Civil’s 1994 edition, recorded variants did not only concern text and content but also the kind of signs used. The listing of variants was coded in such a way that it enabled him, as he was in the editing process, to make changes from the main text to the *varia* section quite easily, with the help of his computerized text editor. Indeed, editing practices changed as automation and large data hashing were increasingly made possible by the progressive use of computers in the second half of the 20th and the beginning of the 21st centuries. Such changes went hand in hand with what became a new perception of the witnesses and their *varia*. New editions indeed are now shaped to display what is considered to be different layers of transmission of the text. Thus, Delnero’s 2012 study and edition rest on 740 witnesses. In his edition, groups of similar variants are understood as testimonies of a transmission taking place in a same school or place. The edition has the shape of a score which, in conformity with Edzard’s style, records each witness’ content. An eclectic best text is provided, and variants from this text feature in boldface. The tablet sigla, using a system of subscripts and upper-case letters, indicates in a left-hand column the provenance of a tablet as well as the nature and the state of the source. Indeed, some witnesses might be broken fragments of tablets while others could be extant double-columned ones. This edition also separates the standard school compositions of the second millennia from the scarcer sources that have sometimes come down from the first millennium.

Such an edition then not only attempts to take into account the multifarious versions to which a widely diffused text can give rise when it has no fixed author, but it also enables a visualization of both the material state of the sources and the complex history of the text. At a glance, different states of the text become accessible in the published edition. Cooper’s chapter is a testimony of the editorial creativity of editors faced with specific sources, new tools and new editorial goals. They gave birth to new kinds of editions, and, above all, new ways of representing witnesses and their *varia*. Here, these editions are precisely correlated with the specific nature of the documents dealt with, while reflecting the material environment in which editors operate. In a sense, we thus see the circumstances in which and the processes through which new philological cultures emerge.

Assyriologists began editing their texts through the importation of philological practices that had been shaped for other kinds of source material. Gradually, they adopted new goals and mobilized new techniques for their editions. Their sources compelled them to pay attention to the very diverse conceptions of text and authorship to which various documents testify. These sources also led Assyriologists to question classic conceptions—such as that the ‘Ur’ text—and the general

validity of some of the classic tools for making editions—such as the stemma. Could the goals and techniques Assyriologists devised now inspire new ways of editing documents produced in other contexts and other times? The question is worth considering, and it illustrates the benefits that may derive from approaching the history of editorial work from a world-wide perspective.

In fact, even though for different reasons, both Netz and Cooper show why editions sometimes are not just about recovering an original text, or elements of the original text. Such a goal might sometimes be out of reach, sometimes meaningless or even hide essential information for the history of science. Rather, editions could display different states for which a text and its elements are documented. They would then testify to these states rather than expose the ever-elusive search for an original.

With these remarks, we conclude our observation of how inscriptions specific to scientific texts were dealt with in editions and translations as well as how, in relation to the nature of the documents available, editors and translators shaped artificial textual forms to re-present the source material and the features that they deemed important. Clearly, these elements present major variations depending on the editions dealt with. How can these analytical tools help us approach the differences between different editions of the same work and understand their impact? This is the issue to which Part IV of the book is devoted.

1.2.4 Publishing Ancient Mathematical and Astronomical texts: Comparative Perspectives

Comparing the ways in which different types of ancient and modern actors have constructed editions or elaborated translations of a same mathematical or astronomical work can more generally help us better perceive the correlation between, on the one hand, the specific purposes for which, and the specific readers for whom, editions and translations were made and, on the other, the texts produced. Reflecting upon the differences between editions and translations made on the basis of the same documents may in particular allow us to increase our critical awareness with respect to texts that purport to make the past available for the present. What is more, a comparison of this kind can help us further identify key specific features of the philological cultures in the context of which these editions and translations were prepared and how these cultures left their hallmark on the works produced.

A first chapter, in which Micheline Decorps outlines a long-term history of editions and translations of Apollonius' *Conics*, takes us back to an issue that was discussed above when evoking Pollock's contribution—the diverging criteria with which editors with different scholarly backgrounds make choices between variants—, but this time for a mathematical work. In the cases presented by Decorps, like in those studied by Pollock, a contrast can be drawn between the variants adopted for the text edited on the basis of mathematical concerns and those made to ensure textual faithfulness to the witnesses that were deemed important. Decorps illustrates such an opposition quite strikingly, for instance, with the difference between the edition and translation into Latin of Apollonius's *Conics* made by a mathematician who knew Greek and Arabic, Edmund Halley (1656-1742), and the critical edition of the same text made in 1891-1893 by Heiberg, the philologist evoked at the beginning of this introduction as well as in the previous section for his editions of Euclid and Archimedes' works.

The notion of 'best text' embodied by Halley's *Editio princeps* of the *Conics*, in 1710, was that of a clear mathematical exposition that would adequately display and articulate the logic of the reasoning, leaving space so that mathematical commentaries transmitted with the text—those of Eutocius and Pappus—could be conveniently perused. These commentaries included Eutocius' annotations composed in the context of his sixth-century edition of the first four books of the *Conics*. It also included the auxiliary propositions ('lemmas') needed for some proofs in the *Conics* and collected in Pappus' fourth-century *Collection*. Halley's Latin translation similarly aimed to be a tool for subsequent mathematicians interested in a mathematical reading. Mathematical meaning was thus here the chief guiding principle for the establishment of the text, even if it was for reasons differing from those of Thibaut. Heiberg's edition of the *Conics*, on the other hand, embodies both

the kind of choices for the text that are motivated by beliefs with respect to the nature of the text *qua* text, as well as by the kind of conservatism that reflects a certain kind of fetishism towards the ancient documents chosen as the basis of editorial work. To the former can be attached the decision to consider as interpolated all the auxiliary propositions that had parallels in Pappus' *Collection*. As for the latter, it is best exemplified by the preservation of bizarre syntaxes and singular meanings (*hapax*). However, it should not escape us that the fetishism is exercised here on the basis of a corpus of documents for which decisions of inclusion and exclusion are based on judgments heavily loaded with personal assessments.

Indeed, the contrast between Halley and Heiberg can also be grasped at the level of their treatment and their textual representation of the sources. Halley's seamless text is composed as a marquetry of variant readings drawn from all possible sources, treated on an equal footing, without allowing the reader to keep track of their origins. By contrast, in line with the modern methods of textual criticism that he applied to mathematical texts of Antiquity, Heiberg's philological work starts with a classification of the witnesses that expresses the historical and textual relationships between them. The point of this first operation is to assess their relative value as witnesses and to eliminate, from the corpus on which editorial work would concentrate, those that are deemed derivative. The shaping of the evidence to be considered thus brings into play wholly different textual technologies. As a result, in Heiberg's work, not all variant readings are granted the same historical value. What is more, the textual technology of the footnotes is put into play to fulfil the goal of allowing the reader to get an overview of the witnesses taken into consideration and to judge the choices made. The different philological cultures in the context of which the two editions were produced are hence reflected in the textual *dispositifs* of the editions.

Although, as Decorps underlines, Halley and Heiberg illustrate, in a sense, two opposite ways of making an ancient text available to a given public, they are nevertheless united by the same wish: that of presenting, each in his own way, a coherent text. However, this goal derives from a major assumption, which in turn guides how witnesses are handled: both editors assume that the witnesses reflect what originally was a coherent work. Decorps highlights how the search for consistency would lead both Halley and Heiberg to select a reading that was deemed to be the 'best'—the 'best' being, according to the case, decided either by linguistic or by mathematical criteria, and hence eventually producing different texts. By contrast, Decorps-Federspiel's editorial work and French translation, published at the beginning of the 21st century, led them to question this assumption.

What these two editors suggest, instead, is that the internal linguistic and textual variety to which the witnesses of the *Conics* attest have a meaning. What is more, for them, this variety can be correlated with the actual history of the production and transmission of Apollonius' *Conics*. As a result, homogenizing the language and more generally the text, wherever a witness allows it, as previous editors have done, erases clues that offer precious historical evidence about these ancient processes. In other words, for Decorps, what lies behind the variety to which the witnesses of the *Conics* testify are the different versions which circulated, co-existed, and were sometimes regrouped and (re-)homogenized. In fact, such a history underlines how, to begin with, a work takes shape, and how it is then reshaped according to the different assumptions of what editors think the work should be: linguistically homogeneous, logically structured, or having specific elements of a certain kind, according to what is demanded of a mathematical text.

Indeed, Apollonius composed the *Conics* on the basis of a compilation/synthesis of other texts on the topic, which he then significantly developed. He sent out several drafts of the successive books, writing the parts that eventually made up the work in stages. We presume Apollonius's work circulated in schools where it was studied and commented upon; his compositions were thus worked upon. As in the case described by Cooper, works that were the objects of study make for particular—and particularly modified—witnesses. Like Theon for Euclid's *Elements*, the *Conics* was transmitted through Eutocius' (480-540) re-edition of the first four books, to which Eutocius attached his commentaries. The *Conics* thus underwent a first radical

transformation when at least its first books became a unitary work. Decorps argues that Halley's mathematical edition continues a tradition of mathematical edition of the *Conics* inaugurated by Eutocius. However, the ancient commentator describes how he has put together several recensions of the work on which his editorial work relied. According to his own testimony, he notably collected from them all the different demonstrations he could find for the various propositions in the text, and selected those that would go in the main part of the text for their simplicity and clarity, while others would be put in the margins. Eutocius then himself had started this work of homogenizing the first four books of the *Conics* according to mathematical criteria.

Crucial to Decorps and Federspiel's edition is that Apollonius's *Conics* was translated into Arabic by a pool of practitioners of mathematics, which included the ninth-century scholar Thābit ibn Qurra. However, for the first four books that they edited and translated, neither Halley nor Heiberg took the Arabic witnesses into consideration. They thus neglected key testimonies of the work. Such an example shows how the editors' conceptions of the sources shape the evidence that is deemed meaningful for the editorial work. The preface of the Arabic translation makes clear that these scholars had a copy of Eutocius's commentary, which they claim to have followed for the first four books, and another manuscript of the seven first books, which they used for the translations of books V to VII. This Arabic translation of Apollonius's *Conics* is striking precisely because its style is not homogenous and also because it is partly similar to and partly divergent from the extant Greek witnesses. For Decorps and Federspiel, both the lack of homogeneity and the discrepancies, far from being a stumbling block, offer precisely means to examine how the witnesses shed light on the processes of composition and transmission of the *Conics*. In other words, instead of aiming to restore a single text, the editors' goal is now rather to unfold before the readers' eyes the processes of composition and transmission reflected by the witnesses. Different contexts, different *Conics*!

The comparison carried out by Decorps highlights how scholars with different disciplinary backgrounds and operating in different times understood editorial work differently. The comparison drawn in Agathe Keller's chapter adds another dimension, since she compares translations and editions produced by two nineteenth-century actors working in two different contexts. We have already encountered them, since they are the Indologist H. T. Colebrooke (see Section 1.2.2) and the *pandit*, librarian and teacher at the Government Sanskrit College in Benares, S. Dvivedin (1855-ca.1910), whose collaboration with Thibaut was discussed in Section 1.1.4. Colebrooke and Dvivedin are of interest to us here insofar as they shaped quite different books out of a same work. Indeed, Keller centers on the scholarly translation and the edition of chapter 12 of a Sanskrit astronomical treatise: the *Theoretical treatise on the true Brahmā [school of astral science] (Brāhmasphuṭasiddhānta)* completed in 628 by Brahmagupta, to which both scholars, respectively, devoted a publication. What Keller examines in particular are the tacit textual operations that molded the publications of this treatise: the typographical structure of the publications, their sections and para-texts serve a vision of the work which influences the way it and its parts are understood.

In Section 1.2.2, we have encountered H. T. Colebrooke as the author of an 1824 memoir on Hindu authors' logical works. We meet again with him here, as the author of an English translation of mathematical documents. Colebrooke's first operation was to take two chapters of Brahmagupta's astronomical treatise as separate tracts and thus to detach them from the other astronomical chapters with which they composed the treatise. This was a radical move, which gave artificial autonomy to chapters that Brahmagupta had integrated in a treatise. This transformation further artificially associated two chapters that might not have been thought of as closely related to one another by the original author: chapter 12 called 'chapter on mathematics' (*ganitādhyāya*) and chapter 18 called 'chapter on the pulverizer' (*kuṭṭakādhyāya*). What both disciplines ('mathematics' and 'pulverizer') were for Brahmagupta, and how they were to be related is still in need of elucidation, maybe precisely because Colebrooke and others in his wake have attempted to make the contents of these chapters familiar to the modern reader, associating the first chapter to 'arithmetic' and the second to 'algebra.' More, Colebrooke took the contents of chapter 12 to necessarily cover all the topics included in the definition of 'mathematics' given as a preliminary by

Brahmagupta. This involved reducing this chapter to two parts, ‘operations’ and ‘practices,’ and gathering all that did not fit into this structure at the end of the text as ‘supplements.’ Colebrooke’s translation further highlights what he sees as an internal structural similarity between arithmetic and algebra in Brahmagupta’s treatise. He also draws parallels between this ‘arithmetic’ embodied in Chapter 12 and what might have been for his English reader antiquated but familiar subdivisions of what Colebrooke identified as ‘logistics’ or ‘practical mathematics’. These two facets of Colebrooke’s interpretation of the *Theoretical treatise on the true Brahmā [school]* derive from the fact that he puts these two chapters in relation with what was for him the most important text of Sanskrit mathematics and astronomy: Bhāskara II’s *Crown of Theoretical Astronomical Treatises (Siddhāntaśiromāṇi)* from the twelfth-century—and, more precisely, what he considered as two autonomous chapters: the arithmetical *Līlāvātī* and the *Algebra (Bījagaṇita)*. Both chapters—which were likewise extracted from what was seen as their astronomical environment—were also translated in Colebrooke’s 1817 publication.²¹ By projecting the opposition between the twelfth-century *Līlāvātī* and *Bījagaṇita* onto the two chapters extracted from the seventh-century *Theoretical treatise on the true Brahmā [school of astral science]*, H. T. Colebrooke inscribes, in the translation itself, his perception that the two works reflect an unchanging tradition. In other words, the translation creates a structure that conveys to the reader what Colebrooke understands as an ahistorical tradition of mathematics, embodied both in Brahmagupta’s work (in which it is seen in an older form) and in Bhāskara II’s (in which it was best expounded). This remark holds true more generally: Colebrooke’s point of view on the contents of the mathematical chapters as devised by Brahmagupta, as well as his perception of the history of mathematics in Sanskrit sources, with its canonical authors, both shape many details of his published translation.

The translator’s approach to and understanding of the text shapes not only the different parts of the published work, but also how the treatise relates to its commentaries. Indeed, Pṛthūdaka’s (fl. 860) commentary on Brahmagupta’s *Theoretical treatise on the true Brahmā [school of astral science]* was an essential tool for Colebrooke, notably to access the contents of Brahmagupta’s mathematical rules. However, Colebrooke operates another major transformation when he refashions both Brahmagupta’s treatise and Pṛthūdaka’s commentary as he finds them in his sources. What the manuscripts presented as a running commentary, embedding the treatise in the form of successive quotations of the sections commented upon, becomes, in the translation, a marginal and fragmented composition, featuring in bits and pieces in the footnotes to what now is given pride of place as the main text: Brahmagupta’s composition. As in the translations studied by Michel in which numbers were shaped for historians of economics, Colebrooke’s translation might have been composed to make ancient ‘exotic’ works comparable to other books, more familiar to his readers. The reduction of Pṛthūdaka’s commentary into fragments placed in footnotes might have had the aim notably of making its text accessible to readers for whom some of its exegeses might have seemed at least partly incomprehensible—for instance, when he developed grammatical analyses of the original. It might have intended to enable comparisons with other mathematical texts in other languages, using portions that would have made the comparative work easier. This had important consequences on how Brahmagupta’s mathematics would be perceived by nineteenth-century readers of Colebrooke’s translation.

Furthermore, the translator’s personal interest also comes into play, having a hand in the way the translation is shaped. For instance, Colebrooke is intent to be as close as possible to the

²¹ The status of Bhāskara II’s *Līlāvātī* and *Algebra* in relation to his astronomical *Crown of Theoretical Astronomical Treatises* is still under investigation. In the wake of Colebrooke’s publication, which follows some Sanskrit commentators, they were often thought of as chapters extracted from the astronomical treatise, and having had a more or less autonomous life. Recent studies of the inner coherence of these texts have suggested that these chapters might have been from the beginning three independent treatises (Ramasubramanian, Montelle and Hayashi 2019: xxi sqq). An edition of all three works taking into account the different strata of editorial work on the texts is thus in need.

reconstruction of computational practices offered in the commentaries. He carefully reproduces tabular displays of numbers that such commentaries describe.

Many of Colebrooke's choices differ from those made by Dvivedin, the author of the *Editio princeps* of Brahmagupta's Sanskrit treatise almost seventy years later. To begin with, Dvivedin integrates— in continuity perhaps with a Sanskrit tradition in which he was trained as a *pandit* — Pṛthūdaka's commentary within his own Sanskrit commentary. What is more, he edits the whole astronomical treatise. Lastly, in contrast with the interpretation promoted by Colebrooke, Dvivedin does not underline the structural similarity between Brahmagupta's treatments of arithmetic and algebra. Thus, Colebrooke's English translation and Dvivedin's Sanskrit edition offer two different kinds of 'source' texts. Clearly, a translation like an edition embodies points of views on a composition, neither of them providing a direct access to a given work.

However, one might argue that the translation and the edition both display, each in its own way, the adherence of Brahmagupta's *Theoretical treatise on the true Brahmā [school of astral science]* to a broader Sanskrit context. Indeed, Dvivedin and Colebrooke converge when they shape a history of mathematics which takes Brahmagupta as an older testimony of what would have been a homogeneous 'Hindu' tradition in mathematics and astronomy; a tradition essentially defined by the works of Bhāskara II. In Dvivedin's commentary on chapter 12 of the *Theoretical treatise on the true Brahmā [school of astral science]*, for instance, each of Brahmagupta's rules is likened to what can be found in Bhāskara II's compositions.

From the viewpoint of the textual *dispositif* of the edition, Dvivedin edits the work in new ways that are reminiscent of the nineteenth century actors discussed in Graheli and Preisendanz's contributions. His editions are hybrids which incorporate principles inherited from the printing medium of the book and German nineteenth-century philology, on the one hand, and, on the other, modes of re-edition notably through commentary, familiar to Sanskrit scholarly milieus, as described in Pollock's contribution. Thus, just as what we have seen with Heiberg's editions, Dvivedin uses philological tools such as the critical footnote, to display the results of the comparison between different manuscripts—a practice which he may have learned from the German philologist whom we have encountered above, Georg Thibault, with whom he had closely worked. Further, although he opts for the edition carried out in the context of a commentary that embeds the treatise and other commentaries, his position as a modernist *pandit* might best be visually embodied by his use of mathematical symbolism in his Sanskrit commentary. The latter feature is in line with the fact that Dvivedin focusses on mathematical ideas and does not reproduce elements of the computational practices which can be found in Pṛthūdaka's commentary. He might also have inherited from Thibault the idea that we have mentioned above, according to which scientific texts require a specific kind of edition that focusses on the contents rather than on the style.²² However, Dvivedin's edition of Brahmagupta's treatise also pays attention to a feature of the text that the English translation leaves unattended: its textual form as a set of verses. In this respect, Dvivedin's commentary shapes a linguistically coherent text, notably by homogenizing its versification. The comparison between his works and Colebrooke's thus interestingly highlights different aspects on which, in editions and translations, homogenizing is carried out.

This example further illustrates how multifarious are the kinds of textual operations implicitly carried out by editors and translators as they publish ancient texts. In the same way as what was shown in Preisendanz's study of the labels of anatomical drawings in modern editions of *Caraka's compendium*, more or less visible editorial acts, such as the harmonization of verses and the choice of mathematical symbolism in commentaries, combine to embody a point of view on the edited source, to assert the social position of the editor, and to put the editorial work in dialog with different editorial practices. Where Colebrooke's English translation can be seen as a work fashioned for transmitting something foreign and maybe exotic to his European readers, Dvivedin's edition was transmitting what he perceived as his heritage, updated for a new Sanskrit reading public: The editor's and the translator's aims shaped their publications. This, then, influenced the

²² See Section 1.1.4.

way the texts were read and understood. But then again, these works were read in ways that might have been different from the initial project of those who had them published. For instance, readers of Colebrooke's translation took it as a quasi-direct access to a primary source.²³

More largely, mathematical and astronomical texts in Sanskrit were subsequently read as testifying to a logical coherent system, best embodied by Bhāskara II's works. The fabrication of a 'Hindu' tradition as a coherent mathematical system was inherent to the way the texts were shaped in translation and in edition, and this belief, to which both the editor and the translator were committed, was furthermore tacitly transmitted to those who accessed the past through these channels. This might account for why and how this view has been so enduring since.

Colebrooke's and Dvivedin's editorial choices also left their imprint on many other elements of the text, in ways that shaped the historiography of mathematics in India. Until today, reflections on mathematical proofs in Sanskrit commentaries lament that they are often fragmented and irregular—a view no doubt reinforced, if not inherited, from Colebrooke's piecemeal rendering of commentaries. Colebrooke and Dvivedin were also influential with respect to the type of text and editorial practices that they shaped for the purpose of giving Sanskrit mathematical texts to read: throughout the 20th century, Sanskrit mathematical and astronomical texts have often been edited and translated in very similar manners. A first enduring practice is that the Sanskrit text is generally translated into English with a commentary which focuses on its mathematical content. What is more, mathematical and astronomical components of the same treatise are often published and studied separately from one another.

As noted above, the case study dealt with in Keller's chapter compares a translation and an edition of the same text—the 'mathematical' part of a seventh-century treatise—which were carried out by scholars situated in two different scholarly worlds. Colebrooke was a British Indologist who had been in contact with *pandits* in India, whereas Dvivedin was a 'modernist *pandit*', both rooted in a Sanskrit tradition and learned in works of mathematics that had been introduced into India from the British Isles. Knowledge of mathematics from other traditions played out in the way the translation and the editing of the Sanskrit mathematical text were carried out, albeit in different ways. The case study that Zhu Yiwen and Zheng Cheng present in the next chapter deals with editions of *Mathematical Book in Nine Chapters* (*Shushu jiuzhang* 數書九章, hereafter *Mathematical Book*, 1247) by Qin Jiushao 秦九韶 (1208-*ca.* 1261) that were prepared by Chinese scholars in the eighteenth and nineteenth centuries, and it differs from the previous case study in at least two key respects. Firstly, although mathematical knowledge that had been introduced from Europe into China since the beginning of the seventeenth century certainly had an impact on these editions, the way in which it played out was quite different. Incidentally, this remark highlights the benefits that can be derived from adopting a world-wide outlook on our topic, as we do in this book. Secondly, these editions were making available to a larger number of readers a thirteenth-century work, parts of which had in the meantime become incomprehensible to Chinese readers, just as had several other mathematical works from about the same period. As a result, copies of *Mathematical Book* had become scarce and difficult to access. The decisive fact is that, shortly before the editions under study were undertaken, Chinese scholars made a breakthrough, and managed to partly recover the meaning of those of the works that were still available in China, precisely thanks to the mathematical knowledge that had been introduced from Europe by the mediation of some Jesuits. In other words, in this case, the relationship between the eighteenth- and nineteenth-century actors involved in editing and the work whose edition they prepared was the product of quite specific historical circumstances.

To make these points clearer, we need to give elements of information, which brings us back to one of the contexts discussed by Han Qi in relation to *The Gnomon of the Zhou [Dynasty]* (see Section 1.2.2). Indeed, in our discussion of this other case study, we mentioned Mei Wending's contribution to the recovery of ancient Chinese works on mathematical sciences and the role of his

²³ (Charette 2012), (Smadja 2016).

grandson Mei Juecheng in the compilation of the 1722 imperially-commissioned encyclopedia *The Basic Mathematical Principles*. They are also key figures in the case study offered by Zhu and Zheng. The fact that large parts of thirteenth-century mathematical works could no longer be understood since at least the sixteenth century was partly due to this: these works gave pride of place to a mathematical practice with calculating rods, and numerals related to them—which feature in thirteenth-century works. In particular, they testify to the use of these calculating rods to write key mathematical concepts and to carry out complex mathematical algorithms. Among these, there was an innovative algorithm for solving any type of algebraic equation (known today as the Ruffini-Horner algorithm) and an algorithm associated with what is called today the ‘Chinese remainder theorem’—precisely, two algorithms that were central in Qin Jiushao’s *Mathematical Book*. However, at the time when editorial work on ancient mathematical texts began, the practice with calculating rods was abandoned, notably because, for computations, since the fifteenth century at the latest, calculating rods generally had been replaced with the abacus. Partly in correlation with this change, the notations and algorithms associated with calculating rods were gradually forgotten. The works in which they played a central role became accordingly incomprehensible. In his effort to restore ancient mathematical knowledge to which Chinese writings attested, Mei Wending devoted a work to the ancient use of calculating rods. Then, in 1745, his grandson Mei Juecheng caused a sensation with the publication of *Pearls Lost in the Red River* (赤水遺珍, 1745): in this work, using knowledge of a type of algebra that had been introduced from Europe, Mei Juecheng managed to crack some of the lost meaning of thirteenth-century mathematical works, establishing that these works were precisely dealing with a kind of algebra similar to that imported from Europe. Indeed, he established that the notations with calculating rods that had become unintelligible were simply notations for polynomials and algebraic equations. This discovery made a strong impact on Chinese scholars who then turned to the analysis of the relationship between ‘Western science’ and ‘Chinese science’ in new terms. It also elicited an active movement of search and interpretation of ancient Chinese mathematical works. It is at this juncture that the modern editions of Qin Jiushao’s *Mathematical Book* were prepared.

As Zhu and Zheng explain, the first modern edition was carried out for the imperially commissioned *Complete Library of the Four Branches*, also evoked in Han’s chapter, which was completed in 1781. This holds true for *Mathematical Book* as well as—as we explained in Section 1.2.2—for all the other Chinese mathematical works composed before the fourteenth century, with the exceptions of *The Gnomon of the Zhou [Dynasty]* and another auxiliary work used as a textbook in the seventh century Imperial University.²⁴ Therefore, these late eighteenth-century editions were all produced in the context of a major enterprise, through which the imperial institutions aimed to shape the national heritage according to their views. In particular, in the ‘mathematics’ section of the *Complete Library*—which had been carefully designed (Chu 2010: 148-157)—the comparison between China and ‘the West’ was part of the subtext: works translated from European sources were placed alongside Chinese works. However, Chinese works were always positioned at the forefront. Moreover, the editors again took up the thesis of the ‘Chinese origin of Western knowledge,’ notably in relation to *Mathematical Book*: Zhu and Zheng emphasize how the ‘summary’ placed before its edition states explicitly that the algebra associated with ‘the West’ originated precisely from Qin’s work.

Like several other mathematical books for which the *Complete Library* offered an edition, Qin Jiushao’s work had also been selected for inclusion in the previous gigantic imperially-

²⁴ Note that this assertion is true for China, but not for Korea or for Japan, where some of these works were the objects of earlier editions. Moreover, this statement implies that we do not consider as ‘editions’ works based on thirteenth-century works like Gu Yingxiang’s 顧應祥 (1483-1565) works based on Li Ye’s *Measuring the circle on the Sea-Mirror* (Ceyuan haijing 測圓海鏡, 1248) and Wu Jing’s 吳敬 *Great Compendium of The Nine Chapters on Mathematical Methods with Analogies* (Jiuzhang suanfa bilei daquan 九章算法比類大全, 1450). On these works, see, respectively, (Guo Shirong 2015) and (Zhou Xiaohan 2018).

commissioned undertaking of this kind, at the beginning of the fifteenth century: the *Great Compendium of the Yongle Era* (1505-1508).²⁵ In such cases, the editors relied primarily—and in Qin’s case, exclusively—on this former edition. Zhu and Zheng explain why this was a challenging task. What is clear for our reflection is the impact that, in this context, official projects of this type have had in saving such mathematical works from oblivion. In ways reminiscent of Dvivedin’s work, this edition of Qin Jiushao’s *Mathematical Book* bears the mark of a long-lasting interest in China for shaping the written heritage, notably the mathematical heritage. What is also clear is that, when the edition of *Mathematical Book* was prepared for the *Complete Library*, large sections of the work remained incomprehensible. Since the base-text is lost, we cannot examine how exactly this played out in the way the editing was carried out. However, Zhu and Zheng can still identify key features of the base-text that were not reproduced in the edition of the *Complete Library*. In fact, unlike other thirteenth-century mathematical books that simply disappeared from China—and were later discovered in Korea and in Japan—, Qin’s *Mathematical Book* was copied at the beginning of the seventeenth century. Zhu and Zheng consider that these copies derived from the edition that had been used for the *Great Compendium of the Yongle Era*. The copy made by Zhao Qimei 趙琦美 (1563-1624) in 1616 is still extant and can thus give us insights into how the *Complete Library* edition was made.

Regardless of the defects of the edition, the publication contributed to draw Chinese scholars’ attention to Qin’s work, at a time when restoring a national heritage in mathematics and situating it with respect to works translated from European writings appeared as valuable endeavors. Not only copies of this edition, but also copies of Zhao Qimei’s manuscript began circulating among scholars involved in both historical and mathematical work in China at the time. Their notes and their interpretations attest to their engagement with passages of the book that had long been obscure. They made clear the need for a new edition.

These were the circumstances in which, in 1842, a more commercial edition appeared. It had been prepared by Song Jingchang 宋景昌 (fl. 1840), a scholar who belonged to these circles and who, for his composition, relied on exegetical and editorial work carried out by his peers and his master. Zhu and Zheng show that both the base of the edition and the editorial techniques distinguish the 1842 publication from that of the *Complete Library*. For instance, by contrast with the latter, Song’s edition took two witnesses into account, and he further added editorial notes to the text, which testified to his textual collation and his attitude towards his sources. What is more, Song certainly understood the mathematical ideas at issue better than his predecessors.

However, Zhu and Zheng focus on another difference between the two editions, which brings an additional dimension to our discussion. Qin’s *Mathematical Book* features many computational diagrams, in which numbers were represented using numerals made with calculating rods (also known as ‘rod-numerals’). At the end of the eighteenth century, the way in which numbers were represented with rod-numerals was already well understood. If we judge from Zhao Qimei’s copy, however, the edition of Qin’s work that was included in the *Great Compendium of the Yongle Era* presented in this respect a remarkable feature, which, to our knowledge, is specific to *Mathematical Book*: in some of these computational diagrams, the representations of numbers are regularly linked by different types of lines. In a recent work, Zheng and Zhu (2010) drew on Zhao Qimei’s copy to establish that these lines represented in fact a symbolic notation of the operations applied to the numbers thereby joined. More precisely, they showed that, in these diagrams, different operations were written using different types of line. In other words, Zhao Qimei’s copy contains a symbolic and dynamic inscription of a computational procedure. This notation was not understood at the time the editions were prepared. On the basis of the 1616 manuscript, it appears that the *Complete Library* edition of the work neither completely erases this feature of the base-text, nor does it seem to have reproduced its base-text faithfully in this respect. In other words, the eighteenth-century edition still contains hints of this feature of the original text, without offering the

²⁵ On the way in which mathematical and astronomical works were edited, drawing on that earlier project, see (Chu 2010: 148-149; 160-162 (Tables 3 and 4)).

readers a solid base to interpret the lines. By contrast, in Song Jingchang's 1842 edition, these lines have simply disappeared, and with them, the possibility for readers to understand what was at issue in Qin Jiushao's computational diagrams. Zhu and Zheng surmise that the copy of Zhao Qimei's manuscript used by Song Jingchang might not have reproduced the lines of its base-text. Perhaps also, Song Jingchang's versatility in mathematics led him to decide that the lines that still featured in the *Complete Library* edition were meaningless. Whatever the reason, Song's edition neither shows nor mentions these lines. As a consequence, exegetes all interpreted these 'computational diagrams' as static illustrations of computations carried out elsewhere. A key element of the original book—its use of a symbolic representation of the dynamics of a procedure—was lost in the shaping of successive editions of the text.

What matters for the reflection that this book aims to develop is this: the editions of ancient works often erase all kinds of clues that their sources still contain on mathematical practices. To put it differently, editions and translations are molded by what editors know and what they pay attention to as much as by what they are ignorant of and what they consider irrelevant. As a result, readers using these editorial works are effectively deprived of essential information that could have drawn their attention to the authors' mathematical practices. We can reformulate in these terms the remarks that we have put forward in Section 1, about how diagrams and the expression of numbers were dealt with in nineteenth- and early twentieth-century editions and translations. Through a comparison between an eighteenth- and a nineteenth-century editions of *Mathematical Book*, Zhu and Zheng show that the same conclusion applies to the specific inscriptions that Qin Jiushao used to write down his computational procedures. However, in this case, two elements played a specific role: the fact that the tradition in which *Mathematical Book* made sense was discontinued together with the fact that the modern editions were shaped in a context in which actors perceived a form of competition between different traditions.

Zhu and Zheng further suggest that the transformation that took place in these editions had a major influence on the modern reception of Qin Jiushao's *Mathematical Book*: in correlation with how modern editions have distorted these notations, subsequent historiographies have given more weight to Qin's mathematical achievements than to his writing practices. Indeed, today *Mathematical Book* is famous for its procedures to solve simultaneous linear congruences and its mode of resolution of equations of higher degree. This is correlated with the fact that, after its publication, Song Jingchang's 1842 edition of the work became the most accessible edition. In particular, it was taken up by nineteenth-century European scholars, notably Alexander Wylie (1815-1857), who recognized in *Mathematical Book*—probably with the help of Li Shanlan 李善蘭 (1810-1882), with whom he cooperated on translations of mathematical books into Chinese—the 'Chinese remainder theorem', which he compared with the 'Hindu Cuttaca' he knew from H.T. Colebrooke's translations of Brahmagupta and Bhāskara II evoked in Keller's chapter. Subsequently, *Mathematical Book* acquired an important status in the writing of a history of mathematics in China.

Zhu and Zheng reflect that in some way, the re-shaping of the diagrams of Qin Jiushao's original book is not unlike the reading of Qin Jiushao's reasonings, at the end of the nineteenth and beginning of the twentieth century, with a modern algebraical notation. Indeed, the tools that editors use to interpret as well as those they assume that ancient actors used to practice mathematics shape the way texts are edited. In return these tools change deeply how these texts are understood by subsequent readers, and thus influence the way the histories of mathematics that rely on these editions are written.

Similar conclusions emerge from the next chapter, in which Matthieu Ossendrijver analyzes the pioneering efforts to make sense of and edit astronomical material in cuneiform script from the first millennium BCE that began to surface in the 1870s from excavations in the Middle East. Before the emergence of these tablets, the only existing evidence of astral science activity in Mesopotamia came from scattered references in ancient Greek and Roman sources. In this case, too, thus, source material produced in the context of traditions that had been discontinued was suddenly available. Almost nothing was known about these traditions: neither the technical vocabulary used

and type of approach followed, nor the phenomena that had interested the ancient actors, nor even the types of text used by the practitioners. In addition, the sources discovered were not ‘stand-alone works’: They were tablets, which, moreover, were often broken into disjointed pieces. Finally, in contrast with the Chinese work discussed above, in this case, the source material was not claimed by modern local actors seeking to retrieve their own tradition.

Nevertheless, as early as 1881, a first publication concerning these documents appeared. From that point onwards, and until 1955, when Otto Neugebauer (1899-1990) published his seminal *Astronomical Cuneiform Texts*, Ossendrijver examines in a diachronic fashion how practices of edition and translation were gradually shaped and how they interacted with the progressive work of interpretation of these sources. The first publication was authored by two Jesuit priests, and more generally, until Otto Neugebauer entered the field, most editors and translators were catholic priests. This illustrates from yet another perspective a point that we have regularly emphasized: studying editions and translations of ancient source material involves paying attention to the social identity of editors and translators and, accordingly, to the corresponding significance they attach to this type of work—a direction of inquiry that Ossendrijver explores.

The 1881 article was the result of cooperation between two Jesuit authors, in a context in which astronomy and issues of chronology were meaningful in the Jesuit order. Beyond the fact that they were both Jesuits, Johann Nepomuk Strassmaier (1846–1920) and Joseph Epping (1835–1894) had quite different disciplinary backgrounds: Strassmaier had competences in Assyriology whereas Epping was particularly versed in astronomy. Ossendrijver points out how, over the decades they spent editing and translating these sources, the alliance of the two disciplinary backgrounds proved essential. Further, Ossendrijver highlights how editors and translators mobilized these two skills in different ways and in different combinations. To begin the work of interpretation, knowledge in mathematics and astronomy was crucial. Deciphering started with tablets that were purely numerical tables, and relied on an analysis of the structure and nature of the sets of numbers recorded. An approach of this kind meant that numbers were central not only to the interpretation, but also to the edition, in which ‘errors’ were rectified to fit the pattern identified. Ossendrijver pursues this line of inquiry, examining diachronically how, at different stages, the various editors and translators made use of their scientific knowledge and how this had an impact on the edition and the translation carried out.

In order for Epping to deploy this approach, Strassmaier had to copy the source material from the British Museum—which, for the two authors, remained the single location in which they found their sources. This dimension of the editorial work highlights another general issue, on which Ossendrijver dwells: that of how editors and translators have access to the source material. This issue involves all kinds of consideration, including—as Ossendrijver points out—the way the documents are catalogued and identified in collections, which, in the case of dozens of thousands of tablets and bits thereof, is not a minor concern. For all sorts of reason, direct access to a collection was not always an available option. Further, in the case of the cuneiform documents dealing with astral sciences, producing hand-copies of the sources required knowledge in Assyriology which the copies in turn passed on in part to their users. As a result, for decades Strassmaier’s copies of the documents were reproduced to serve as a basis for the work of several subsequent Assyriologists’ works—to begin with, for those of the Jesuit Franz Xaver Kugler (1862-1929) and the catholic priest Johann Baptist Schaumberger (1855-1955). This explains that these reproductions were found in several Assyriologists’ archives, and that they were employed even after the technology of photography began being used as a means of access to the source material. Indeed, slowly the photograph became an essential tool to carry out the edition. Eventually, it was published within it. However, Strassmaier’s copies continued to be reproduced as part of later editions of tablets. This remark brings us to another general issue that this case study highlights: that of the shaping of types of text for editions and translations.

Ossendrijver distinguishes different axes along which we can contrast different editions of the source material from a textual viewpoint. As Cooper’s contribution showed for the case of literary texts, editors provided access to astronomical tablets through different settings. Part of these

settings included diagrammatic representations of the text. Depending on the case, these pictorial representations used copies, drawings, and/or photographs. To represent, this time discursively, the text deciphered on the tablets, types of transliterations were progressively honed, evolving with the better understanding of the technical terms, the underlying approaches in the astral sciences and the languages written using cuneiform script. From the beginning, specific types of translations were introduced—with the label ‘factual translations.’ They aimed to make the mathematical and astronomical component of a tablet explicit rather than to be faithful to the text, especially when the early editors were not always sure of the readings of a given tablet. For this aspect, too, the interpenetration of the Assyriological and the astral science approaches to the tablets is manifest. Scholars shaped editions and translations, recycling practices common in other domains of Assyriology, while innovating in relation to the demands specific to their source material.

Another facet of the editorial enterprises appears to be revealing: it concerns the scope of the source material under consideration. To begin with, Ossendrijver shows, the edition bore on parts of a tablet that could be interpreted, like a couple of columns of numbers. With the expansion of the text understood, or the discovery that distinct bits were originally part of the same tablet, greater portions of a tablet were edited. In fact, the astronomical tables that can be found among cuneiform astronomical tablets were the first to be edited. Several textual artefacts were introduced to convey the meaning of the table *qua* table. Columns were given labels, the labelling being organized in such a way as to indicate simultaneously the place of a column in the table and tablet, and the astronomical component computed. The latter label was used in the commentary to the edition, as a symbol in the writing of formulas and equations to represent and analyze the algorithms to which the tables displayed testified. Distinct types of fonts as well as other types of signs were introduced to distinguish between the material on the tablet and the material that could be restored thanks to the structural analysis of the table. For the edition of tables, diagrammatic elements such as lines and double lines were also employed to make apparent their inner structure. All these textual additions display what we have referred to as the artificial character of the text of an edition.

On the basis of textual and exegetical work of this kind, relationships progressively appeared between tablets. These links delineated corpora of tablets, which then became the purpose of the editions. As Ossendrijver shows, editions and translations of astronomical texts were progressively made according to the idea of exposing what was thought to be a system of Babylonian astronomy. We thus see the correlation that can be established between how editors understand the ancient actors’ scientific practice and how they then conceive their editorial projects. This new goal required a systematic scheme of edition for the entire corpus, and notably the use of uniform symbols which might present more systematically the mathematical and astronomical components of the system as a whole. Put differently, symbols previously had been introduced to explain a tablet and prepare the mathematical commentary that would go with its edition. The system of symbols gradually developed and structured scholarly discussions about the sources. They eventually stabilized and formed the backbone of the edition of a corpus.

Moreover, the project of editing and translating corpora was also articulated around the shaping of a typology of texts reflecting the different facets of the system: tabular texts were distinguished and edited separately from procedure texts, these being separated from astronomical diaries and astrological texts, each type of text also requiring its specific tools for editing. Neugebauer’s publications, and notably his edition of tables and procedure texts in *Astronomical Cuneiform Texts* (1955), constitute the apex of such a project. In this classic work, the editions of different types of texts are scattered across text genres: Tables are always edited as a whole, and transliterations are provided ‘in an idealized layout with added ruling that reflect the mathematical structures of the column’. The procedure texts are edited procedure by procedure rather than tablet by tablet. Finally, the translations, as well, are more intent in conveying to the reader the meaning of the texts in modern terms than in respecting, for instance, variations in terminology that could have been identified.

Such a way of editing, Ossendrijver further argues, rests on different editorial cultures, elements of which would be used to create a new specific edition. We have highlighted its

dependence upon some features of editorial practices in Assyriology. Neugebauer was further inspired by the editions of Greek and Latin texts made by Heiberg, Hultsch and Tannery, whom we have encountered above: editorial practices do not only circulate within Assyriology, but also across the various branches of history of science. However, these editorial traditions contributed to the forging of a textual *dispositif* that was idiosyncratic for the cuneiform tablets dealing with astral sciences, with its system of photographs, drawings, transliterations, editions, translations and analysis. The device was understood as the process necessary to make texts accessible ‘easily’ and ‘in their best available form’. For the editor and translator, this complex manufacture was providing, as best as it could, a first-hand source to the reader. Thus, Ossendrijver’s contribution highlights how the editorial and translational practices reflect editors’ perceptions of the mathematical tools used by the ancient actors under consideration, and more even, their perceptions of whole ancient mathematical and astronomical theories. While this systematic way describes especially Neugebauer’s *Astronomical Cuneiform Texts*, Ossendrijver documents also how Neugebauer uses processes that had been explored by his predecessors. The artificial text of an edition is the outcome of a cumulative process that is intimately related with the advancement of the history of science. In this case, it was also shaped through a continuous tradition of editorial efforts that has been applied to the same tablets.

This cumulative and layered historical work which, in the end, produces a standard frame for critical editions seems to summarize, or totalize, the succession of case studies of this book. Gathered together, these contributions give us a glimpse into the great diversity of texts, goals and the multifarious creations that presided over the edition, publication and translation of ancient texts.

1.3. Conclusion

At the end of this exploration, a few general questions arise naturally: how can we situate our historical foray into the editions and translations of ancient and medieval scientific texts within the broader fields of the history of text criticism and that of translation? And also, what can such undertakings in the history of science contribute to a general history of these topics?

These are some of the issues considered by Glenn Most in the postface with which he concludes this book. However, to these queries, he adds another, which seems innocuous, but points out important issues with respect to our subject: why, does he ask, have we so few historical studies focused on the text criticism, critical edition and translation of ancient scientific texts?

In examining this question, Most develops a reflection on the way in which texts of science have been perceived with respect to texts on which the history of philology has concentrated, that is, in his own words, ‘central literary and especially poetic texts.’ In particular, in Most’s view, if historians of philology and translation have shown no interest in past editions and translations of ancient scientific texts, this might derive from widespread assumptions about science and accordingly about scientific works. This remark invites us to ponder how images of and values attached to science have played out more globally in our history. Of Most’s reflection, several points come out that draw our attention.

To begin with, the hypothesis that what matters for practitioners of science is what a text says, and not how this text is formulated might have led historians of philology to assume that the editing of scientific texts has followed aberrant practices and could not contribute to a reflection on the general history of editing. There is some truth to this hypothesis: we have mentioned above editions produced by editors who shared precisely this belief about scientific texts and prepared editions of ancient texts accordingly. However, our book also examines editions that were carried out with entirely different assumptions regarding works of this kind. In other words, the history of the editions of scientific texts attests to a large spectrum of editing practices that, precisely because of its variety, deserve to be taken into consideration.

What is more, as we emphasized at the beginning of this introduction, we cannot, with each new piece of research, redo the critical editions of the scientific works on which we need to draw. In this respect, a historical understanding of how a given edition was carried out seems crucial. This historical awareness provides tools which help us to find ways of using this edition, despite the fact

that it does not fulfil present-day requirements. This is why, for historians working on ancient documents that attest to scholarly activities, there are still many topics that need further exploration. These include the changing purposes and modes of editions and translations, the practices of ancient philologies (and their modes of edition) world-wide, the history of shapes of scientific texts, the international networks of publishers and scientists in the nineteenth and twentieth centuries, the politics and economics of publications as well as the way technologies have shaped editions and translations, to name a few. These topics, obviously, do not only concern historians of ancient science.

In Most's view, the lack of interest by historians of philology for editions of scientific texts may stem from another assumption they have made about these texts: these historians might have perceived these texts as having been less important— from a cultural and social viewpoint—than 'other canonical or scholarly literary texts.' As a result, they might have assumed that the editing practices on the former texts were derivative with respect to those that bore on the latter. To put it differently, considering the history of the editions of scientific texts was deemed as bringing nothing new to a history of philology.

Is this true? For sure, as we have emphasized above, several examples on which the book focusses show editors of scientific texts emulating philological practices that had been designed for other types of texts. For example, some of them made use of critical apparatus and of stemma, which, as they were well aware, had been introduced in other contexts. Indeed, more generally, the way in which editions of scientific texts might have been the by-product of philological techniques elaborated to deal with other types of sources is worthy of further explorations.

However, this phenomenon does not exhaust the range of questions that such editions call for. As Most emphasizes, scientific texts are specific because they commonly contain, e.g., expressions of numbers and quantities as well as diagrams. Editors of such works must thus elaborate solutions for problems that were not central for the edition of other types of text and that philologists have hence not addressed in a systematic way. Accordingly, the historical approach to editions of scientific texts that this book contributes to has compelled us to introduce new analytical tools. These tools allow us to describe more accurately how technical non-discursive elements were dealt with in early-modern and modern editions. Such studies and the related analytical tools certainly constitute a contribution to a general history of philology

We could actually argue that this book goes further, and opens perspectives that could be of interest to all historians working on texts. Indeed, editions and translations of scientific documents are also texts in their own right. The studies published here shed light on the specific kinds of text that editors created to convey both a representation of an ancient work that is faithful to its witnesses—'faithfulness' being an epistemological value that was understood in different ways depending on the context—and these editors' understanding of the work. Such texts are often surprising, non-conventional, precisely because they deal with documents that reflect very peculiar technical content textualized in a very peculiar way. Indeed, the textual invention of editors of cuneiform astronomical tablets or the multilinguistic labels of drawings in some editions of Ayurvedic works are some striking examples of how scientific writings, and accordingly their editions and translations, are also creative modes of textuality that should be of interest to all.

In fact, the present book brings another input to a general history of text criticism, in relation precisely to the fact that it concentrates on texts of science. This point appeared clearly when we evoked above how Chinese actors in the seventeenth and eighteenth centuries reacted to the introduction of knowledge brought from Europe. The search for ancient Chinese books of science and the effort to interpret and edit them that the encounter between Jesuits, Chinese scholars and high-level officials elicited were motivated by the project of shaping a place for China in a world narrative of history of science. More generally, we have examined how the symbolic value attached to science played out in various ways on how editions of ancient texts were constructed. From this viewpoint, the history of editing ancient scientific texts sheds light on the values that different social groups associate with the past and invites us to a wider reflection on the various meanings that

editions and translations take for actors. We might refer to this type of concern as 'the politics of philology', a subject dear to S. Pollock.²⁶ Perhaps no better than with scientific texts can we measure the meanings of such an expression and its effects on editions and translations. For example, crucially, in editions and translations, past scientific texts have been subject to a philology aiming to modernize them. In case studies presented in this book, we have examined how the modernizing of scientific content in ancient texts could be an efficient way of constructing editions in which some texts belonged to a contemporary scholarly conversation while at the same time, others, which were not subject to such a modernization, could appear as ancient and/or exotic. Scientific texts are indeed a crucial place where the politics of modernization encounters philology.

This wider political dimension of philology might be indeed one of the key lessons to be taken from this book and a major way in which a historical approach to the philology of ancient scientific texts might be of interest for a general history of philology.

Last but not least, these historical considerations also question the kind of philological studies, critical editions and scholarly translations we want to compose today or in the near future. Such questions are raised by the historical study of scholarly technical texts but are addressed to philologists and translators at large. Indeed, the studies contained in this book have invited us to reconsider some of the usual objects of critical editions, reminding us of how notions of 'original texts', 'best texts', or 'variants' could be multifarious, and at times misleading. How then should we carry out critical editions today? Which bearing might the reflections presented in this book have on our editions of scientific texts? Studies on how specific parts of scientific texts were dealt with in former editions convince us that we need to find new ways of editing configurations of noted signs as well as diagrams, to begin with, through historicizing how notations for numbers and quantities and diagrams were transformed. The changing social and cultural function of a same text also raises questions for the future editor. For instance, how should we edit works that fulfilled different functions in different contexts and time periods? Can we, and should we, edit them as being at the same time literary, pedagogical, and scientific texts? We could go on listing many other such questions that historical investigations raise to editors of today.

In a way, we seem to be historically extending the 'maximally inclusive' editions that Pollock described for ancient Sanskrit editors of poetry, involving the transmission (and discussion) of all readings. Pollock notes that such editions could be a fruitful example of a philological pluralism which would non-dogmatically take into account all the known versions of a 'true' text. And indeed, digital humanities provide us with a wealth of new tools to host this chorus of multiple voices. But the stories in this volume also indicate that a good edition remains one that makes choices. Cooper's contribution highlights how we should beware of the information overload such maximal editions could contain, encouraging us to create visual devices which would enable an edition to both contain large volumes of information and remain readable.

But our awareness of the blind spots of past editorial enterprises mingled with technological euphoria make us hope for more. More than a record (history and analysis) of the various states of a text and of its different meanings, digital editions bear new and greater fantasies. One of these is the ambition to produce editions which could also stand the scrutiny of future questions. Can we imagine an 'open' editorial device that would enable us to question ancient sources with new criteria and new inquiries without requesting the whole editorial project to be re-done?

In our quest to critically and historically examine reconstructions of the unreachable 'Ur' text, we have undoubtedly forged a new ideal. This editorial utopia can be drawn from the methodological questions we raise as we want to undertake new publication projects: in print as well as digitally can we, with sufficient economy, display the multifarious information and stories retrieved around a document, its travels and metamorphoses, while still leaving the door open to new interpretations? Can we further do so, highlighting the specificities of the text as a scientific text, notably with its peculiar non-discursive elements? The past teaches us that in the future we

²⁶ (Pollock 2016), (Pollock 2009).

will probably invent creative *dispositifs* to publish new editions. Maybe, somewhat like this book of studies made with multiple hands and expertise, can we dream of (or would it be a nightmare?) an international community of critical editors, Wikipedia style, perpetually enhancing the critical edition of a text, with new points of view, new discussions and new stories about its past.

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