Author manuscript of

Dumas Primbault, Simon, "How Leibniz read Pascal's Geometry: The Practice of Reading as Hybrid Hermeneutics in the Materiality of Leibniz's *Pascaliana*," *Nuncius*, vol. 37, issue 3, 2022.

simon.dumasprimbault@epfl.ch
Laboratory for the History of Science and Technology, EPFL (Lausanne, Switzerland)

Abstract

Between 1675 and 1676, while in Paris, Gottfried Wilhelm Leibniz (1646–1716) got privileged access to some geometric manuscripts from late Blaise Pascal's hand. Although said manuscripts are not extant, Leibniz's reading notes were preserved, together with his personal papers in Hannover, under the heading "*Pascaliana*." The mathematical content of these notes and the influence they had on Leibniz's later work are quite known nowadays. At the crossroads of the history of ideas, historical epistemology, and material history, this contribution looks at Leibniz's *Pascaliana* through the prism of their materiality—format, layout, organization, corrections, and additions—, and the practices it betrays—copying, commenting, excerpting. Parallel to knowing *what* Leibniz read in Pascal, this perspective allows us to shed light on *how* Leibniz read Pascal, on the very intellectual-material operations that allowed him to incorporate a foreign thought and, eventually, start developing his own.

Introduction

It is well known that Blaise Pascal's published *and unpublished* works have dramatically influenced Gottfried Wilhelm Leibniz's thought,[1] especially during his stay in Paris (1672-

[1] For a brief state of the art on the subject, cf. Ohad Nachtomy's introduction, "On Living Mirrors and Mites: Leibniz's Encounter with Pascal on Infinity and Living Things Circa 1696," in *Oxford Studies in Early Modern Philosophy*, Volume VIII, ed. Daniel Garber and Donald Rutherford (Oxford: Oxford University Press, 2018), 159–188.

1676).[2] More specifically, a bundle of reading notes that Leibniz jotted down in 1675-1676, as he had privileged access to Pascal's manuscripts, drew the attention of several French scholars of Pascal during the 20th century, especially in compiling Pascal's complete works.[3] The so-called *Pascaliana* notably allowed historians to show the influence of Desargues' *Brouillon project* on Pascal's thought as well as the latter's contribution to the geometry of conics in comparison with that proposed by Descartes.

In the last year greater and more thorough attention has been dedicated to Leibniz's notes on Pascal. The *Pascaliana* have been read from Pascal's point of view, and the commentaries on its mathematical content led to the attempt to reconstruct Pascal's lost treatise.[4] As for Leibniz, the possible influence of Pascal′s papers on his mathematical work has been extensively assessed. Notably, they have been interpreted as a debate across time between two scholars with opposing views about what should be considered a "pure" geometry.[5] Besides the *Pascaliana*'s general format, it is still scantly acknowledged that reading them through the prism of materiality may *also* reveal Leibniz at work and, alongside to all the commentaries on their content, they should be considered as a source for those historians who intend to document Leibniz's scholarly practices.

Alongside the work by Valérie Debuiche, who showed how Leibniz reinterpreted Pascal's work on conics in dynamic and perceptive terms, thus paving the way for his geometry of situation,[6] the present contribution is a material analysis of the reading and writing practices which allowed for such a reinterpretation. Although sharing the same methodological approach

[2] Joseph E. Hofmann, *Leibniz in Paris (1672-1676): His Growth to Mathematical Maturity* (Cambridge: Cambridge University Press, 1974).
[3] See below. Cf. also Bernard Vinaty, "Nouvelles vues sur les recherches géométriques de Pascal, particulièrement sur son étude des sections coniques," *Angelicum* 75, no. 2 (1998):235–253.
[4] On the mystic hexagram, in particular, cf. Andrea Del Centina, "Pascal's Mystic Hexagram, and a Conjectural Restoration of his Lost Treatise on Conic Sections," *Archive for History of Exact Sciences* 74, (2020):469–521. If Del Centina offers an overview of the general format of Leibniz's notes, he does not discuss what this peculiar materiality can tell us about Leibniz's scholarly practices and instead focuses on the reconstruction of their content.
[5] Valérie Debuiche, "L'invention d'une géométrie pure au 17è siècle: Pascal et son lecteur Leibniz," *Studia Leibnitiana* 48, no. 1 (2016):42–67.
[6] Ibid.

used by Dominique Descotes in his material analysis of another Pascalian manuscript on geometry,[7] my aim is not to reconstruct Pascal's writings, but rather - by following Matthew Jones' perspective - to "highlight Leibniz's philosophy as practice."[8]

Indeed, cognition is both embodied in the scholar's flesh[9] and distributed in their (paper) tools.[10] From this perspective, ink and paper are not *traces* of thinking; they are themselves the thinking. Through the prism of "cognitive practices", according to Lorraine Daston's definition,[11] and more specifically of the practices of reading and note-taking[12] revealed by the materiality of Leibniz's manuscripts, the *Pascaliana* - taken as a case study - act as a magnifying glass showing the intricacy of various practices akin to archival know-how.[13] In turn, in these papers we will *read* the practices and operations of intellectual work *construed as* a hybrid hermeneutics.[14]

At the crossroads of a history of ideas that focuses on the content of reading, a material history that approaches the form and practice of the act of reading through the materiality of documents, and a historical epistemology, this paper proposes to shed new light on *how* Leibniz

[7] Dominique Descotes, "An Unknown Mathematical Manuscript by Blaise Pascal," *Historia Mathematica* 37, no. 3 (2010):503-534.
[8] Matthew L. Jones, *The Good Life in the Scientific Revolution: Pascal, Descartes, Leibniz, and the Cultivation of Virtue* (Chicago: The University of Chicago Press, 2006), 231.
[9] Christopher Lawrence and Steven Shapin,eds., *Science Incarnate: Historial Embodiments of Natural Knowledge* (Chicago: The University of Chicago Press, 1998).
[10] Hélène Mialet, *Hawking Incorporated: Stephen Hawking and the Anthropology of the Knowing Subject* (Chicago: The University of Chicago Press, 2012); and Ursula Klein, *Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century* (Stanford: Stanford University Press, 2003).
[11] "what might be called cognitive practices: economies of attention, arts of memory, the solidification and erosion of belief. […] they are part of a learned (and learnèd) habitus, which has bodily, mental, and ethical components." (Lorraine Daston, "Taking note(s)", *Isis* 95 (2004):443–448, 444 and 446.)
[12] Among a vast collection of studies, cf. notably Ann Blair, *Too Much to Know: Managing Scholarly Information before the Modern Age* (New Haven: Yale University Press, 2010); Richard Yeo, *Notebooks, English Virtuosi, and Early Modern Science* (Chicago: The University of Chicago Press, 2014); and Andrés G. Freijomil, *Arts de braconner. Une histoire matérielle de la lecture chez Michel de Certeau* (Paris: Classiques Garnier, 2020).
[13] Lorraine Daston, "The Sciences of the Archive," *Osiris* 27 (2012):156–187. And, more recently, Lorraine Daston, ed., *Science in the Archives: Pasts, Presents, Futures* (Chicago: The University of Chicago Press, 2017).
[14] "The hybrid hermeneutic of reading and seeing, and of melding multiple and multimedia observation into a single definitive one." (Lorraine Daston, "The Sciences of the Archive," 180.)

practically assimilated and appropriated Pascal's writings on geometry.[15] After a brief presentation of the *Pascaliana* manuscripts, we will delve into their materiality and document Leibniz's practices of reading— *marginalia* and *verbatim*, selecting and sorting, excerpting and commenting, extracting and reformulating—and how these multifarious practices wove into novel considerations on matters of pure geometry.

About the *Pascaliana*[16]

As he was in Paris (1672-1676), as we will see, Leibniz swiftly realised that studying the more recent published treatises would not have been enough to acquire a better knowledge of mathematics, and that he should have also dived into the archive of knowledge which consisted of the contributions of his contemporaries as well as the bequest of recently deceased scholars, such as Blaise Pascal's drafts.

In all likelihood Pascal's editor and librarian, Guillaume Desprez, introduced Étienne Périer— Pascal's nephew and heir—to Leibniz, when he was in Paris. A letter from Périer to Leibniz, dated June 1674, attests that they had probably met nearby the hotel where the German philosopher resided in Paris.[17] Another letter dated June 1675, from Leibniz to Oldenburg, attests that Étienne Périer, then Councillor to the King in Clermont-Ferrand, intended to publish posthumously some of his uncle's drafts. Therefore, thanks to the mediation of his brothers Louis and Blaise, who were students in Paris, he sent to Leibniz two folders of Pascal's unpublished manuscripts on geometrical subjects.

---

[15] For an example of a material perspective on "*how*" a scholar thinks, see Jean-François Bert, *Comment pense un savant? Un physicien des Lumières et ses cartes à jouer* (Paris: Anamosa, 2018). More recently, see also the historiographical programme ventured by Jean-François Bert and Jérôme Lamy, *Voir les savoirs. Lieux, objets, gestes de la science* (Paris: Anamosa, 2021).

[16] This section retraces in short how Leibniz had access to Pascal's manuscripts, according to Pierre Costabel's work, "Traduction française des notes de Leibniz sur les Coniques de Pascal," *Revue d'histoire des sciences et de leurs applications* 15, no. 3–4 (1962):253–268; Jean Mesnard, "Leibniz et les papiers de Pascal," in *Leibniz à Paris*, vol. 1, ed. A. Heinkamp (Wiesbaden: Steiner, 1978), 45–58; and Andrea Del Centina, "Pascal's Mystic Hexagram."

[17] Akademie Ausgabe (thereafter AA), Reihe III, Band 1, nº 27, 112–113.

The letter to Oldenburg[18] and two signed notes addressed to Périer's brothers[19] show that Leibniz had twice a direct access to Pascal's archive—"a few quires of said Sieur Pascal's Geometric works, marked as 6, 7, 8, 9, 10, 11, 12, 13, 14."[20] Indeed, the Périer brothers cautiously preserved their uncle's material legacy and allowed other people to consult it only in person and requested a signed receipt—"I was willing to confess with this note that I have received it from their hands."[21] Only after duly returning the first folder of manuscripts, was Leibniz allowed access to the second one.

Between spring 1675 and August 1676, Leibniz could read a few of Blaise Pascal's unpublished manuscripts on which he wrote notes, copies, comments, and reflections, now kept and recorded under the heading "*Pascaliana*" at the Landesbibliothek in Hannover.[22] On August 30th 1676, Leibniz returned the last manuscripts, attaching a letter to Étienne Périer in which he gave him advice on the best strategy to publish these fragments, with which we will deal more in depth in the following pages.[23]

Pascal's *Traité des coniques* - as is called today - was never published and the original papers were lost. However, as a careful and faithful reader, Leibniz kept the notes of his thorough study. Therefore, Pascal's writings on conics—that is, the intersections between a cone and a plane (ellipses, parabolae, hyperbolae)—were reconstructed on the basis of Leibniz's notes.[24] I intend now to investigate Leibniz's material operations in reading these two folders.

---

[18] AA, III, 1, nº 55, 254–256.
[19] Ibid., nº 53, 253 and nº 74, 364.
[20] "*quelques cahiers des ouvrages Geometriques du dit Sieur Pascal, marquez de 6, 7, 8, 9, 10, 11, 12, 13, 14*" (Ibid., nº 53. All translations are by the author, unless stated otherwise.)
[21] "*J'ay bien voulu avouer par ce billet, de l'avoir receu de leurs mains.*" (Ibid.)
[22] Gottfried-Wilhelm-Leibniz-Bibliothek (thereafter GWLB), Leibniz-Handschriften (thereafter LH) XXXV, 15, I.
[23] AA, III, 1, 587–591. See also Jean Mesnard and René Taton, "Édition critique de la lettre de Leibniz à Périer du 30 août 1676," *Revue d'histoire des sciences et de leurs applications* 16, no. 1 (1963):11–22.
[24] The *Hexagrammum mysticum*, the *Conica Pascaliana*, the *Generatio conisectionum*, the *marginalia* of the *Essay pour les coniques*, the verso of the *Essay pour les coniques*, and the *Conica excerpta* were published respectively as AA, VII, 7, nºs 61, 62, 63, 64, 65, 72—*i.e.,* in the volume dedicated to curves and the construction of equations.

Marginalia and *verbatim*

Among the documents to which Leibniz had access there were two printed copies of Pascal's *Essay pour les coniques*. Leibniz thus took the liberty of keeping one for himself and notified Étienne Périer of it in a letter, when he returned the manuscripts: "There is a printed paper whose title is: *Essai des Coniques*; and since there is a duplicate, I hope you will allow me, Sir, to keep one of them."[25] This one-page essay dates from 1640. It was Pascal's first published work and the only work of geometry he ever published. Or, rather, he circulated it, since there was no mention of the publisher on the single-sided leaflet, that had a print run of only fifty copies. It also announced the forthcoming publication of a larger work and was probably meant to circulate among a few acquaintances close to the Mersenne circle.[26]

The copy kept by Leibniz shows that, while reading, he had taken notes directly on the printed document (cf. Fig. 1). Pascal's document contained a great number of typographic and notational mistakes, unusual for a paper of that size—it is also worth noting that Pascal did not use a consistent spelling for words denoting concepts as "*point*" or "straight line [*droite*]." Leibniz marked at least two of the dozen mistakes present in the *Essay pour les coniques,* and he corrected them directly on the paper: the notation of the vertex μ in the top-left figure and one of the points of a straight line in the central paragraph of the work. Furthermore, in the paragraph corresponding to the second description, Leibniz added three words—"or a point [*ou un point*]"—to the list of possible conics, thus recalling a particular case that needed to be

---

Leibniz's draft of the letter to Étienne Périer was published in his mathematical correspondences (AA, III, 1, nº 90). The digital version of the *Pascaliana* is available on the website of the GWLB (http://digitale-sammlungen.gwlb.de/sammlungen/sammlungsliste/werksansicht?tx_dlf%5Bid%5D=548&tx_dlf%5Bpage%5D=1&cHash=8999322f5fbfd9f5cacbf3a23117bc07).

[25] "*Il y a un papier imprimé dont le titre est: Essai des Coniques; et comme il s'y trouve deux fois tout de même, j'espère que vous permettrez, Monsieur, que j'en retienne un*." (AA, III, I, nº 90.) The other copy is now preserved at the Bibliothèque nationale de France.

[26] René Taton, "L'"Essay pour les coniques" de Pascal," *Revue d'histoire des sciences et de leurs applications* 8, no. 1 (1955):1–18.

tackled separately. This is noteworthy, as Leibniz intended to conceive the unity of all conics—including points, lines, and angles—in terms of perception of simultaneity and movement, as we will see.

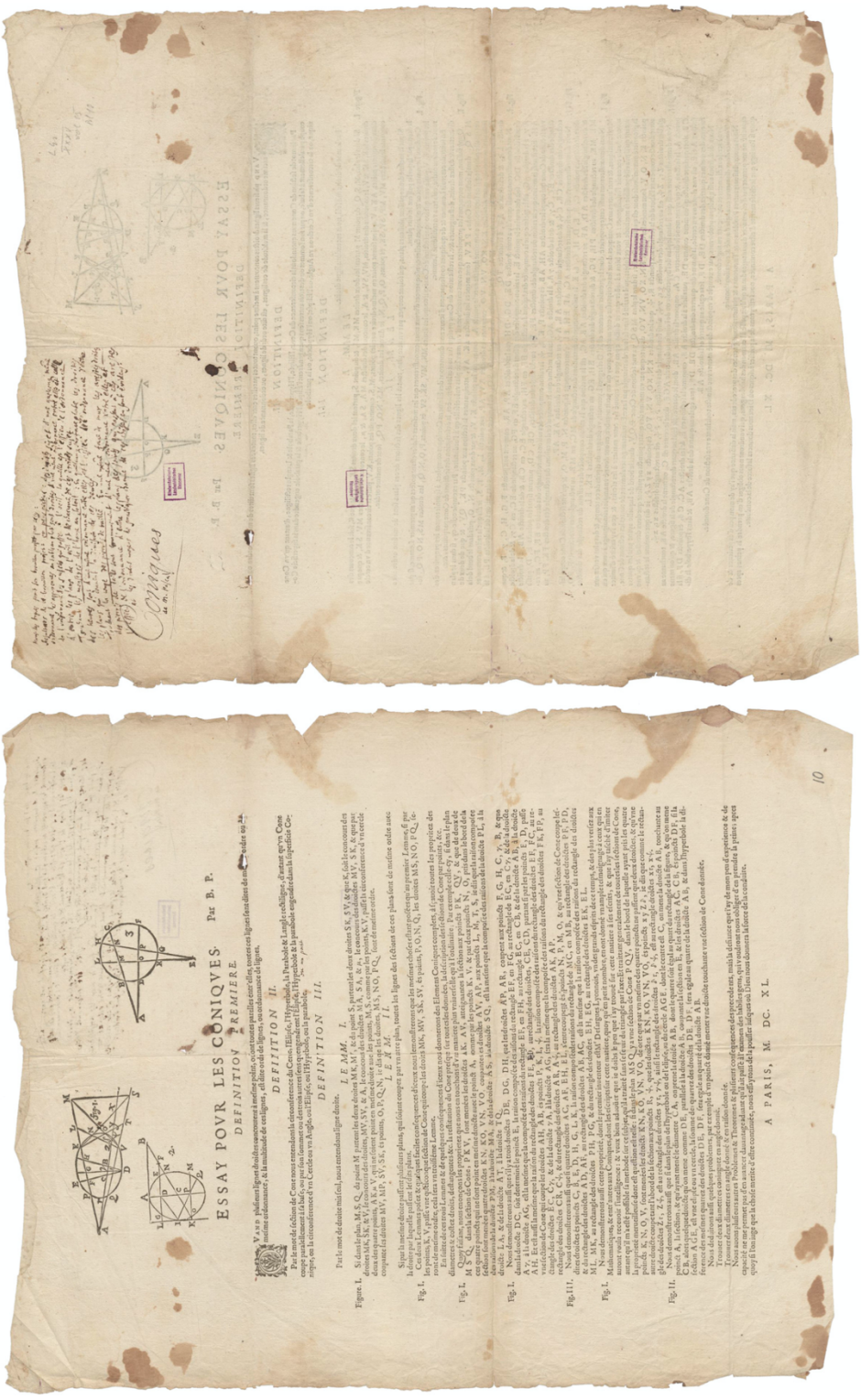


Figure 1—GWLB, LH XXXV, 15, I, fº 10rv.

Other publications in Leibniz's private library, preserved in the collection "Leibniz Marginalien" of the Hannover library, show reading marks, comments, and notes taken directly on the pages of the printed works. Notably, it is the case for the long *marginalias* Leibniz wrote on his copy of Malebranche's *Des Loix de la Communication du Mouvemens*, published in 1692.[27] However, it does not seem to be Leibniz's usual practice of reading, as most of "Leibniz Marginalien" books habitually feature very few notes: for example, in his copy of the *Horologium Oscillatorium,* published in 1673 by Christian Huygens. Although Leibniz later declared that he had been greatly influenced by this work, his copy of the book shows very few reading notes.[28] The same goes for Leibniz's copy of Newton's *Principia Mathematica*, in which his famous *marginalias* remain relatively rare, if compared to the size of the book.[29] On rare occasions, as is the case for his reading of the *Discours du mouvement local* published in 1670 by Father Ignace-Gaston Pardies, Leibniz cut his reading notes into pieces of paper to fold and paste on the page margins of the book (cf. Fig. 2).[30] Except for quick reactions, Leibniz rarely used page margins that were compressed by the materiality of books and leaflets.

Moreover, on the first blank pages of his volumes Leibniz also used to jot down his considerations while reading, with specific references to the pages of the book, as happens, for example, in his copy of Abraham Bosse's geometrical work *La Maniere universelle de Mr Desargues, pour pratiquer la perspective par petit-pied*.[31] However, as we will see in more detail, much more frequently Leibniz used to take notes on loose folios, probably because their

[27] GWLB, Leibniz Marginalien (thereafter LM) 20.
[28] GWLB, LM 70.
[29] Gottfried Wilhelm Leibniz, *Marginalia in Newtoni Principia Mathematica (1687)*, ed. Emil Alfred Fellmann (Paris: VRIN, 1972). Cf. also Radu Suciu, "Leibniz annote et corrige Newton," in *Le lecteur à l'œuvre*, ed. Michel Jeanneret, Nicolas Ducimetière, Valérie Hayaert, and Radu Suciu (Geneva: Fondation Martin Bodmer, 2013).
[30] Notably GWLB, LM 28, *passim*.
[31] GWLB, LM 175:1.

paper surface provided him with the space he needed for his commentary and to develop his own critical reflection.

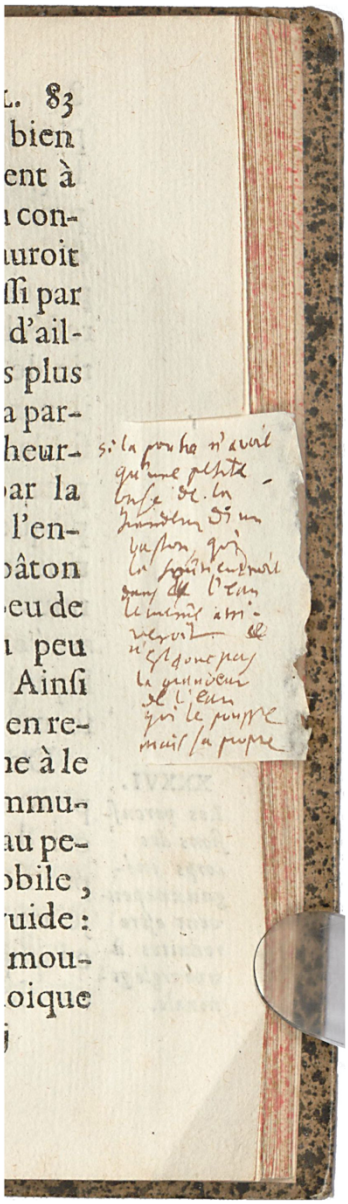


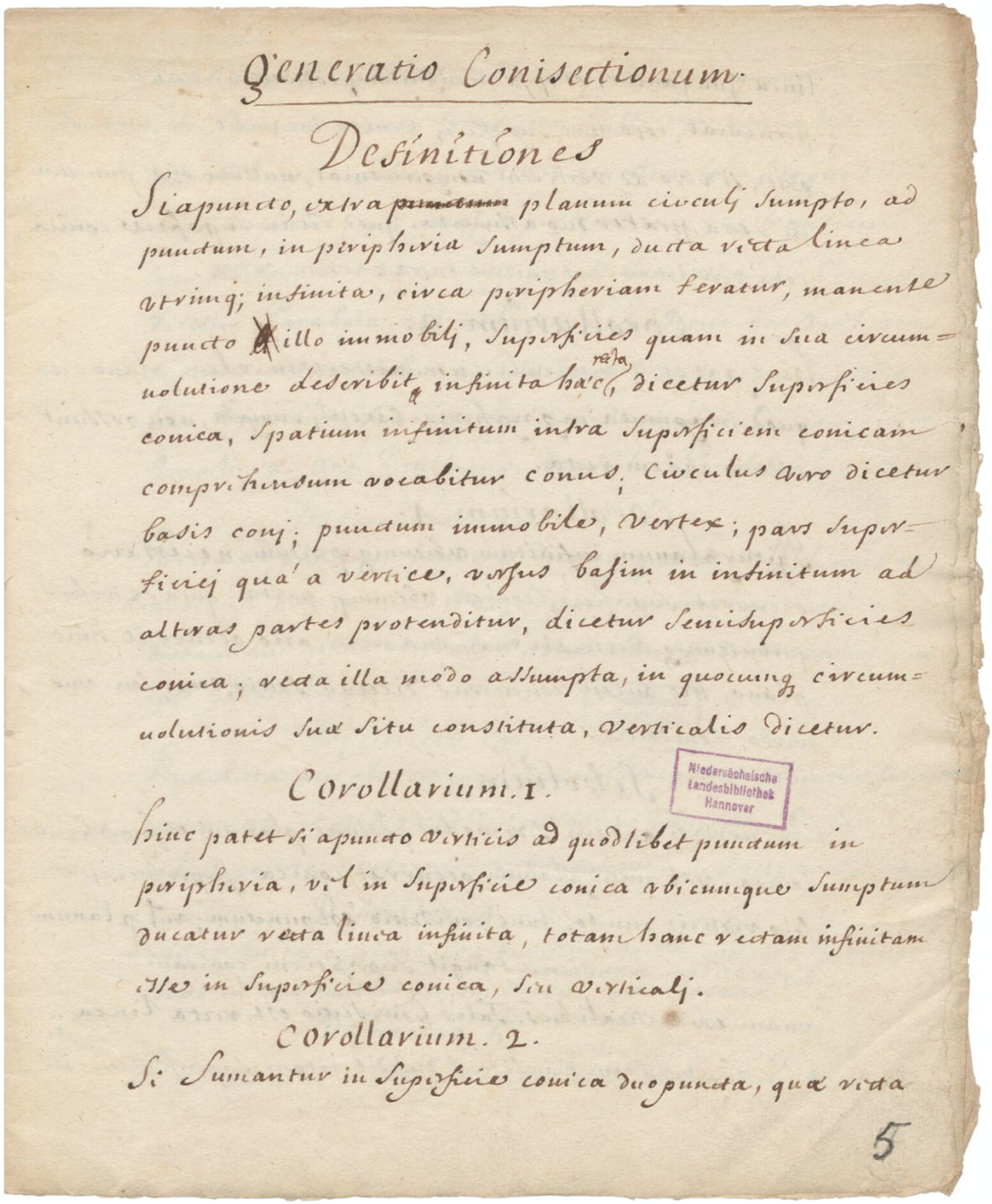
Figure 2—GWLB, LM 28, 83.

On the blank side of the printed Pascalian leaflet, Leibniz copied *verbatim* the last three paragraphs of Girard Desargues' *Brouillon project,* a geometrical work, whose publication the previous year had inspired Pascal. Here we find another reading practice, which clearly appears

in Leibniz's copy of what he considered as the first and most important of six Pascalian fragments, since "it is the foundation of all the rest."[32]

Indeed, Leibniz's *Pascaliana* contain six quartos that seem to be the *verbatim* copy of a short fragment entitled *Generatio conisectionum*. The text is organised in definitions, corollaries and scholia. We see a clean unknown handwriting and regularly spaced lines. Margins have a fixed size and are blank. Crossing-outs, extremely rare, correct typographic details and belong to Leibniz himself (cf. Fig. 3).

[32] "*c'est le fondement de tout le reste*" (AA, III, I, nº 90, 587.)



Generatio Conisectionum.

Definitiones

Si a puncto, extra ~~punctum~~ planum circuli sumpto, ad punctum, in peripheria sumptum, ducta recta linea utrinq; infinita, circa peripheriam feratur, manente puncto illo immobili, superficies quam in sua circumvolutione describit infinita hæc, recta dicetur superficies conica, spatium infinitum intra superficiem conicam comprehensum vocabitur conus, circulus vero dicetur basis coni; punctum immobile, vertex; pars superficiei quæ a vertice, versus basim in infinitum ad alteras partes protenditur, dicetur semisuperficies conica; recta illa modo assumpta, in quocunq; circumvolutionis suæ situ constituta, verticalis dicetur.

Corollarium. 1.

Hinc patet si a puncto verticis ad quodlibet punctum in peripheria, vel in superficie conica ubicunque sumptum ducatur recta linea infinita, totam hanc rectam infinitam esse in superficie conica, seu verticali.

Corollarium. 2.

Si sumantur in superficie conica duo puncta, quæ recta

5

Figure 3—GWLB, LH XXXV, 15, I, f° 5r.

This means that Leibniz had someone copy the six folios which compose the so-called foundation of Pascal's *Traité des coniques*—as lent by Étienne Périer—and that he later added minor corrections in the margins or between the lines. It has been systematically taken for

granted that these pages from the Leibnizian *Nachlaß* were a *verbatim* copy of the unpublished manuscripts of the French mathematician, so that their content has been directly ascribed to Pascal and included in the successive edition of his works: by Gerhardt in 1892,[33] then by Brunschvicg, Boutroux, and Gazier in 1908,[34] and in 1992 by Mesnard who, analysing in detail the extent of "Leibniz's intervention,"[35] came to compare Lower-Saxony with a province of Auvergne: "In this sense, the *Pascaliana* collection in Leibniz's papers in the Provincial Library of Hanover constitutes a sort of annex of the Périer collection."[36] More recently, Leibniz's *verbatim* copy has been included in his *Sämtliche Schriften* within the Akademie Ausgabe.[37]

However, our interest here is not to identify the copyist or the author, but to analyse this *verbatim* text, which seems to have been fundamental to Leibniz, who wanted to possess a copy of a document that he considered as the foundation of a method and did not expect to see published shortly afterwards. Whoever the author or the copyist may have been, this *verbatim* was realised in a very specific format. It consists of a series of 20 by 17 cm quartos, folded and nested into each other to form a small notebook, loosely bound with a string.[38] The copyist knew in advance how many folios were necessary. This copy of a Pascalian manuscript, provided with a cover page on which (on the top left corner) Leibniz wrote "*Pascalii generatio conisectionum*,"[39] remained unpublished but nonetheless materially was an object destined to be on the shelves of a library. This material practice as well as Leibniz's cutting and pasting of slips of paper show that Leibniz considered libraries, archives, correspondence—books, papers, and letters— as inextricably entwined.

---

[33] Carl Immanuel Gerhardt, "Desargues und Pascal über die Kegelschnitte," in *Sitzungsberichte der königlich preussischen Akademie der Wissenschaften zu Berlin*, 1892, Tome I, 197–202.
[34] Blaise Pascal, *Œuvres de Blaise Pascal publiées selon l'ordre chronologique*, 14 volumes, ed. Léon Brunschvicg, Pierre Boutroux, and Félix Gazier (Paris: Hachette, 1908–1914).
[35] "*l'intervention de Leibniz*" (Jean Mesnard, "Introduction," in Blaise Pascal, *Œuvres complètes*, ed. Jean Mesnard (Paris: Desclée de Brouwer, 1962-1992), Tome 1, 54.)
[36] "*Ainsi le fonds* Pascaliana *des papiers de Leibniz à la Bibliothèque Provinciale de Hanovre forme une sorte de dépendance du fonds Périer.*" (Ibid.)
[37] AA, VII, 7, n° 63.
[38] GWLB, LH XXXV, 15, I, ff° 6v-7r.
[39] Ibid., f° 4r (= AA, VII, 7, n°63, 584).

Selecting and Sorting

In his *Essay pour les coniques*, which represents a first attempt to tackle the geometry of conics and confront his contemporaries' opinions,[40] Blaise Pascal announced that he was working on a more thorough treatise that would complete this modest introduction:

> By means of these three lemmas and certain deductions, therefrom, we propose to derive a complete ordered sequence of conics, that is to say, all the properties of diameters and other straight lines, of tangents, &c, the construction of the cone from substantially these data, the description of conic sections by points, etc.[41]

These *Elemens coniques complets* [complete ordered sequence of conics] were never published, but numerous unpublished manuscripts found by Pascal's heirs in his working papers attest that he worked on these *Elemens* until 1654 and was almost about to publish his results. As early as 1642, Girard Desargues praised Pascal's talent.[42] In the same vein, the preface to the *Cogitata physico-mathematica,* published by Father Mersenne in 1644, refers to Pascal's work as a unique proposition whose four hundred corollaries would contain the whole version of Apollonius of Perga's *Conics*.[43] It is what René Taton confirms in an article dating from 1962

[40] The *Essay* concludes with the few following lines: "There are many other problems and theorems, and many deductions which can be made from what has been stated above, but the distrust which I have, due to my little experience and capacity, does not allow me to go further into the subject until it has passed the examination of able men who may be willing to take this trouble. After that, if someone thinks the subject worth continuing, I shall endeavor to extend it as God gives me the strength [*Nous avons plusieurs autres Problemes & Theoremes, & plusieurs consequences des precedens; mais la defiance que j'ay de mon peu d'experience & de capacité ne me permet pas d'en avancer davantage advant qu'il ait passé à l'examen des habiles gens qui voudront nous obliger d'en prendre la peine : après quoy si l'on juge que la chose merite d'estre continuée, nous essayrons de la pousser jusques où Dieu nous donnera la force de la conduire.*]" GWLB, LH XXXV, 15, I, fº 10r (= Blaise Pascal, "Essay pour les coniques," in Blaise Pascal, *Œuvres complètes*, Tome 2, 228–235).

[41] "*En suitte de ces trois lemmes & de quelques consequences d'iceux, nous donnerons des Elemens coniques complets, à sçavoir toutes les proprietez des diametres & costez droits, des tangentes, &c., la restitution du Cone presque sur toutes les données, la description des sections de Cone par points, &c.*" Ibid. (Translated from the French by Frances Marguerite Clarke, "'Essay pour les coniques' of Blaise Pascal," *Isis* 10, no. 1 (1928):16-20.)

[42] René Taton, "L'œuvre de Pascal en géométrie projective," *Revue d'histoire des sciences et de leurs applications* 15, no. 3–4 (1962):197–252, 217.

[43] Marin Mersenne, *Cogitata physico-mathematica, Certissimis Demonstrationibus Explicantur* (Paris: Antoine Bertier, 1644).

, in which he even ventures, "without showing an excessively reckless optimism,"[44] that Pascal's treatise may even have gone beyond Apollonius' results. "Therefore, we can understand Leibniz's insistence on trying to publish it," concludes Taton,[45] who considers this unfinished treatise as "one of the most beautiful geometric works of the 17th century."[46]

Therefore, besides the printed version of the *Essay pour les coniques* that he kept in his personal archive, Leibniz also had direct and first-hand access to numerous Pascalian handwritten documents loaned by Étienne Périer. The aim of Périer, nephew and heir to the archive through his mother Gilberte Périer, née Pascal, was to publish his uncle's manuscripts posthumously. It was with this very prospect in mind that he sent that bundle of papers on the geometry of conics to Leibniz in Paris. Leibniz answered positively Périer's question:

> I conclude that this work is ready to be printed; and it is not necessary to wonder whether it deserves it. I even believe that it is good not to delay any longer, because I see treatises appearing which are somehow related to what is said in part of this one. That is why I think it is good to publish it as soon as possible before it loses the grace of novelty.[47]

He even advised Pascal's heir on the order and logical system according to which the diverse fragments of the bundle were to be assembled, in order for them to form a work of geometry worth publishing:

> I believe that, having read them enough, I am able to satisfy your request, telling you that I consider them sufficiently complete and finished enough to be given to the public. And so that you can judge

[44] "*sans faire preuve d'un optimisme trop imprudent*" (René Taton, "L'œuvre de Pascal en géométrie projective," 247-248.)
[45] "*Aussi comprend-on l'insistance que mettra Leibniz pour tenter d'en faire réaliser la publication*" (Ibid., 247–248.)
[46] "*l'un des plus beaux textes géométriques du XVIIe siècle*" (Ibid., 233.)
[47] "*Je conclus que cet ouvrage est en état d'etre imprimé; et il ne faut pas demander s'il le mérite. Je croi même qu'il est bon de ne pas tarder d'avantage, parce que je vois paroitre des traitez qui ont quelques raports à ce qui est dit dans une partie de celui-ci. C'est pourquoi je crois qu'il est bon de le donner au plûtost, avant qu'il perde la grâce de la nouveauté.*" (AA, III, I, nº 90, 591.)

> whether I speak with assurance, I will give you an account of the parts of which they are composed, in the way that I believe that one can arrange them[48]

Leibniz's progressive formulation of this conclusion can be followed reading his notes on the surface of some fragments of the *Pascaliana*. "Conica excerpta" consist in a long slip of paper—roughly thirty-three by five centimetres—dated August 1676. It seems to be the first extant draft of his endeavour to select and organise Pascal's manuscripts into a well-structured and thus publishable work (cf. Fig. 4).[49] This slip of paper is organised into small blocks delimited by horizontal lines drawn across the paper's surface. These blocks correspond to an inventory of the various treatises identified by Leibniz, whereas the separating lines materialise inferred discontinuities—e.g., between principles (*elementa*) and applications (*fructus*)[50]—, repetitions—"everything is repeated in the other [text]"—, and relations of succession—"after [the following] words: […] one ought to read".[51] Although some fragments already bore explicit titles given by Pascal himself, Leibniz was not always satisfied with them—"This should not have been entitled *de Tactionibus.*"[52] Not yet fully ordered, a certain organisation nonetheless starts to emerge out of the spatial arrangement of Leibniz's notes on this slip of paper. However, Leibniz's selection can only be partial, as he deemed that some "semi-perfect," albeit "useful," *miscellanea* could be set aside.[53]

---

[48] "*je croy les avoir lus asses pour pouvoir satisfaire à votre demande et pour vous dire que je les tiens asses entières et finies pour paroitre à la vüe du public. Et afin que vous puissiez juger si je parle avec fondement, je veux vous faire un récit des pieces dont elles sont composées, de la manière que je crois qu'on les peut ranger*" (Ibid., 587.)

[49] GWLB, LH XXXV, XV, I, ff°11rv (= AA, VII, 7, n° 72).

[50] See also Pierre Costabel, "Traduction française des notes de Leibniz sur les Coniques de Pascal," 261.

[51] "*omnia repetuntur in alio"* and "*post verba: […] legenda sunt*" GWLB, LH XXXV, XV, I, ff°11rv (= AA, VII, 7, n° 72, 634).

[52] "*Non debuisset inscribi de Tactionibus*." Ibid. (= AA, VII, 7, n° 72, 635).

[53] "*Miscellanea schedaeque semiperfectae, et utiles.*" Ibid. (= AA, VII, 7, n° 72, 635).

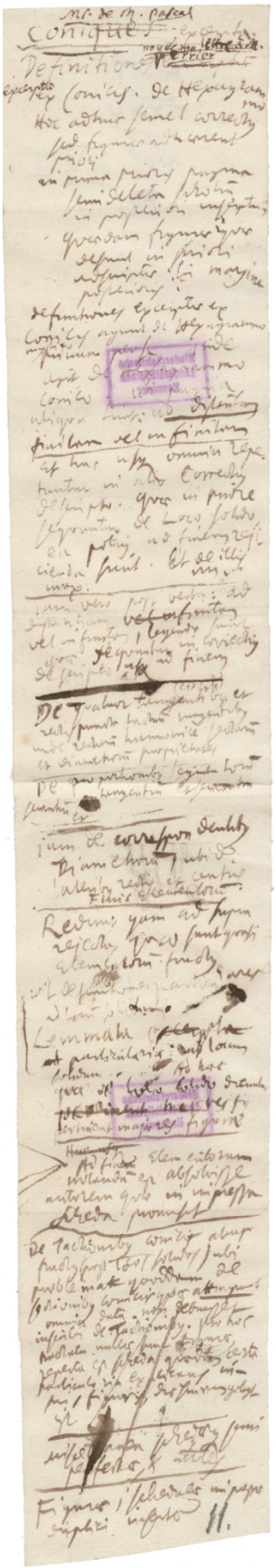


Figure 4—GWLB, LH XXXV, 15, I, f° 11r.

We find a more advanced selection and order in a draft of a letter he addressed to Périer, to which the mentioned slip of paper referred.[54] Although they were just preparatory to the final (now lost) letter, these folios have a well-defined structure organised into successive paragraphs, beginning with a capital Roman numeral. When crowned with a small sign, they correspond to the six treatises that form a part of the whole work (cf. Fig. 5). According to Leibniz, the entire work was thus composed as follows: the first treatise sets the geometrical foundation for the others, by defining how conic sections are generated—the *Generatio conisectionum*—, the second demonstrates the core lemma of Pascal's work—the *Hexagrammum mysticum*—, whereas the last four treatises are organised according to a logical dependence by distinguishing between principles and applications. The whole work would provide a step-by-step resolution of the problem of Pappus of Alexandria, starting from the initial fragment's definitions and propositions. It is worth noting that what Leibniz considered as "the foundation for all the rest"[55] does not merely result from the philosophical and, therefore, reputedly immaterial discourse, but at the same time from his material operations of selecting and sorting.

The corrections on the draft do not indicate many changes, but only that Leibniz's tone became more assertive—"In my opinion, I think the first piece should be" becomes "The first piece should be".[56] To judge from one of the two extant copies of the final letter, the spatial layout of the surface of the letter's paper may have been preserved, or even strengthened, to emphasise the selection of treatises, their order and articulation.[57] The list of six treatises is

[54] Ibid., ff° 3rv.
[55] "*le fondement de tout le reste*" (AA, III, I, n° 90, 587.) See above.
[56] "*Je crois qu'il faut commencer à mon avis par la pièce*" becomes "*Il faut commencer par la pièce*." GWLB, LH XXXV, XV, I, ff° 3r (= AA, III, 1, n° 90).
[57] Bibliothèque nationale de France, Fonds français 20945, ff° 306v-308r.

followed by a note on the remaining fragments: they are not to be included in a possible publication.

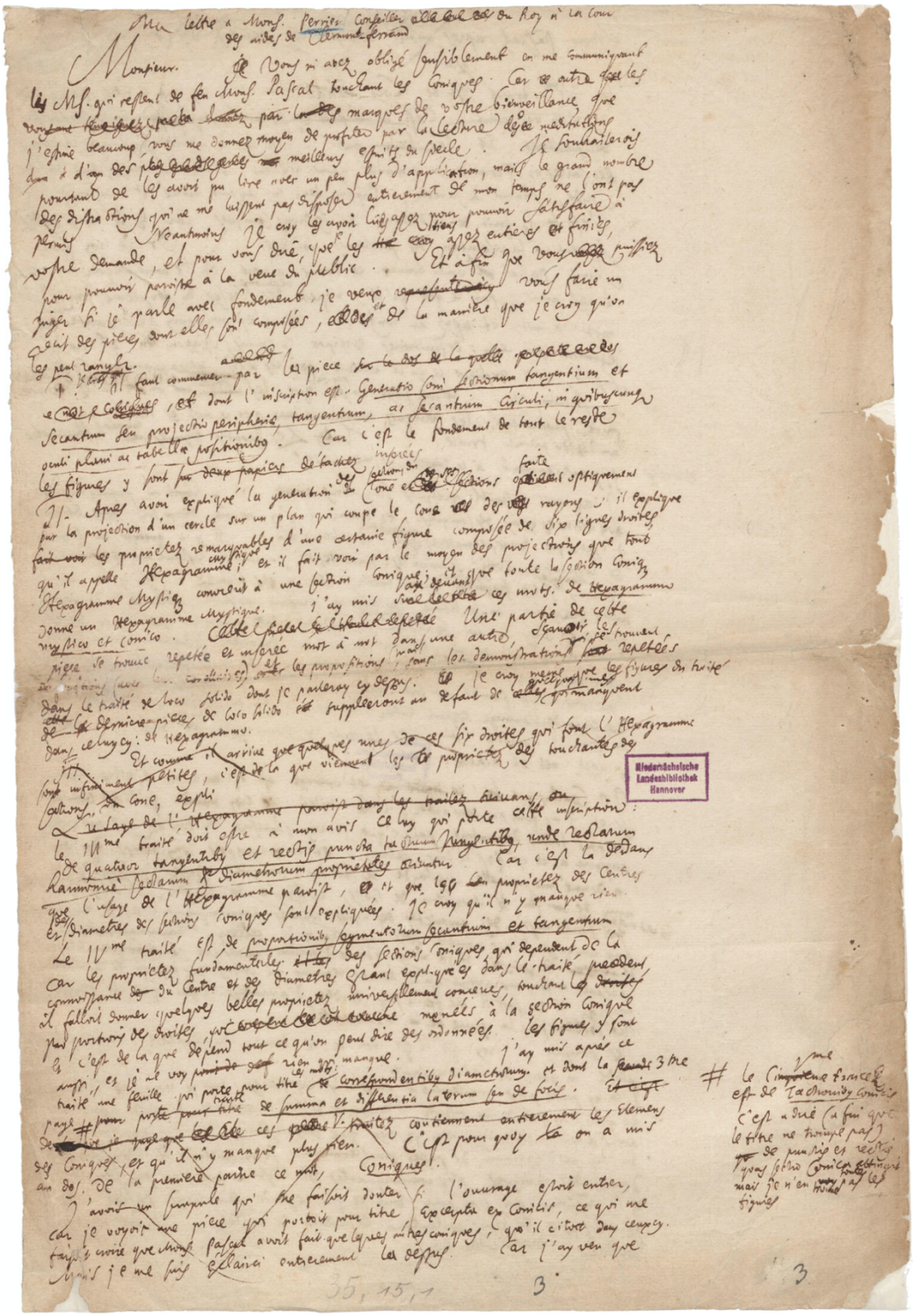


Figure 5—GWLB, LH XXXV, 15, I, fº 3r.

In order to organise Pascal's bundle of manuscripts into a publishable work, Leibniz, therefore, had to carve a series of smaller treatises into the whole by, first, identifying discontinuities in layout and content and, then, articulating them logically—while excising *miscellanea* that he deemed as irrelevant. When treatises were not explicitly entitled by Pascal, Leibniz took the liberty to invent them ("I added these words before" or "I added this title as there was none"[58]). These operations allowed him to write an ordered and structured inventory of Pascal's manuscripts using headings, titles, and numbered units, thereby leaving his own mark on them. Still, he probably strove to proceed as their author would have done, opting for "small treatises into which—according to Pascal's habit—his great work was divided."[59] In assimilating Pascal's posthumous work and proposing to publish it, Leibniz acted at once as a mathematician and an editor, but also as an archivist*:* he employed archival practices aimed at selecting, storing, and sorting Pascal's archive and his own.[60]

Excerpting and Commenting

Despite Leibniz's work and his letter to Étienne Périer, who intended to posthumously honour his uncle's memory, Pascal's manuscripts on the geometry of conics were not published before Gerhardt's 1892 edition. Leibniz, who had not contacted again Périer after returning the manuscripts, expressed his regret about the failed publication to Gilles Filleau des Billettes, a French scholar whom he had met in Paris before Billettes became an Academician. Later, in two more letters dated 1692, Leibniz complained to Billettes and asked him to intercede with the Périer brothers on his behalf to publish the text which he had organised twenty years earlier:[61]

---

[58] "*J'ai mis au devant ces mots*" and "*J'y ai mis ce titre parce qu'il n'y en a point*" (AA, III, I, nº 90, 587.)
[59] "*des petits traités entre lesquels se divisait—selon l'habitude de Pascal—le grand ouvrage*" (Jean Mesnard, "Introduction au Generatio Conisectionum," in Blaise Pascal, *Œuvres complètes*, Tome 2, 1105.)
[60] About scholars' personal archives, see Jean-François Bert, *Qu'est-ce qu'une archive de chercheur?* (Marseille: OpenEdition Press, 2014).
[61] AA, I, 8, nº 197, p.334 and ibid., nº 347.

> In Paris Messieurs Perrier showed me the Geometric Manuscripts of the late M. Pascal, and I organised them at their request and wrote a letter to the elder brother about their order; it is a pity that they have not published them. It would be necessary to urge the other [brother] to do so.[62]

In his answer dated May 1697, Billettes explained why the publication of the *Traité des coniques* had been unsuccessful. Étienne Périer's editorial project had died with him, and a publication was not on his surviving brother's agenda:

> The one left of the Perier brothers is a priest and dean of I don't know which chapter of Clermont in Auvergne, at his birthplace, with a worthy sister to both of them and their uncle. There is nothing to expect from the works of the latter. They must have lost them or consider it unsuitable to bring them to light.[63]

Thus, over only a few months Leibniz enquired twice about the progress of the publication of Pascal's *Traité des coniques*. As a close acquaintance of the Périer brothers, Gilles Filleau des Billettes had himself first-hand access to Pascal's papers, while Étienne Périer was still alive. Indeed, a loose folio, included in the now-*Pascaliana* of the Leibniz collection in Hannover and entitled "Excerpt of a Fragment of the Introduction to Mons. Pascal's Geometry," bears, just beneath its title, the mention "communicated by Mons. Des Billets" (cf. Fig. 6).[64]

---

[62] "*Messieurs Perrier me monstrerent à Paris des Ms. Geometriques de feu M. Pascal et je les rangeay à leur priere, et ecrivis une lettre à l'aisné des freres touchant leur ordre, c'est dommage, qu'ils ne les ont point publiés. Il faudroit y exhorter celuy qui reste.*" (Ibid., nº 347, 568–569.)

[63] "*Il ne reste plus des Messrs Perier que celuy qui est prestre et doyen de Je ne sçay quel chapitre de Clermont en Auvergne au lieu de sa naissance, avec une seur digne d'eux tous et de leur oncle. Il n'y a rien à attendre des œuvres de ce dernier. il faut qu'ils les ayent perduës, ou ne les ayent jugées propres à mettre au jour.*" (AA, I, 14, nº 133, 229.)

[64] "*Extrait d'un Fragment de l'Introduction à la Geometrie de Mons. Pascal* […] *que Mons. des Billets m'a communiqué*" GWLB, LH XXXV, 15, I, fº 13r (= Blaise Pascal, "Extrait d'un Fragment de l'Introduction à la Géométrie de Monsieur Pascal, que Mons des Billettes m'a communiqué," in Blaise Pascal, *Œuvre de Pascal*, Tome 3, 435–437).

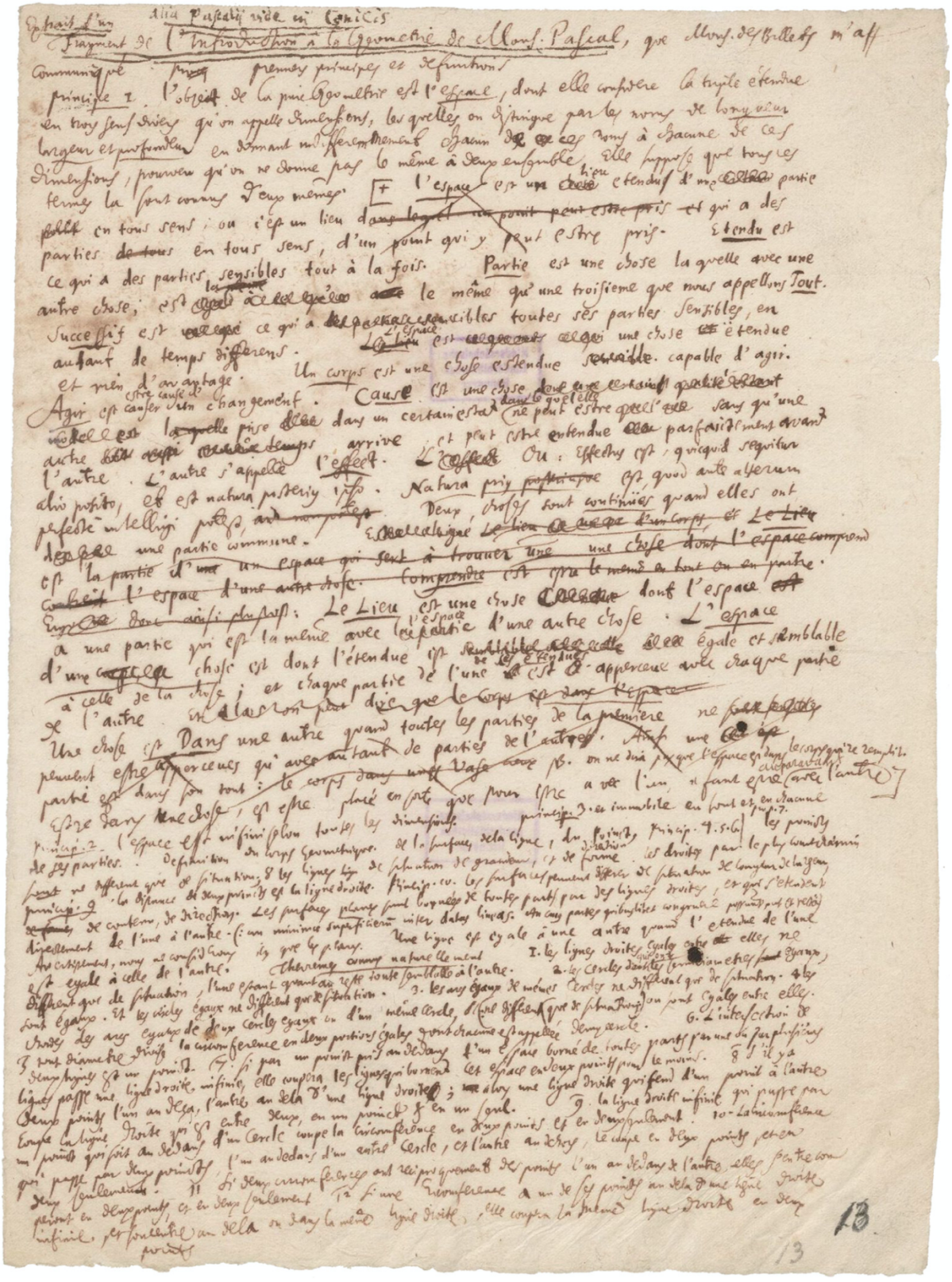


Figure 6—GWLB, LH XXXV, 15, I, f° 13r.

However, no mention is made of this fragment's circulation in the correspondence between Leibniz and Billettes, spanning from 1692 to 1713. This document was probably borrowed by Leibniz, when he was in Paris and Périer was still living, so that Billettes might have personally handed the manuscript to Leibniz. We can imagine that Leibniz studied this introduction and wrote his reading notes at the same time of his study of the other Pascalian manuscripts, those lent by the Périer brothers. Therefore, in all likelihood this folio dates from 1676.

Reading Pierre Nicole's preface to *Nouveaux éléments de géométrie* published in 1667 by Arnauld we know that Pascal had already written his own *Éléments de géométrie*:

> One of the greatest minds of this century, and one of the most famous for his admirable openness towards Mathematics, had realised in a few days an essay of *Elemens de Geometrie*; and as he did not have this desire for order, he was satisfied to change several of Euclid's demonstrations to replace them with clearer and more natural ones. As this little work having fallen into the hands of the man who composed the *Elemens*, this latter was surprised that such a great mind had not been astounded by the confusion he had left about the method.[65]

These elements, which have remained unpublished and circulated only within the French mathematical networks around 1657-1658, are now lost. The only extant trace is Leibniz's "excerpt of a fragment" of an introduction lent by Gilles Filleau des Billettes.

At first glance, the manuscript can be divided into four parts: a heading separated from the text by double underlining; the first part of the document's body containing the "*Principe 1*" of the "*premiers principes et definitions*," most likely a *verbatim* copy of the Pascalian text; then we find, within brackets and with many redaction and correction notes, what seems to be

[65] "*Un des plus grands esprits de ce siècle, et des plus célèbres par l'ouverture admirable qu'il avoit pour les Mathématiques, avoit fait en quelques jours, un essay d'Elemens de Géométrie; et comme il n'avoit pas cette veuë de l'ordre, il s'estoit contenté de changer plusieurs des démonstrations d'Euclide pour en substituer d'autres plus nettes et plus naturelles. Ce petit ouvrage étant tombé entre les mains de celuy qui a composé les Elemens, il s'étonna qu'un si grand esprit n'eust pas esté frappé de la confusion qu'il avoit laissée pour ce qui est de la méthode.*" (Pierre Nicole, "Préface," in Antoine Arnauld, *Nouveaux Éléments de Géométrie* (Paris: Charles Savreux, 1667). Quoted in Blaise Pascal, *Œuvres de Blaise Pascal*, Tome IX, 232–233.)

one of Leibniz's long personal digressions, consisting of about thirty lines and referring to a remark by Pascal; finally, the copy resumes, in a clearer way, after the digression, filling the remaining space at the bottom of the folio.

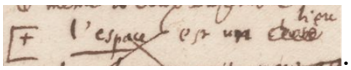
The three-line long heading is succinct. It is probably the first thing Leibniz did before taking notes, writing the title and author of the manuscript he was about to copy and comment: "Introduction à la Geometrie de Mons. Pascal," adding in passing that Billetes had handed him the manuscript. It is worth noting that the name of Périer is nowhere mentioned in the other fragments. So, after pointing out the source of the loan—Billettes, who was not the heir of Pascalian archives—Leibniz later added on top of his folio: "*alia Pascalii vide in Conicis*." These notes are today included in Pascal's complete works. They are scant notes, as Leibniz realised when he later added on the left of his heading, "Excerpt of a Fragment of [*Extrait d'un Fragment de*]." Indeed, the content of this folio seems to have led Leibniz to a more thorough study, as already emerges in a commentary on the paper surface, developed between the copy of two principles from Pascal's *Introduction*.

After specifying that he was only dealing with "first principles and definitions," Leibniz started copying the fragment. The first principle defines the object of geometry—space in three dimensions—and thus serves as a definition of this branch of mathematics. Then a long comment, after which Leibniz returned to the principles. However, it seems that the mere act of copying turned into an effort to summarize, as suggested by mere references to definitions or lists of principles that had not been copied: "Definition of the Geometric body of the surface, the line, the point, principle 4.5.6 [*Définition du corps Géométrique de la surface, de la ligne, du poinct, princip. 4. 5. 6*]." In total, ten principles and twelve theorems— that Pascal probably considered as "naturally known [*connus naturellement*]" and therefore left unproven—are thereby copied, abridged, or only alluded to. The original manuscript that Leibniz could read is now lost; it is impossible to know what its exact content was.

Now, let us focus on the first principle, which seems to have been faithfully copied, and serves a as a definition of the field of geometry:

> Principle 1. The object of pure geometry is space, whose threefold extent it considers in three divergent directions, which are called dimensions, distinguished by the names of length, breadth, and depth, ascribing each of these names to each of these dimensions indifferently, provided that two dimensions are not given the same name. It presumes that all these terms are known in themselves.[66]

There are two aspects about which Leibniz seems to worry the most and that triggered his personal reflection. First, according to Debuiche, although Pascal's definition of space is unoriginal and widely "accepted," it was however quite "audacious" to place the concept of space at the core of pure geometry as its first and foremost object.[67] Debuiche argues that this principle might have fostered Leibniz's understanding of geometry in situational terms.

Second, Leibniz separated his original comment from the *verbatim* copy, by drawing an open bracket, followed by a plus sign—likely to denote that he intended to add something to the original text:  . Just before this sign, Pascal had concluded his paragraph with this pregnant sentence: "[Geometry] presumes that all these terms are known in themselves." In other words, this first principle serving as a definition would be self-explanatory and, as such, would constitute the first element of a conceptual foundation of geometry.[68]

---

[66] "*Principe 1. L'objet de la pure géométrie est l'espace, dont elle considère la triple étendue en trois sens divers qu'on appelle dimensions, lesquelles on distingue par les noms de longueur, largeur et profondeur, en donnant indifféremment chacun de ces noms à chacune de ces dimensions, pourveu qu'on ne donne pas le même à deux ensemble. Elle suppose que tous ces termes là sont connus d'eux-mêmes.*" GWLB, LH XXXV, 15, I, f° 13r (= Blaise Pascal, "Extrait d'un Fragment de l'Introduction à la Géométrie de Monsieur Pascal, que Mons des Billettes m'a communiqué," 435).

[67] "*convenue*" and "*audacieux*" (Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 50.)

[68] This stems from the "*lumière naturelle*" in Pascal's *De l'esprit géométrique.*

Leibniz did not consider the terms introduced by Pascal as an apodeictic evidence—"*connus d'eux-mêmes*"— and provided a definition of the notion of "space [*espace*]" that , in his opinion, was not self-evident. Indeed, as highlighted by Itard: "The use of the word 'space' will certainly seem banal to the modern reader. Actually, in the precise sense in which Pascal uses it here, it almost represents a scandal in the middle of the 17th century, in an introduction to geometry which is meant to be elementary."[69]

This explains why Leibniz then wrote and reworked a series of interrelated definitions. The definition of the notion of space called for the definition of "extension [*étendu[e]*]," which in turn called for the definition of "part [*partie*]," and so on, before getting back to the initial concept—"Space is a thing extended and nothing more [*L'espace est une chose étendue et rien d'avantage*]." After that, Leibniz seems to dwell on a second series of definitions, now related to causality, and then to focus again on matters of places (*lieux*), spaces, and extensions.

These thirty or so lines are quite rough and muddled, often crossed out, corrected and supplemented. They show Leibniz's interest in defining pure geometry as the study of space, as well as his determination not to leave unexplored terms that are only supposedly "known in themselves", and therefore his desire to lead a logical regress to a minimal set of simple concepts.[70] On this issue Itard wrote these few lines: "Leibniz throws himself into a frenzied cascade of attempts to provide definitions until when, tired or discouraged, he starts again to copy Pascal's text more calmly."[71]

---

[69] "*L'emploi du mot 'espace' paraîtra certainement banal au lecteur moderne. En fait, et dans le sens précis où Pascal l'utilise ici, il fait presque scandale au milieu du XVIIe siècle, dans une introduction à la géométrie qui se veut élémentaire.*" (Jean Itard, "'L'introduction à la géométrie' de Pascal," *Revue d'histoire des sciences et de leurs applications* 15, no. 3–4 (1962):269–286, 273.)

[70] This could be construed as an early attempt of Leibniz to reduce a logical proposition to the combination of its elementary building blocks.

[71] "*Leibniz se lance dans une cascade échevelée de tentatives de définitions jusqu'au moment où, fatigué ou découragé, il s'arrête pour se remettre d'une main plus calme à la copie du texte de Pascal*." (Jean Itard, "'L'introduction à la géométrie' de Pascal," 273.)

This single folio, indeed, remarkably shows to what degree "Leibniz's personal contribution reveals us his character and working method."[72] First and foremost, copies, notes, commentaries and novel reflections are inextricably entwined in these few lines, as well as more generally in Leibniz's working papers. Here specifically, Leibniz carefully selected what he deemed worthy of copying—some definitions are only mentioned while principles 4, 5, and 6 have been altogether bypassed—and organised his thought having recourse to a minimal layout—introducing the folio with a heading, delimiting his original comment with brackets, underlining the concepts defined inline. In this sense, according to Debuiche, by developing an original reflection on the very object of geometry from mere excerpts of a fragment, these notes led Leibniz to initiate a shift in the definition of pure geometry towards a geometry of situations.[73]

Extracting and Reformulating

Between January and August 1676, Leibniz took notes on the *Essay pour les coniques*, had someone copy the *Generatio conisectionum*, organised Pascal's treatises, realised a summary and commentary of the *Introduction à la géométrie*. All these traces, which are now part of Leibniz's archive, are considered as fragments of Pascal's works and therefore as a proof of Leibniz's assimilation of the Pascalian geometry of conics. However, as we have already suggested, Leibniz's practice is more than mere assimilation, it is a work of appropriation and reinterpretation of Pascal's thought, so that he develops his own original reflections. To further document Leibniz's active reading practices, let us go back to the papers lent by Étienne Périer at the beginning of 1676.

Of the six treatises that Leibniz identified among Pascal's manuscripts, at least two seem to have been the object of more thorough reflection. The first of them is the *Hexagrammum*

[72] "*l'apport personnel de Leibniz est très révélateur de son caractère et de ses méthodes de travail*" (Ibid., 272.)
[73] Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 50-53.

Pascalianum (cf. Fig. 7).[74] In this case, Leibniz did not make a copy of Pascal's manuscript. Rather he jotted thoughts on paper, together with a few schematics drawn by the German mathematician and physicist Ehrenfried Walter von Tschirnhaus (1651-1708), with whom he used to worked during his stay in Paris. The two mathematicians kept a correspondence until Tschirnhaus' death in 1708. We can follow their quill pens tracing figures, texts and then symbols, eventually composing a single page of interlaced objects of varied types. This page can only be understood in a glance through a hybrid hermeneutics, which we will detail in the present section.

The four figures seem to have been drawn first; the textual notes most probably followed. The figures are rather rough sketches, as some lines were crossed out. Interestingly, three straight lines that materially intersect at one point on the paper were nonetheless qualified as parallel. This putative parallelism is made visible with the help of another schematic drawn just beneath the heading: a series of three horizontal straight lines joined two-by-two with braces. This same indication can be found for two parallel lines in the bottom left corner of the folio. According to Costabel, this peculiar key and the comment on the left of the page—"Two parallel lines are understood as concurrent, although the *locus* of their intersection is infinitely remote"[75]—attest that Leibniz knew Pascal′s and Desargues' consideration that two parallel lines could be said to intersect at infinity. Using particular case studies materialised in these figures,[76] Leibniz and Tschirnhaus reduced on paper the generality of Pascal's lemma[77] to make sense of the "mystic hexagram" that lies at the heart of his understanding of conics.[78] Finally,

[74] GWLB, LH XXXV, 15, I, f° 12r (= AA, VII, 7, n° 61).
[75] "*Duae lineae parallelae concurrere intelliguntur, etsi locus concursus infinite absit*" Ibid. (= AA, VII, 7, n° 61, 579).
[76] René Taton, "L'œuvre de Pascal en géométrie projective," 242.
[77] As can be compared with the version of the *Essay pour les coniques* (ibid., 202-203).
[78] Andrea Del Centina, "Pascal's Mystic Hexagram, and a Conjectural Restoration of his Lost Treatise on Conic Sections".

at the bottom right corner of the folio, a concise version of Desargues' involution theorem is written in symbols and accompanied by an undetermined figure.[79]

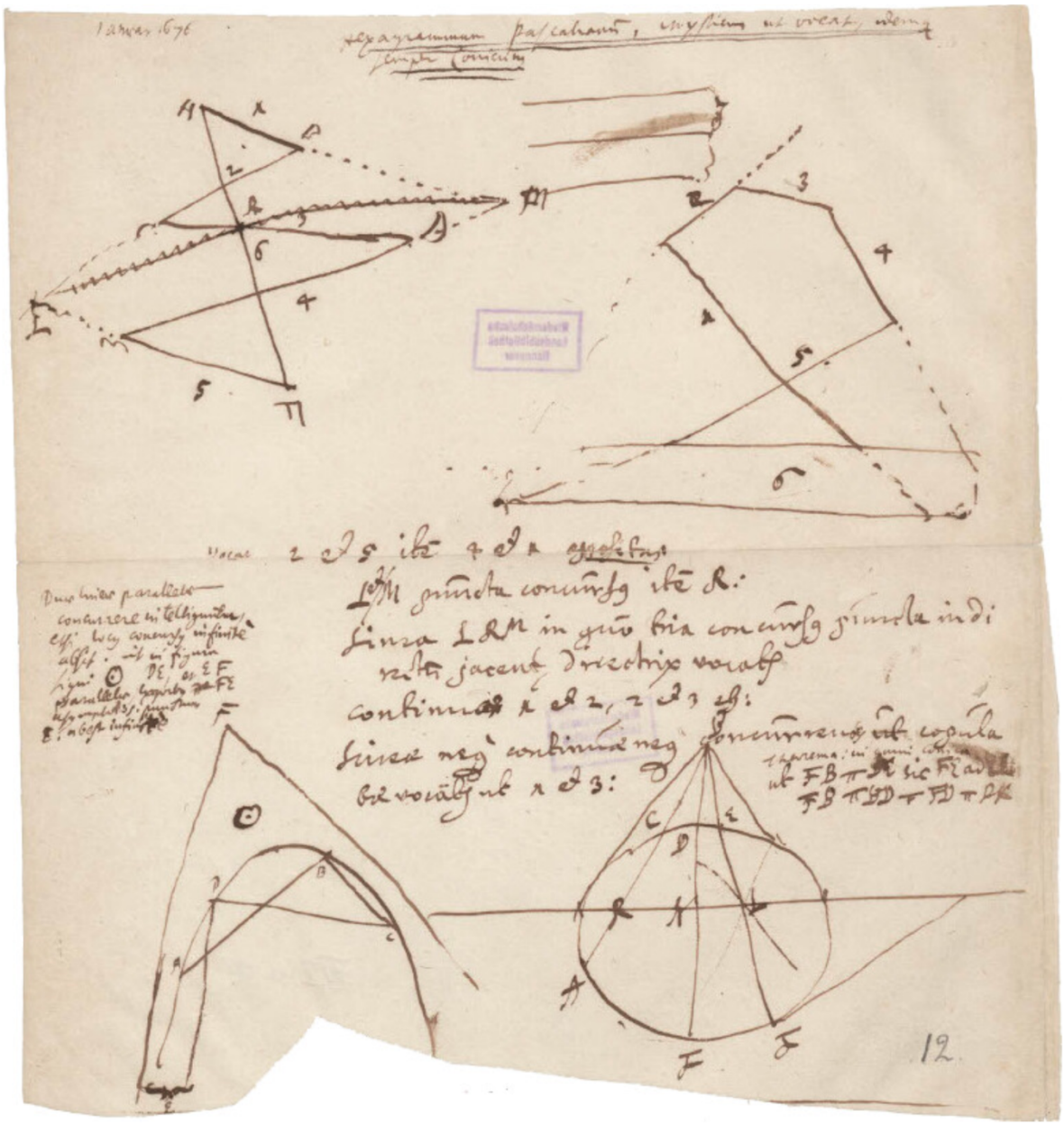


Figure 7—GWLB, LH XXXV, 15, I, f° 12r.

Although we cannot exclude that this symbolic and spatial formulation was also present in Pascal's writings, Leibniz's material way of writing the theorem recalls the writing

[79] Ibid., 498-499.

techniques he developed years later and whose aim was to be able to "see all at once" on the paper surface.[80] Rather than excerpting and commenting, Leibniz and Tschirnhaus most likely extracted mathematical relations from Pascal's notes on the mystic hexagram. They did so with their own means—Pascal is mentioned in the third person—thereby reformulating their reading as a set of particular geometrical situations.

The second fragment from Pascal's *Traité des coniques* was extracted and reformulated by Leibniz, resulting in a folio entitled "Conica Pascaliana", composed even more roughly than the others and supplemented with varied figures, drawn and written by both Leibniz and Tschirnhaus (cf. Fig. 8).[81] Apart from the theme that they have in common—the generation of conics by "optical" methods—it is difficult to detect where all the notes stem from, even after a thorough study of their content: they are not a *verbatim* copy of some Pascalian fragment, they do not make any reference to other lent manuscripts and are not mentioned in Leibniz's letter to Périer. They are most likely a collection of notes taken while reading Pascal's *Generatio conisectionum*[82] and written as something between a commentary and an original reflection. So much so that, within Pascal's complete works, this folio is designated as a "note by Leibniz on Pascal's *Conics*"[83] rather than as part of Pascal's writings, that is, the *Generatio conisectionum*.

[80] Matthew Jones, *The Good Life in the Scientific Revolution*.
[81] GWLB, LH XXXV, 15, I, fº 1r (= AA, VII, 7, n° 62).
[82] Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 56.
[83] "*note de Leibniz sur les Coniques de Pascal*" (Pierre Costabel, "Traduction française des notes de Leibniz sur les Coniques de Pascal.")

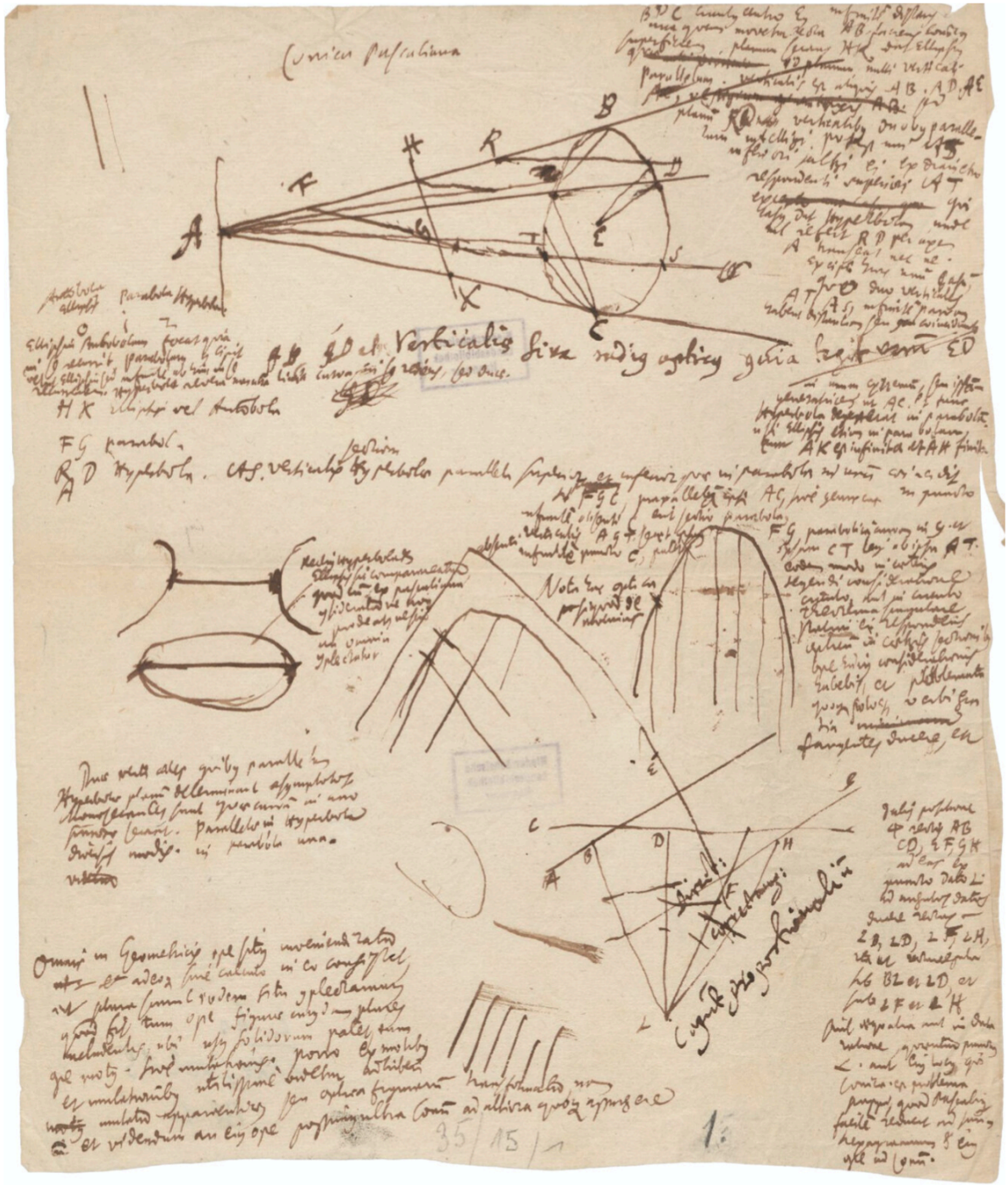


Figure 8—GWLB, LH XXXV, 15, I, fº 1r.

Two distinct handwritings are easily distinguishable on the folio. Leibniz organised his writing into small distinct paragraphs in the margins of the paper, whereas Tschirnhaus seems to have drawn the first and last figures, adding comments. Within this specific folio, Costabel identified a summary and an original part. According to him: “The general style, however, is

not Pascalian. It is a summary of Pascal, composed and written by Leibniz, perhaps helped by Tschirnhaus, who had previously drawn two figures."[84]

Once more, all the figures were drawn before the comments accompanying them. While the figures in the bottom half of the paper are flat, the one at the top of the folio is drawn in perspective—BDC is said to be a circle—and depicts, on the finite paper surface, geometrical objects situated at infinity—the center E is said to be at an infinite distance. On its left side, the figure is provided with a commentary and a table which inventories Pascal's conics—antobola or ellipse, parabola, hyperbola. This table is exactly the same one at the end of the *Generatio conisectium.* However, here it is accompanied by a figure and a short comment on the relations between conic sections. More importantly, it is also supplemented by a second inventory of conics, including the point and the angle that Pascal had left out. This rough table denoting conics with their reference letters is meant to be read together with the figure.

By combining a perspectival figure depicting objects at infinity with a table allowing us to go from inventory to figure, Leibniz and Tschirnhaus make it possible to grasp all the possible conics at once. Furthermore, whereas in the *Generatio conisectionum,* Pascal had metaphorically situated the viewpoint at the cone's vertex, imagining the observer's eye perceiving conics as apparent projections,[85] the Leibnizian reader looks at the figure from an outside position, which makes it possible to seize infinity. Imagination now allows the reader to figure the movement of plane and cone as well as to seize the transformation of their intersection. According to Debuiche, this change in perspective led Leibniz to redefine Pascal's pure geometry of incidence—rooted in his mystic hexagram—as a geometry of situations in space, a *characteristica geometrica*.[86]

[84] "*Le style général n'est cependant pas Pascalien. Il s'agit d'un résumé de Pascal, composé et écrit par Leibniz, peut-être aidé par Tschirnhaus, qui avait préalablement tracé deux figures.*" (Ibid., 255.)
[85] Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 46.
[86] Ibid., 65.

Therefore, the most striking aspect is Leibniz's deliberate appropriation of Pascal's work and the way he used it for his own project. In studying the Pascalian manuscripts Leibniz was interested not only in the results on conic sections *per se*, but also in the work method of pure geometry—that is, in how all the conic sections can be obtained by the intersection of a cone and a plane with varying angles of incidence. In a note inserted between the two central parabolic figures and that spreads into the right column, Leibniz highlighted the heuristic powers of such a method, which, by generating conics from a circle, allows him to generalise any result obtained on a circle and project it on the rest of the conics: "Note. By this optical consideration of shadows,[87] if we discover a singular theorem of the circle or in the circle, therefore we immediately have the corresponding [theorem] for the other conics; and we also solve problems such as the determination of tangents, etc."[88]

Beyond the particular projective geometry method, Leibniz was fascinated by the general method of invention in mathematics and - more broadly - in thought. In a paragraph packed in the lower-left corner of the folio, he had already identified the possibility of extending the powers of projective geometry to other domains of mathematics and knowledge in general, through the conceptual generalisation of the method:

> The whole method of discovering geometrical things on the basis of their situation, that is, without calculating, consists in seizing at once a plurality in the same situation; this can be done either with the help of a particular figure that contains a plurality, where the use of solids appears; or with the help of motion, that is mutation. Furthermore, among motions and mutations, it seems that the mutation of appearances or the optical transformation of figures are very useful; we must see whether by this means we can also rise to higher things beyond the cone.[89]

---

[87] Leibniz considers projected points and lines as the "shadows" of the original objects.

[88] "*Nota. Hac optica tegendi consideratione, si quis de circulo aut in circulo inveniat theorema singulare, statim ei respondens igitur in coeteris sectionibus, ope hujus considerationis, habebis ; et problemata quoque solvebis, verbi gratia tangentes ducere, etc.*" GWLB, LH XXXV, 15, I, f° 1r (= AA, VII, 7, n° 62, 581).

[89] "*Omnis in Geometricis ope situs inveniendi ratio, ideoque sine calculo, in eo constat ut plura simul eodem situ complectamur ; quod fit, tum ope figurae cujusdam plures includentis, ubi usus solidorum patet ; tum ope motus, sive mutationis. Porro, ex motibus et mutationibus, utilissime videtur adhiberi mutatio apparentiae, seu optica*

We may recall here what a commentator defined as Leibniz's "mathematical optimism"[90], that is, despite his limited skills in mathematics then,[91] his ability not to stop at the results *per se*, but to study the method that allowed for them. It is worth noting, in passing, what René Taton observed about the "Conica Pascaliana" in particular:

> The influence of Pascalian geometrical thought on Leibniz himself is indisputable. [...] It does not seem that Leibniz was much interested in the numerous results stated and demonstrated in the *Traité des Coniques*. On the other hand, as always, what interests him most are the methodological and philosophical foundations of the work.[92]

Our material reading of Leibniz's paper allows us to enrich his methodological remark. The method of discovery that he promoted and later developed is not to be understood as *purely* imaginative or metaphorical. If indeed Leibniz considers space as the "structure or order within which things are arranged"[93] and if the folio is the material space where geometrical space is represented, then the paper surface becomes the *material condition of possibility* for the simultaneous perception of objects in the same situation. For an historian of practices, the paper surface represents the very space where Leibniz can see all things at once, including objects situated at infinity, the alphabetical characters that reference them, the tables where they are inventoried, and the textual comments all around. This materiality is what makes us say with

figurarum transformatio ; videndum an ejus ope possimus ultra conum ad altiora quoque assurgere." Ibid. (= AA, VII, 7, n° 62, 582).

[90] Marc Parmentier, "L'optimisme mathématique," in Gottfried Wilhelm Leibniz, *La naissance du calcul différentiel. 26 articles des* Acta eruditorum, ed. Marc Parmentier (Paris: VRIN, 1995), 11–52.

[91] Costabel highlights this important matter of fact when arguing that "[Leibniz's assimilation] also attests that he was late in matters of geometry compared to Pascal and Desargues"; and a little later: "The fact is significant: what for Pascal was so commonplace for a long time was not at all so for Leibniz." (Pierre Costabel, "Traduction française des notes de Leibniz," 255.)

[92] "*Sur Leibniz lui-même, l'influence de la pensée géométrique Pascalienne est indiscutable. [...] Il ne semble pas que Leibniz se soit beaucoup intéressé aux nombreux résultats énoncés et démontrés dans le Traité des coniques. Par contre, comme toujours, ce qui l'intéresse avant tout, ce sont les fondements méthodologiques et philosophiques de l'œuvre.*" (René Taton, "L'œuvre de Pascal en géométrie projective," 249.)

[93] "*structure ou ordre dans lequel se disposent les choses*" (Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 43).

Debuiche that "the geometry of situations, like perspective, calls for a structured, ordered space, closely linked to perception."[94]

Indeed, on this folio, where Leibniz wrote his reading notes about Pascal's paper, it is clearly possible to see to what extent things merge with words—paper serving as the material support for the ink, which allows for the inscription of words, figures, and symbols denoting a certain experience of space and the manipulation of volumes within this space. Leibniz himself seemed to be evoking the heuristic coexistence of words and things under the discerning eye of the scholar, when he noted that the powers of the projective method consist in "seizing, at once, a plurality in the same situation."[95] And, somehow, that is what he did when he took notes, inextricably entwining figures and phrases, words and things—as is the case for that already mentioned remark stretching on both sides of a previously drawn figure (cf. Fig. 8).

A little lower, at the bottom of the folio, Tschirnhaus' writing appears now superimposed on the outline of a figure, while Leibniz's notes follow its contours as if text and drawing were but one single object (cf. Fig. 8). This spontaneous coalescence between words and things is strengthened by the multiple cross-references between the notes to the figures: points, straight lines, and angles are designated by symbolic notations using Roman capitals, allowing to go back-and-forth between text and drawing. The figure not only facilitates the understanding of the note by illustrating it, but also imposes symbolic and logical constraints on it, guiding reasoning.[96] In its turn, the text does not solely explain the figure but also shapes it in return, requiring here a letter to denote a vertex, there to extend a line to materialise a geometrical property.

---

[94] "*la géométrie des situations, comme la perspective, convoque un espace structuré, ordonné, lié étroitement à la perception*" (Valérie Debuiche, "L'invention d'une géométrie pure au 17e siècle," 65).
[95] "*in eo consistet, ut plura simul eodem situ*" GWLB, LH XXXV, 15, I, fo 1r (= AA, VII, 7, n° 62, 582).
[96] See, e.g., Kenneth Manders, "Diagram-Based Geometric Practice," in *The Philosophy of Mathematical Practice*, ed. Paolo Mancosu (Oxford: Oxford University Press, 2008), 65.

In this sense, Leibniz put his readings to use. This peculiar use comprised numerous material practices and various intellectual operations: copying, extracting, summarising, commenting, unfolding a vast quantity of handwritten notes on papers that were then collected, stored, classified, observed. These are what Lorraine Daston identified as "archival practices."[97] This archival know-how aimed at gathering words, just like naturalists gathered things, and reading books, just as others read the book of nature.[98] It is indeed a hybrid hermeneutics that Leibniz put to work while actively reading Pascal's manuscripts.

Conclusion

It is well-known that, in a letter dated March 1693 addressed to Guillaume de l'Hospital, Leibniz claimed that he could barely orientate himself in that pile of notes, so much so that, when he forgot something, he needed to repeat all the steps of the elaboration process that had led him to it: "After having done something, I forget it almost entirely within a few months, and rather than searching for it amid a chaos of jottings that I do not have the leisure to arrange and mark with headings, I am obliged to do the work all over again."[99]

Indeed, Leibniz was not always as meticulous as in his conscientious study of Pascal's manuscripts, and he did not store only formatted notes like commonplace books. The numerous slips cut or torn off printed books that we now find scattered across his papers indeed bear witness to a certain freedom in the way he took notes. This is what happens, for example - among the *Pascaliana* - with Leibniz's reading notes on Pascal's *Traité de l'équilibre des*

[97] Lorraine Daston, "The Sciences of the Archive."
[98] It is noteworthy that Elizabeth Yale identified the birth of the archive in early modern naturalists' practices (Elizabeth Yale, "With Slips and Scraps: How Early Modern Naturalists Invented the Archive," *Book History* 12 (2009):1–36).
[99] "*Quand j'ay fait quelque chose, je l'oublie presque entierement au bout de quelques mois, et plustost que de le chercher dans un chaos de brouillons que je n'ay pas le loisir de digerer, et de marquer par rubriques ; je suis obligé de faire le travail tout de nouveau.*" (AA, III, 5, 506. Translation from James G. O'Hara, "'A chaos of jottings that I do not have the leisure to arrange and mark with headings': Leibniz's manuscript papers and their repository," in *Archives of the Scientific Revolution: The Formation and Exchange of Ideas in Seventeenth-Century Europe*, ed. Michael Hunter (Woodbridge: The Boydel Press, 1998), 160.)

liqueurs. Here Leibniz filled an entire slip of paper with *verbatim* quotes with no mention of their place in the book (cf. Fig. 9).[100] It was indeed quite frequent for Leibniz to throw notes on loose folios, sometimes just slips, covered from one side to the other with thin handwriting and no reference to page numbers or chapter titles.[101]

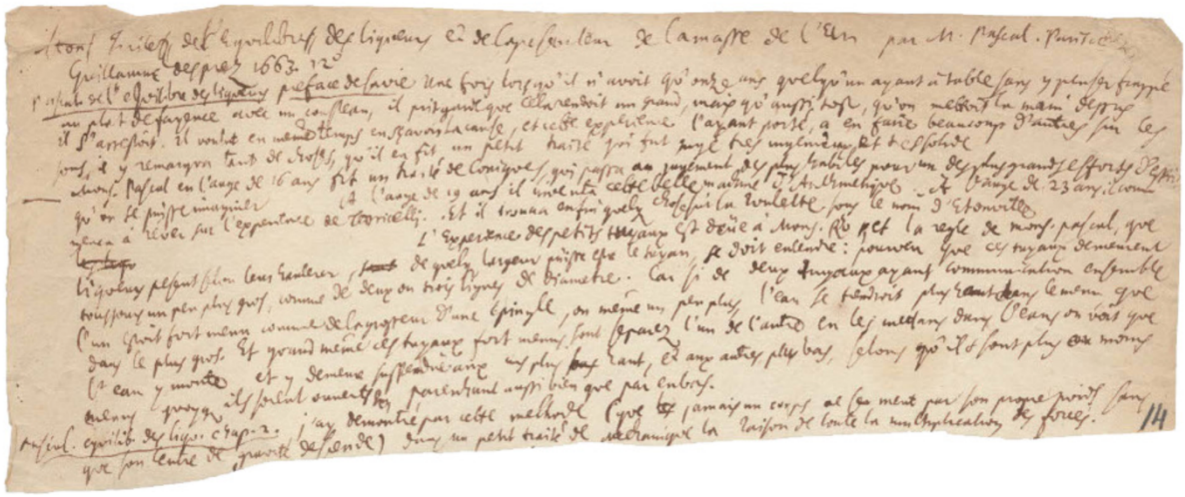


Figure 9—GWLB, LH XXXV, XV, f° 14r.

That said, the famous remark sent to the Marquis de l'Hospital does not reflect exactly the organisation of Leibniz's notes. If, beyond the *Pascaliana*, we glance at the reading notes that are legion in his archive, things change. Excessively numerous indeed, these notes were nonetheless taken in a very systematic manner, according to the method of one of his correspondents, Martin Fogel.[102] Written down on slips of paper of various sizes, Leibniz's notes are usually preceded by headings mentioning the author's name, the title, place, and year of publication of the work. The notes are of two types: either excerpts copied from a book or comments about an author. Usually being both, they were indicated by the archivists as "*aus und zu* [author's name]."

[100] GWLB, LH XXXV, 15, 1, f° 14rv.
[101] E.g., GWLB, LH XXXV, XIV, "Aus und zu F. W. Nylandt, Elementa physica, Den Haag 1669".
[102] Ann Blair, *Too Much to Know*, 87–88.

By turning to the *Pascaliana* files archived in the personal papers of Leibniz, we have encountered a set of documents—whose topical and temporal unity was already constructed by Leibniz himself—that constitutes a genuine "network of writings"[103] allowing us to account for a multiplicity of links which inextricably entwine, on the one hand, the various types of documents that compose the corpus (books, notes, correspondence, drafts, copies, etc.) and, on the other hand, a plurality of corpora (here Leibniz's and Pascal's personal archives locally merge through correspondence, reading, note-taking, copy, etc.). Therefore, we observe the irreducible variety of an archive which *prima facie* appears extremely heterogeneous to archivists and historians but that reveals an undeniable intellectual homogeneity, when properly handled, (in)formed, shaped, constructed through the multifarious archival know-how of the savant—copying, excerpting, summarising, commenting, unfolding the numerous handwritten notes on paper then selected, stored, sorted, and scrutinised.[104]

An intellectual homogeneity that tends to blur a hypothetical boundary between a simple note and the beginning of new research, so that it becomes even more difficult to distinguish between the work of one and that of the other. We have seen the localised and partial dissolution of Leibniz's work into that of Pascal, and reciprocally. Indeed, Leibniz's notes, be they considered *verbatim* copies or commented summaries, were later published within Pascal's complete works, since they were the only extant traces of lost manuscripts.[105] Reciprocally, this bundle of notes, copies, and commentaries can also be considered the work of Leibniz, so that they were published—after careful selection, transcription, reorganisation—as part of Leibniz's

[103] Béatrice Fraenkel, "Actes d'écriture : quand écrire c'est faire," *Langage et société* 121–122, no. 3 (2007):101–112.
[104] For an ecological perspective of the scholar's personal archive conceived of as a *milieu*, cf. Simon Dumas Primbault, "Un milieu d'encre et de papier. Brouillons, notes et papiers de travail dans l'archive personnelle de Vincenzio Viviani (1622-1703)," *Cahiers François Viète* III, no. 10 (2021):21–54.
[105] On the material precariousness of knowledge in the early modern period and, consequently, the importance of practices of copy and note-taking, see Martin Mulsow, *Savoirs précaires. Pour une autre histoire des idées à l'époque moderne* (Paris: Éditions de la Maison des sciences de l'homme, 2018).

Sämtliche Schriften. The *Pascaliana*, their circulation and alteration, their copy, transcription, and publication are the perfect example of a "boundary object" that complicates established distinctions between authors, archives, and libraries, as well as between so-called "grey literature" and completed works.

What nonetheless contributes to the unity of the archive and the corpus are the material practices that allow the savant to navigate through this ocean of papers, books, and correspondences. According to Lorraine Daston, "It is practices, not uses or users, that compose the *basso continuo* of scientific archives."[106] The family resemblance between all the material practices at work in the *Pascaliana* allows for no clear-cut distinction between reading and thinking. They are somewhat different regimes of the same set of material practices indifferently aimed at organising Pascal's treatise and developing an original reflection. If Jones saw the roots of Leibniz's writing techniques as "borne out in his experimental practice of the late 1670s,"[107] the present material understanding of the *Pascaliana* argues that his early cognitive practices can also be found in Leibniz's interaction with Pascal's geometrical papers.

Indeed, for Leibniz, practices such as copying, summarising, abridging, note-taking, or corresponding structure the main archival know-how, in turn structuring a mass of papers into an archive. These various practices at the heart of archival know-how have to do with a hybrid hermeneutic shuttling back-and-forth between words and things, drawings and texts, paper and the book of nature. A kind of hermeneutics that underpins Leibniz's active reading of Pascal's work as well as both scholars′ reading of mathematics in general. A kind of hermeneutics that emerges from all things entwining on the paper surface where Leibniz, while reading, takes notes that continuously turn into the first sketches of new considerations aimed at formalising his reflections.

[106] Lorraine Daston, "Introduction—Third Nature," in *Science in the Archives*, 8.
[107] Matthew Jones, *The Good Life in the Scientific Revolution*, 241.

These few papers taken from the Leibnizian *Nachlaß*, published in various editions of Pascal's complete works as well as in Leibniz's Akademie Ausgabe, show how much archives, libraries, and correspondences are mutually porous: papers, books, and letters circulate, are copied, commented on, reworked, often by several different hands, as part of a practice sometimes very close to that of an editor. As the material manifestation of all theoretical and intellectual knowledge mobilised on the surface of these papers, archival know-how pervades many and varied practices of exchange, copy, note-taking, commentary that later enabled Leibniz to manage and process all knowledge and information made available by his grand inventory. Indeed, after Paris, his two-sided profession, as both a librarian and an archivist, was inextricably entwined with his scholarly activity. For Leibniz, all knowledge is archival knowledge: there can be no such thing as a general science without an inventory, *i.e.,* without the necessity to collect, observe, sort, conserve, and classify all possible knowledge, information, practices, and objects.[108]

Acknowledgments

I would like to express my gratitude towards both reviewers, the proofreader, and the editor whose thorough and detailed critiques helped me improve this article substantially.

[108] Lorraine Daston, ed., *Science in the Archives*.