# AN INK–AND–PAPER AUTOMATON: THE CONCEPTUAL MECHANIZATION OF COGNITION AND THE PRACTICAL AUTOMATION OF REASONING IN LEIBNIZ'S *DE AFFECTIBUS* (1679)

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**Abstract.** On ten loose handwritten folios dating back from April 1679, Leibniz gradually devised, in the course of three days, a full-blown theory of thought that nonetheless remained unpublished and still has received little attention from scholars. Conceiving of *affectūs* as the driving forces that set the mind in motion from one thought to another and *passiones* as the inertia opposing such movement, this manuscript results in a systematic psychology understood as a dynamics of thoughts modelled on the mechanical laws of motion for solid bodies. Delving into Leibniz's working papers to witness the unfolding of his thoughts, I propose to pay attention to the many intellectual operations that paved the way for his metaphysics. From his reading notes on Descartes to his syllogistically redefining a set of concepts and propositions, Leibniz here defines an affective theory of cognition and sets the first foundations of a combinatorial ontology: his so-called *scientia generalis*. Focusing on the material practices that govern his use of paper, I would like to show that Leibniz's conceptual mechanization of cognition is materially dependent on a practical automation of reasoning reduced to a propositional calculus on paper. Eventually, this contribution is a plea for a media-historical reading of Leibniz's working papers.

**Keywords:** Leibniz, affect, automation, reasoning, working papers, *medium*, material practices

## Introduction

In 1679, halfway between his return from Paris, where he had already set down most of the working concepts of his differential calculus, and the publication in the *Acta eruditorum* of his "Nova methodus pro maximis et minimis" where he precisely defined the rules and symbols of said calculus, Gottfried Wilhelm Leibniz (1646, Leipzig – 1716, Hannover) started jotting on paper his thoughts about a universal language[1] and the general science that would be grounded in it[2]. The very same year, he also drafted a first theory of mind that aimed at conceptually mechanizing cognition and prepared the ground for his computational metaphysics:

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the unpublished *De Affectibus*. The present paper deals with the material practices exhibited on the paper surface of this manuscript, and their links with Leibniz's computational metaphysics.

*Leibniz's computational dream*

In a handwritten work scribbled around 1688, Leibniz famously expressed his wish that any two opponents would be able to settle their argument by simply calculating the veracity of their rival philosophical propositions.[3] Influenced by Hobbes for whom thinking amounted to reckoning, Leibniz claimed reason is purely computational.[4] Thinking would then essentially be an algorithmic process, that is to say the automatic unfolding of step-by-step operations on symbols – or *calculus ratiocinator* as Leibniz himself calls it no sooner than 1666.[5] While in Paris, Leibniz also attempted to externalize and mechanize reckoning using other hardware, striving to build a calculating machine that would embody the computational mind as a set of cogs governed by the mechanical translation of algebraic rules, thus automating reasoning in a context of proto-capitalism.[6]

Neither pre- nor proto-computational, Leibniz's high rationalism is computational through and through. Yet, parallel to his failed attempts at constructing a calculating machine, his automation of reasoning developed on paper, not in cogs. Indeed, in order for reason to conceptually equate computation, the philosopher insisted in his wish on the practical necessity for contradictors to have "pencils in their hands [*calamos in manus*]" and to "sit down at the abacus [*sedere ad abacos*]," thus reminding us of the necessary material substrate of his combinatorial metaphysics: ink, quill, and paper.

The material and discursive perspectives are but two sides of the same coin. Following Kittler's endeavour to extend Foucault's archaeology down to the very technical substrate of discourses,[7] I conceive of Leibniz's material practices on paper as the conditions of possibility of his discourse – namely computationalism –, and reciprocally.[8] Therefore, by tracing analytic and combinatorial operations on the surface of Leibniz's working notes, while linking them to the logical structure of his discourse, I would like to shed light on the *pas-de-deux* between material and intellectual. The focus on material practices and their isomorphic relation to theory shall help us understand the algorithmic regime of knowledge that undergirds Leibniz's form of computational rationality – and eventually to document the fundamental textuality inherent to his mechanical conception of cognition.

In other words, conceiving of ink, quill, and paper as a *technical medium* through which reasoning is at once enabled, shaped, and constrained, how can we account for the entanglement of computational reason as a discourse and the automated combinatorics that practically governs Leibniz's algorithmic use of paper?

*The* De Affectibus

Among the collection of manuscripts held at the State Library of Lower Saxony in Hannover, ten loose folios written in Leibniz's hand deal with an enquiry into a concept denoted by the Latin word "*affectus.*"[9] This manuscript entitled *De Affectibus* is made up of five in-folios (see illus. 1) that remained unedited but were

later transcribed and briefly contextualised by scholars of the Berlin-Brandenburg Academy of Science for publication in 1999 in Leibniz's *Sämtliche Schriften und Briefe*.[10]

The *De Affectibus* is a work of philosophy, and more particularly a work related to Leibniz's grand encyclopaedic scheme – his *scientia generalis*, to which we will return. As can be read from the heading on the first page (on the top right in illus. 1), Leibniz himself entitled his brief work *De Affectibus* – even adding the resonant subtitle "*Ubi de Potentia, Actione, Determinatione* [On Force, Action, Determination]" that we will try to understand –, giving his writing a certain coherence or unity and a significance focused on *affectus*. He also inserted the date on the first page, as well as on top of each in-folio after that, and numbered them: Leibniz worked on this manuscript from the 10th to the 12th April 1679 in the Julian calendar.

Paying closer attention to the black ink script, though, we may realise that the heading of the first page was most probably added afterwards, albeit not so long after – on the same day or the day after – given the apparent continuity of script and ink colour between the headings and the main text in the following folios. Indeed, the *De Affectibus* appears to be a collection of nine fragments of different lengths and varying contents. After all, and although these fragments all obey the same form, the coherence and unity of this work seem to have been constructed *a posteriori*: these papers are "working notes."[11]
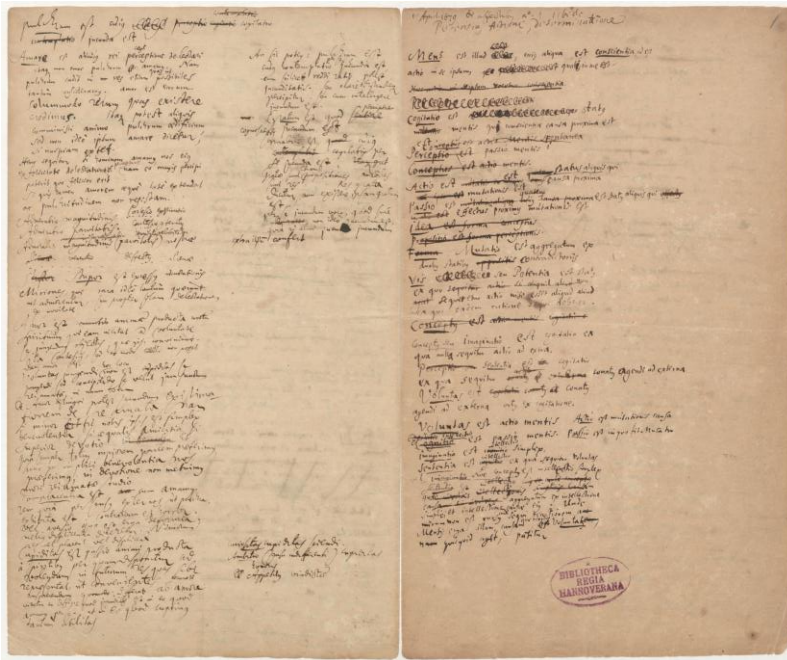


Illustration 1: First and fourth pages of the De Affectibus
(GWLB, LH IV, 7B, ff°1r and 2v).

Delving into Leibniz's working notes, we will enter his "workshop of ideas" for a few days in order to witness his practice of theory by deciphering the only inscriptions left of his intellectual as well as physical activity. We will try and trace the birth and evolution over three days in April 1679 of Leibniz's thought from his reading of Descartes's Latin *Passiones animæ* to his laying the foundations of a computational metaphysics. *Prima facie*, we could conceive of Leibniz's *De Affectibus* as a cognitivist theory of *affectus* – as would support the fact that the next ten folios in the archive gather reading notes on Spinoza's *Ethics* and *Tractatus de Intellectus Emendatione.*[12] But in fact, using the concept of *affectus* in order to support a mechanical understanding of cognition, it would better be understood conversely as an affective theory of mind.

Directly influenced by the Latin translation of Descartes's *Traité des passions de l'âme* (1649), Leibniz's too long neglected manuscript is an attempt at devising a theory of mind modelled on the structure of geometrical mechanics by conceiving of mind as a mechanical system. What Leibniz thus builds in this quickly forgotten work is a genuine *dynamics* of mind analogous to the three basic mechanical laws of motion: as an ontological transposition of the principle of inertia, he states that "*affectus est in animo, quod impetus in corpore* [*affectus* is in the mind what impetus is in the body]". From definitions through syllogisms to a conceptual system, Leibniz delivers a theory of cognition where *affectus* plays a central role. Finally, in the remainder of these notes, he progressively turns his theory of mind into a study of general ontological structures; meaning that, for Leibniz, *affectūs* foster series of thought that themselves play their role in the construction of the subjectivity just as series of things can be conceived of mechanically.

The concept of *affectus* is here a central piece of Leibniz's attempt at conceptually mechanizing thought. Thus, from reading notes on Descartes to a mechanical understanding of cognition, I will first dwell on a contextual and critical reading of Leibniz's *De Affectibus* as paving the way for his later understanding of the human soul as a spiritual automaton.[13]

In the second part of this paper, delving into the ink-and-paper substrate in order to provide a material and media-historical reading of these handwritten notes, I will try to shed light on the dependence of Leibniz's computational discourse on his technical *medium* of thought, that is on the dialectic between his conceptual mechanization of cognition and his material practice of ink and paper. In other words, I would like to show that Leibniz's conceptual mechanization of cognition is materially dependent on a practical automation of reasoning reduced to a propositional calculus.

### The role of *affectūs* in mechanizing cognition
*From a mechanical mind to a spiritual automaton*

A few decades before Leibniz couched his metaphysics in monadic terms at the beginning of the 18th century, the field of physics – understood as a philosophical inquiry inherited from Aristotelian tradition – took a so-called "mechanical" turn. Although the word "mechanism" bore so many meanings that historians of science and philosophy once envisaged to abandon it,[14] we can call "mechanical philosophy"

this trend of natural philosophy born in the middle of the 17th century that fostered, in opposition to scholastic orthodoxy and Aristotelian hylomorphism, a reappraisal of antique theories of atomism and corpuscularianism. Notably inherited from Epicurus and Democritus, these doctrines are indeed physical theories in a modern acceptation in that they intend to describe matter and its changes by reducing all natural phenomena to the movement of and interaction between microscopic particles or corpuscles whose quantifiable attributes only – size, position, speed, direction of movement – are relevant in order to account for daily life's macroscopic phenomena.

Preceded by Gassendi's and Beeckman's work in the 1630s, then Descartes' in his 1644 *Principia Philosophiæ*, the birth of "mechanical philosophy" can be attributed to Robert Boyle who published *Origin of Forms and Qualities According to the Corpuscular Philosophy* in 1666. It is indeed Boyle who, building on previous works, devised this new theoretical framework within which are unified corpuscular thoughts as different as Mersenne's and Hobbes'.[15]

Mechanical philosophy, as being built on and in opposition to Aristotle's physics, brought about a major epistemological shift notably in the understanding of what is a physical explanation. While for the Aristotelian scholastics the latter amounted to knowing the four causes of one thing's being and change – notably its formal cause –, mechanist theory, on the contrary, concentrates on the matter of nature: it is a theory of matter that only takes into account the sole efficient or moving cause and conceives of physical explanation as the knowledge of the laws of nature.[16] Such a mechanist explanation, soon even mechanical, becomes the scholars' preferred mode of intelligibility for natural phenomena.

This mechanical philosophy also aimed at unifying the field of natural philosophy by subordinating the entirety of savant practices to its reductionist theoretical system. Indeed, "mechanism" has so many meanings precisely because it intended to pervade the totality of knowledge, and notably the three branches of physics, experimental philosophy, and mechanics.[17] First, mechanical philosophy builds on a materialist ontology that reduces matter and its phenomena to the movement and interaction of corpuscles. Physics is served. Second, this reductionism at once calls for and relies on the metaphor that depicts the universe as a machine or a mechanism, usually a clock, that it would suffice to disassemble piece by piece in order to understand its workings. Engineers, craftsmen, and artists thus have their say in experimental philosophy. Third, if the whole of natural phenomena can be understood in terms of laws of nature in which only corpuscular motions intervene, then the knowledge of efficient causes is itself reducible to the mathematical science of movement. Therefore, mathematical physics, or mechanics, is in charge of describing and predicting the interactions between atoms, thus the behaviour of the world. Mechanizing the world amounts to automating it.

Reading Leibniz's *De Affectibus*, we will come across a certain number of concepts with evocative names such as *actio, mutatio, potentia, vis…* Evocative because these names were not casually chosen by the philosopher but rather form a specific network of metaphors referring to the motion of bodies. More than just rhetoric, these metaphors are endowed with heuristic properties and fully take part in Leibniz's epistemology. More than just a set of figures of speech, this network of metaphors

becomes a fully-fledged analogy between mechanics and a nascent psychology when, in the fifth and shortest fragment, Leibniz claims point blank:

> *Affectus est in animo, quod impetus in corpore* [*Affectus* is in the mind what impetus is in the body][18]

If "*affectus* is in the mind what impetus is in the body" then the laws of motion that apply to bodies shall also apply to the motions of the soul. Indeed, the affective theory of cognition that emerges from the last fragments of the *De Affectibus* is modelled on the geometrical mechanics of bodies according to the following pairs of analogies: *affectus* for *impetus*, power, or force; *passio* for *inertia*, *mutatio* for motion.

Psychological determination then follows the same rules as mechanical dynamics: a series of thoughts persists as long as it is not opposed by passion or enhanced by an *affectus* – thus striving towards perfection. This analogy, emanating from a broader mechanical philosophy stating that the phenomena of the natural world can all be reduced to the mechanical interaction of elementary corpuscles, makes the *De Affectibus* into a theory about the dynamics of the mind. Therefore, the human subject being reduced by Leibniz to an object of study, it becomes a natural automaton, its behaviour reduced to deterministic laws of nature.[19] Defining "mechanization as the identification of logical operations with physical processes occurring in a machine", then Leibniz mechanizes cognition and turns the mind into a "reasoning machine."[20] It thus becomes possible, as we will see, to automate cognition through its complete algorithmization.

A quick detour by the history of emotions will enlighten us further on the status of mind in Leibniz's philosophy and its progressive automation in the course of his work. Indeed, a quarter of a century later, in his *Nouveaux essais* written in 1705, Leibniz took a metaphysical stance in sharply distinguishing the concepts of activity and passivity – the French *action* and *passion*. Activity, being the power to act or take action, strives towards perfection and is accompanied by a feeling of pleasure. Passivity on the contrary, is the potentiality to be acted upon and leads to imperfection and pain.[21] In this framework, conscious perceptions are understood as arising from the accumulation of multiple minute, insensible, and unconscious perceptions ("*petites perceptions*"), or inclinations. Sensible inclinations are minute perceptions of disquiet ("*inquiétude*") whose accumulation lead to passions and pain, while distinct intellectual inclinations should lead the subject to take action towards the greater joy: "the knowledge and production of order and harmony."[22]

On account of this metaphysical stance, passion, the accumulation of minute perceptions of disquiet, is a confused thought in conflict with clear thoughts brought about by action. It is only by becoming master of our sensible inclinations, hence of our passions, that we may be led to intellectual action, pleasure, and perfection.[23] Accordingly, reason is conceived by Leibniz as a mere computational system: the balance of a perceived good or evil, weighing perceptions in the process of decision-making so as to take *action* – guided by a sentiment of good and rewarded by a feeling of pleasure – in order to overcome *passion* – that passive feeling of pain and metaphysical imperfection leading to evil.

As the outcome of a mechanical reckoning, action becomes the result of a calculus. Leibniz has therefore progressively transformed his affective theory of cognition into an algorithmic process, his mechanical mind into a spiritual automaton. As Christopher P. Noble recently documented, Leibniz's late automation of cognition precisely derives from his early mechanization of mind:

> […] we can isolate three conceptual features of the mechanical automaton that Leibniz incorporates in the concept of the soul. First, mechanical automata move themselves spontaneously according to the laws of their mechanical structure; this is analogous to the way that a soul moves itself according to its internal principle of motion. Second, mechanical automata and the final causes they exhibit exist as a product of artificial design. […] Third, mechanical automata can act spontaneously yet involuntarily. […] In each case, Leibniz transforms the particular mechanical attribute in question to conform to the nature of the soul as a simple, immaterial entity.[24]

### *Leibniz reader of Descartes*

Now, let us come back to 1679 and try to understand in more detail the role played by *affectūs* in mechanizing cognition in the first place. In fact, why "*affectūs*" at all? In order to understand this peculiarity, we have to resort to the work of the only fellow philosopher mentioned by Leibniz in his *De Affectibus*. Descartes, one of whose dreams was to elaborate a *mathesis universalis*,[25] had indeed devised, while corresponding with Elisabeth of Bohemia, a theory of passions: his well-known *Traîté des passions de l'âme*, originally published in French in 1649. This treatise is itself a syllogistic system, breaking down the passions of the soul into their most elementary components along the lines of a demonstrative scheme made up of an ordered series of proofs of so-called "*articles*" that are akin to logical statements or propositions.[26] Here, the French "*affection*" is understood either as sensible perceptions of the body itself (hunger, pain), as opposed to perceptions of external objects; or, in the last two parts, as the passion related to tenderness. No use of the French word "*affect*" though.

It took the translation of Descartes into Latin – achieved by the 26-year-old jurist Henri Desmarets and published in 1656[27] – for Leibniz, reading the *Passiones animæ*, to encounter and redefine "*affectus*".

The Latin word appears four times in this translation.[28] The two mentions of the French "*affection*" (*Articles XXIV* and *XXV*) were translated as "*affectus*" rather than "*affectio*". Since Descartes had sharply distinguished in French between "*affections*" understood as sensible perceptions of the body, and "*passions*" as intellectual perceptions of the soul, the Latin "*affectus*" should not have been used by the translator for any cognate of the French "*passion*", at the risk of confusing Descartes's distinction, and changing the meaning of his text.

Yet, two other occurrences of "*affectus*" in the translation are to be considered. The first occurrence is in the very title of the treatise, as it is written on the title page of the first part: "*Les Passions de l'âme*" become "*Passiones, sive Affectūs animæ* [Passions, or *Affectūs* of the soul]". It would seem at first that this peculiarity

would have no bearing on the overall translation. Yet the formulation is strong, equating "passions" with "*affectūs* of the soul" through the use of the very specific conjunction "*sive*" – which logical implications we know well for a writer like Spinoza for example. The supposed redundancy of "*affectus*" in the title becomes an inconsistency given that the term was already used to translate the French "*affection*" sharply distinguished from the French "*passion*".

This inconsistency could have passed unnoticed if only, in the very 15-line-long *Articulus XXIV* where he had already translated the French "*affection*" into the Latin "*affectus*", Desmarets had not reiterated in translating a simple "*passions de l'âme*" into the sibylline "*Affectuum vel Passionum animæ* [*Affectūs* or Passions of the soul]". Thus, inverting his earlier translation, Desmarets now equates "*affectūs*" with "passions of the soul". In logical terms, are *affectūs* a species of the genus passion or conversely? Are *affectūs* passions-of-the-soul or are *affectūs*-of-the-soul passions? This chiasma in translation makes it difficult for us to venture telling which is which; and a reader like Leibniz could not miss that.[29]

No sooner than the second fragment does Leibniz borrow definitions from Descartes's *Passiones animæ*, without mentioning it. Although he does so implicitly, some short quotes are *verbatim* and only the third fragment of the *De Affectibus* directly refers to Descartes's work. After a few comments in passing about the Cartesian "*amor Dei* [love of God]"[30] or "*risui et fletui* [laughter and tears]",[31] Leibniz clearly states "*Definitiones affectuum ex Cartesio* [Definitions of *affectus* taken from Descartes]"[32] and then follows a list of such definitions mostly taken word for word from Descartes's *articuli*.

Among these reading notes figures a statement that was later crossed-out: "*Affectus generaliter sumtus est passio animæ* [*Affectus* is generally taken as passion of the soul]"[33] and is later followed by this definition of "*affectus*" attributed to Descartes:

> *AFFECTUS sunt perceptiones aut sensus aut commotiones animae qui ad eam specialiter referuntur, quique producuntur, conservantur et corroborantur per aliquem motum spirituum.* [*AFFECTUS* are perceptions, sensations or commotions of the soul which we relate particularly to the soul, and are caused, maintained and strengthened by some movement of the spirits.][34]

This definition is in fact the *verbatim* copy of Descartes's translated "*Articulus XXVII. Definitio Passionum animæ*". *Verbatim*, except for "*passio animæ*" that Leibniz replaced with "*affectus*" while taking reading notes. Thus, using interchangeably "*passio animæ*" and "*affectus*", we could assume that Leibniz took it for granted that they could be equated according to Desmarets's translation of "*passions de l'âme*" into "*Affectuum vel Passionum animæ*".

Yet in fact, Desmarets's inconsistent translation was so puzzling for a reader like Leibniz that, after this purportedly Cartesian definition, the latter retraced his steps and crossed-out his statement equating "*affectus*" with "*passio animæ*" ("~~*Affectus generaliter sumtus est passio animæ*~~"[35]) in order to remain consistent with an earlier statement that he repeats straight after the definition of *affectus*: "*Perceptiones id est*

*passiones animae* [Perceptions that is passions of the soul]".[36] Leibniz thus corrects Desmarets' translation while reading Descartes' text (see illus. 2).
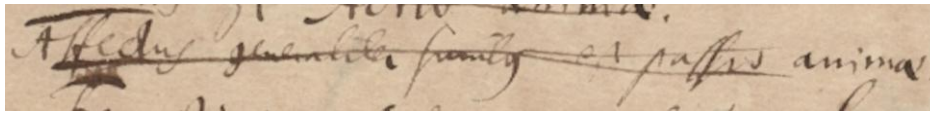


Illustration 2: Detail of the fifth page of the De Affectibus (GWLB, LH IV, 7B, f°3r).

In brief, for Leibniz reading Descartes, *affectus* is a perception effected in the soul, and caused either by the body in itself or by the soul in itself – and not by an external object. *Passio animæ* encompasses all perceptions be they *affectūs* or caused by external objects – but necessarily effected in the soul.

Rather than a fully-fledged commentary of Descartes's treatise, Leibniz draws on the *Tractatus de passiones animæ* as a source of grist for his mill. This critical reappraisal of Cartesian influence, through a peculiar Latin translation, betrays the difference in perspective between the metaphysician and the natural philosopher: although they can be triggered by the senses, perceptions are always purely intellectual according to Leibniz's reading, thus are *affectūs* which are, moreover, necessarily reflexive perceptions caused by the body or the soul.

### Cognition as series of thoughts

Leibniz cannot be content with such a definition of *affectus* though. First, because, on his way towards metaphysics, he has to account for the duality of mind and body. There is indeed a missing link between an *affectus* caused by the body but perceived by the soul; a missing link that would be resolved with his concept of pre-established harmony. Second, and most importantly, because *affectūs* are here understood as a species of *passiones*, the subject passively suffers them. They are, as they later will be in the *Nouveaux essais*, a potentiality to be acted upon. Yet, with his *De Affectibus*, Leibniz wants to account for action and change as is apparent in the subtitle "*Ubi de Potentia, Actione, Determinatione*" that we will now try to understand.

In the very first fragment of the manuscript, in which there is nothing about *affectus* yet, *actio* is defined as the state that causes change (*mutatio*) and *passio* as the effect of change.[37] Later, at the beginning of the second fragment, before resorting to the translation of Descartes, Leibniz defines *affectus* for the first time: "*Affectus est occupatio animi orta ex sententia animi circa bonum et malum* [*Affectus* is an occupation of the soul born from a judgment of the soul regarding good and evil]".[38] Originating from a judgment made by the soul about good or evil, an *affectus* is an occupation, an activity of the soul.

Now, let us jump directly to the fourth fragment, right after the last reference to the *Passiones animæ*. We have come a long way since the hesitant definitional style of the first two fragments and Leibniz's reading of Descartes's translation in the third one. The list of definitions has become a full-grown syllogistic text with a well-defined margin where comments and corrections are neatly ordered –

I will come back on these material considerations later. No more mention of good or evil,[39] *affectus* has become the state of mind that determines series of thoughts; it is an occupation of the mind: "*Affectus est status animi a cogitatione una ad aliam prae alia determinati; vel est animi occupatio* [*Affectus* is a state of the soul determined by a thought, towards another, as a result of another; or it is an occupation of the soul]".[40]

One concept leading to another, Leibniz recovers in the seventh fragment the concepts of *actio* and *passio* that had gone unmentioned since the Cartesian excursus. Defining change (*mutatio*) as the transition of a thing from one state to another that is not originating from the nature of said thing, then *actio* is the power to bring about change and *passio* is the propensity to resist it.[41] Finally, a determination (*determinatione*) being a species of action, an *affectus* becomes the action that brings about change in the mind, leading it to pass from one thought to another.

Thus, with *affectūs* as the driving forces (*potentiæ*), cognition follows what Leibniz calls series of thoughts ("*series cogitationum*")[42] that account for the subject's stream of consciousness. Either linear, branching, or circular, a series of thought may have varying topologies and is all the more appealing for the mind as its ordering rule covers a wider reality.[43] Finally, *perfectio* being defined as the degree of reality,[44] a series of thoughts is all the more appealing to the mind as it is more perfect. Therefore, as we will see, contrary to the passions of the *Nouveaux essais*, *affectūs* are striving towards pleasure and perfection.

No wonder, then, that Leibniz subtitled his work "*Ubi de Potentia, Actione, Determinatione*": at this time, there is for him much more to *affectūs* than simple perceptions or perturbations. Focusing on the modalities of intellectual action, Leibniz makes *affectus* into a centrepiece of cognition in being the action that brings about change in the mind, while *passio* is the propensity to resist this change.[45] *Affectus* is the catalyst of thought, or rather its driving force – as we are about to see, shedding light on the underlying mechanical philosophy.

Lastly, in his ninth and last fragment that can be seen as an opening rather than as a conclusion, Leibniz broadens his theory in order to lay the foundations of an affective ontology, paving the way for his future metaphysics that will nonetheless eschew *affectūs*, eventually. Indeed, in the course of his reflection, while the working notes slowly become a theory, the understanding of series of thoughts ("*series cogitationum*") gradually shifts towards the broader analysis of series of things ("*series rerum*"); Leibniz's metaphysics as a "study of general ontological structures"[46] is here looming. Schepers also vouches for such a trend, arguing that by delving into the *De Affectibus*, we enter Leibniz's "workshop of ideas [*Gendankenschmiede*]" leading to his later *Monadologie*.[47] Even though, according to Roinila, Leibniz's "interest in passions was fired up by the need to explain human behavior in general" and is thus fostered by his work in moral philosophy,[48] we could argue that, as evidenced by his attempt at devising a moral characteristic[49] as well as a juridical one,[50] Leibniz's moral philosophy is subsumed within his all-encompassing and founding metaphysics.

**The role of paper in automating reasoning**

Until now, we only hinted here and there at the manuscript in itself, in its ink-and-paper materiality. Besides these hints, the *De Affectibus* we read so far is the

result of an in-depth editorial work led by the Berlin-Brandenburg and Göttingen Academies of Sciences. Although it provides the researcher with stabilized reference texts and invaluable tools to navigate them – e.g., indexes, cross-references, and classification –, this essential edition – precisely because of the formatting that enables such tools – eschews the very materiality of working papers: the crossing-outs and corrections, the spatial organisation of the folios, their internal referencing system, the use of language and symbols or figures…

Now, in order to understand how Leibniz's practical use of his paper notes shaped his idea of a mechanical cognition, it is necessary to un-edit the manuscript and turn back to the very form of Leibniz's thinking on paper. In this second part, I would therefore like to dwell on a media-historical reading of Leibniz's *De Affectibus* as working papers.

### *A universal archive for a* scientia generalis

First, in order to understand the form of Leibniz's *De Affectibus* and, more generally, its aim, we need to come back to the grand encyclopaedic scheme that we mentioned earlier: his *scientia generalis*. Indeed, Leibniz entertained his whole life the grand project of "recalling the multiplicity of human knowledge to a logical, metaphysical, and pedagogical unity."[51]

First taught in philosophy and logic in Leipzig, Leibniz soon discovered the heuristic power of the combinatorial methods inherited from Ramon Llull.[52] Later travelling to Paris where he stayed from 1672 to 1676, he was introduced to pure mathematics by the finest scholars of his time.[53] Eventually caught up by the curial mechanisms of the Holy Roman Empire, he had to leave Paris in order to become librarian for the Duchy of Brunswick-Lüneburg in Hannover and Wolffenbüttel. [54]

The years surrounding 1679 and the *De Affectibus* are of absolute relevance to understand Leibniz's combinatorial thought in its social and political context broadly. Indeed, in January 1680, Ernst August of Hanover became Duke of Brunswick and Lüneburg after the death of Johann Friedrich, the third of his elder brothers. The latter had been the perfect patron for Leibniz: well versed in the arts and culture, Johann Friedrich was keen on building and maintaining a great library dedicated to the advancement of knowledge and to the cultural standing of his Duchy. On the contrary, his younger brother Ernst August adopted a completely different perspective on this humanist sensibility: arts and knowledge were only valuable to his eyes if they were useful to his empowerment as a Duke and to the rise of his court's prestige. Pursuing the dream to have his Duchy become the ninth electorate of the Holy Roman Empire – a dream that will become true in 1692 –, Ernst August was less magnanimous towards his courtier's cultural endeavours.

During the first year of Ernst August's reign, though, Leibniz multiplied his letters to the Duke and his ministers in order to ensure his nomination as director of the archives, the enlargement of the library, the creation of a *Kunstkammer* and a *Wunderkammer*, of a medical system, a State education…[55] Among these propositions figures the writing of a history of the Welf dynasty that would provide the Duke with historical and legal arguments to claim ownership of the Duchy of Saxe-Lauenburg.[56] Ernst August would therefore expand his territorial grip within the Holy Roman

Empire and strengthen his chances to become the ninth electorate – a principality with the right to partake in the election of the emperor. In the same vein, twice during the year 1680 did Leibniz wrote the Duke with the intent to build a State archive: in order to write the history of the Welf dynasty, he would need past and present administrative documents that he would put forward as proof of the ducal legitimacy to claim inheritance of the Duchy of Saxe-Lauenburg.[57] Leibniz's grand encyclopaedic scheme is already tightly tied to the exercise of power.[58]

These archival proposals directed to Ernst August shed light on how Leibniz conceives of the archive because, in this peculiar diplomatic context, he was led to reflect upon the role libraries play in the order of knowledge as well as in the social and political orders. According to the librarian philosopher turned Baconian epistemologist, the advancement of learning is a collective endeavour that requires to centralise and share knowledge. To this end, the library has to be an encyclopaedic collection of all knowledge, equivalent to a universal science because it amounts to "have everything that may be of use [*tout avoir qui fut d'usage*]".[59]

The library – encompassing the archive – is therefore one of the fundamental tools of an inventory of things that gives material to the general science. For Leibniz, the scholar's work is also, and probably in the first place, the work of a librarian – and archivist – whose practices are the acquisition, organisation, reconfiguration, and transcription of knowledge – archival know-how and practices that are akin to the naturalist's who collects, observes, classifies.[60] Indeed, in order for the library – and the archive – to be accessible in a quick and efficient manner, it has to be provided with the research and navigation tools allowing the reader to find the elements relevant to the resolution of the problem at hand.

For Leibniz, the library – and the archive – is conceived as a "cosmos of knowledge [*cosmos du savoir*]"[61] revealing at first glance the whole of acquired knowledge – a glance made possible by the very architecture and arrangement of the physical space that is a library.[62] Therefore, Leibniz's librarian practice is far from being anecdotal in his studies and his way of thinking. Convinced of the unity and universality of knowledge, and driven by the idea to put its utility at the service of a common good, Leibniz's encyclopaedic endeavour relies on a general science that we are about to deal with, as well as on an exact and general inventory of all acquired information and available knowledge.[63]

Leibniz is therefore particularly aware of the power of written inscriptions when they can be mobilised, he who devoted great care to maintaining in order and in good working conditions his own archive and personal library, he who contributed to the creation and maintenance of the Lower Saxony State library – now Gottfried-Wilhlem-Leibniz-Bibliothek – and to the creation of an administrative and political archive for the Duke Ernst August. He was equally aware of the variety and complexity of the material and intellectual operations that govern the elaboration and perpetuation of an archive and its encompassing library; operations allowing for the conservation but also the consultation of written inscriptions and thereby make them mobilisable, that is useful and practical.

It is of utmost importance to understand the mechanization of cognition within this diplomatic context – and more generally to conceive of Leibniz's thought

as a whole. Indeed, this project of automation goes hand in hand with his general science, that in turn relies heavily on the structure and workings of a hypothetical universal archive – starting with his own personal archive. Until his death, Leibniz relentlessly worked on his idea of a universal library, that is an all-encompassing encyclopaedia of knowledge – an ambitious project relying on his metaphysics and embodying his ideal of a *characteristica universalis*.

Leibniz's *scientia generalis* is supposed to be the science of sciences,[64] in other words the general method for the discovery and invention of all possible knowledge.[65] It relies on the *characteristica universalis*, being in turn a hypothetical universal language based on the analytical and exhaustive inventory of all simple, discrete, and universal concepts – the building blocks of thought and being which it would suffice to combine according to a set of (onto)logical rules in order to obtain all possible complex concepts, hence all possible grammatically correct propositions. Ultimately, the rules of logic would then allow for the determination of the validity of each and every one of these propositions by assigning them a unique and definite truth value.

Relying on such an exercise to construct being and thought through the combination of (onto)logical building blocks, there would be no more possible controversies in any discipline for, according to Leibniz's wish, two opponents could settle their argument by appealing to the power of the *characteristica*.

### The paper materiality of the De Affectibus

The argument I would like to put forward now is that there exists a link, a reciprocal influence, between Leibniz's combinatorial metaphysics as we just depicted it, and his practical use of ink and paper. To that end, I will now dwell on a material and media-historical reading of the *De Affectibus* as handwritten notes, thus delving back into Leibniz's archive rather than relying on the Academies' transcription.

It is well known that languages and the ways in which we use and deliberately twist their linguistic structures determine the field of *what* it is possible to write, therefore to know, and *how* it is known[66] – in other words, that thought is shaped by its linguistic *medium*. This can be well observed and documented by paying attention to the many crossing-outs, corrections, and additions scattered over Leibniz's manuscript.
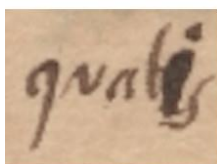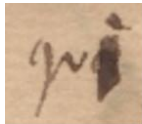


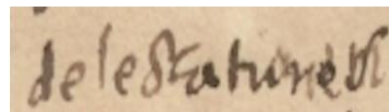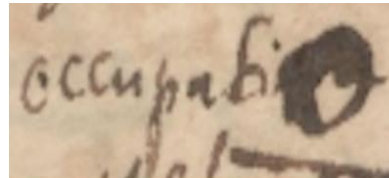Illustration 3: Character substitutions (detail of f°1r).



Illustration 4: Declension changes (detail of ff°2r and 2v).

By subtracting or adding a letter here (see illus. 3), changing a declension there (see illus. 4), and substituting a word for another of the same inflectional paradigm (see illus. 5), Leibniz can alter definitions and propositions extremely locally, even down to a single character – or "symbol" in his own terms. The very combinatorial aspect of the Latin alphabet and the declensive nature of the Latin language determine the rules that Leibniz follows or bends in order to think at the lowest of scales. An intermediary scale is reached in the composition of a proposition in compliance with the rules of Latin grammar: conjugated verbs (*est*, *eo*), prepositions (*ab*, *ex*, *ad*), and conjunctions (*ergo*, *vel*, *seu*) are used as symbolic operators acting on conceptual variables by articulating them.
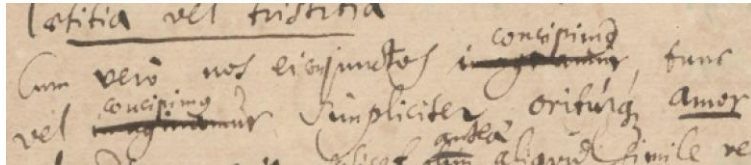


Illustration 5: Word substitution (detail of f°4r).

The next change in scales is operated by renaming a series of words with one single word – *i.e.* by defining a complex concept as the logical and grammatical combination of simpler ones (see illus. 6). Relying on combinatorial processes, such a layered approach allows for a nested structure that can easily be analysed into its constitutive parts, or building blocks, and in turn synthesised into more complex working propositions. It is this very shuttling back and forth between analysis and synthesis that would allow two philosophers to settle their debate by simply calculating the grammatical correctness of their propositions and their sound grounding in simple true concepts.

This cumulative construction of a systematic and coherent body of concepts grounded in seemingly apodeitic definitions has to be understood in material terms for it is embodied in, and permitted by, the combinatorial manipulation of ink inscriptions on the surface of the paper. Indeed, at every scale, Leibniz is able to intervene on his theory in the making by adding, altering, or removing definitions or parts of them (see illus. 7). Therefore, there has to be space intentionally left available on the surface of his folios for Leibniz to play with inscriptions; and this he does by writing in between the lines or, more often, by using the large margins that he never fails to open on the right-hand side of every page. No later than the second folio, Leibniz substantially makes use of his margin to redefine a set of concepts in different terms – "*an sic potius*" (see illus. 8). Note that these new definitions also result from combinatorial tweaking and that these nested definitions and redefinitions leave open the possibility of substituting one inscription for another, in accordance with Leibniz's late metaphysical principle of the identity of indiscernibles.
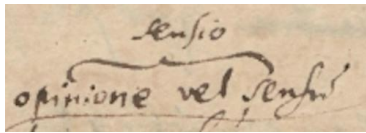
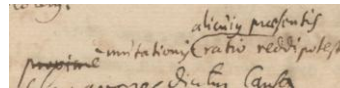Illustration 6: Renaming (detail of f°4r).



Illustration 7: Subtraction and addition (detail of f°1v).
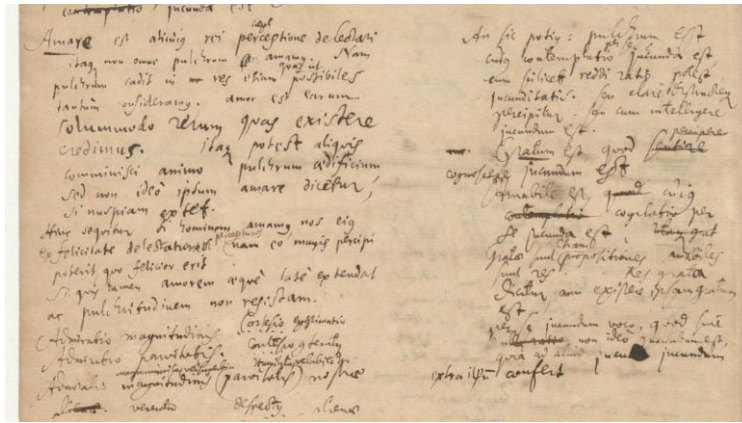


Illustration 8: Use of the margin (detail of f°2v).

From characters and declensions through words to sentences and propositions, the formatting effect of language on thought is made visible by the open-endedness of this ever-unfinished theory. On the next scale, Leibniz uses propositions as the unit blocks of his reflection. This can be seen from the fact that from the beginning on, he organises his folio in successive blocks of text separated by line breaks and introduced by the concept to be defined, written in bold and underlined (cf. illus. 1). Later in the manuscript, some of these blocks are turned into autonomous entities by being boxed within a thin line of ink, and therefore acquire the ability to be moved around without being altered (see illus. 9). Independently from their linguistic structure, now fixed and supposedly correct, propositions are moved around only according to their logical relationship to one another – they become immutable mobiles on the surface of these working papers.
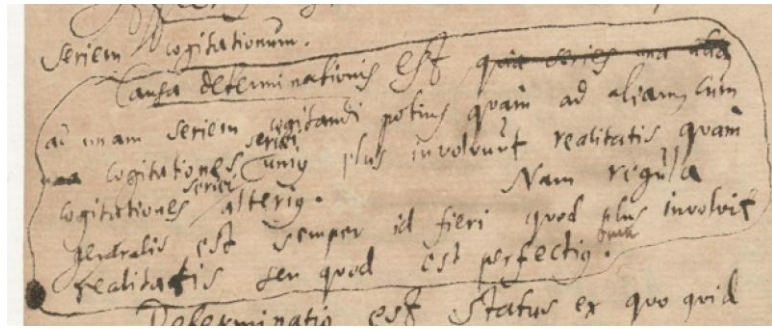
Illustration 9: Proposition as a unit block (detail of f°6v).

These unit blocks are therefore arranged into a reticular structure of growing complexity, as is the organisation of the folios. Propositions are gathered into groups that can, in turn, be moved around, altered, and substituted as is the case on the fourth folio where the sign  is used to refer to a block of definition in the margin (see illus. 10), or on the sixth folio where such an insertion is indicated with the use of a line acting as an arrow (see illus. 11).
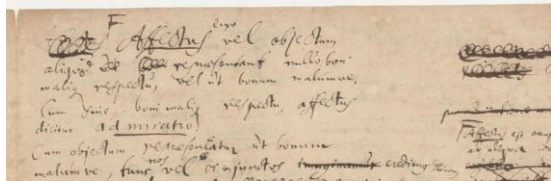

Illustration 10: Referencing the margin
(detail of f°4r).

The growing complexity of Leibniz's analytic and combinatorial system of propositions is even more tangible towards the end of the last fragment where he has to devise a simple referencing system in order to organise his building blocks. In the last three folios, he directly refers to numbered proposition that were demonstrated in the previous pages (see illus. 12) – note that these folios are those where his theory of mind turns into a full-blown ontology, series of thoughts becoming series of things. He also defines a set of four astrological symbols (Sun , Moon , Venus , and Mercury ) that each stand for specific propositions and therefore can be used to refer to them until the following page. This introduction of symbols, shorn of their astrological meaning to be used only as means of
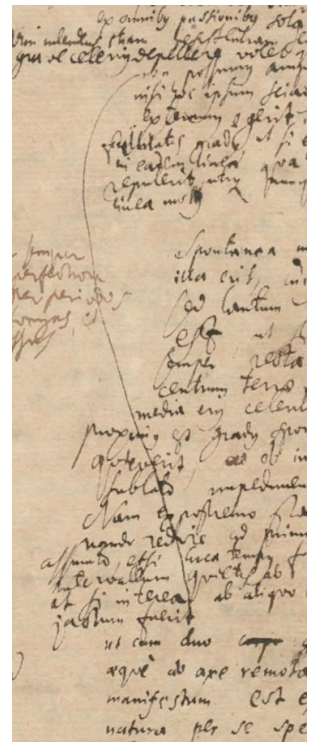

Illustration 11: Detail
of f°6v.

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indicating propositions, gives birth at the end of the same folio to a peculiar proposition where the role of Latin syntagmata acting as logical operators becomes clearer, and where said symbols are akin to mathematical notations – the proposition tends toward a mathematical equation (see illus. 13).

Again, this nested combinatorial structure is made visible at a higher scale in Leibniz's organisation of his own archive. Indeed, the margin is not the only tool used for the rearrangement of his inscriptions. As is the case for most of his personal archive, Leibniz used a series of large folios folded in two so as to make paper folders (in-folios) containing one another. Within this nested but open structure, the philosopher can always add new loose sheets of paper, manipulate them, and reshuffle them as a means to reorganise and shape his thought. More than often, he would as well cut and paste pieces of paper, arrange loose slips, and store them in one of the commonplacing cabinets that were made by Vincent Placcius.[67] For the *De Affectibus*, Leibniz dated and numbered his folios only *a posteriori*, thereby giving his work a title that was not foreseen when he started writing.
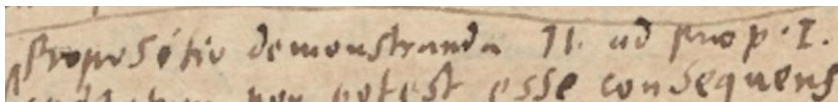

Illustration 12: Referencing a previously demonstrated proposition (detail of f°9r).
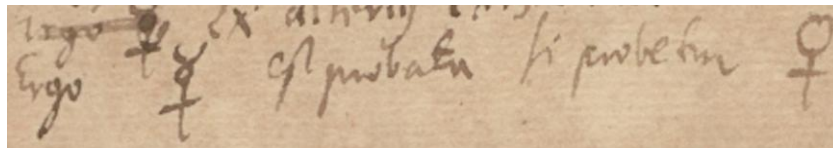

Illustration 13: Using symbols (detail of f°9r).

The first fragment of the collection of working notes on *affectus* written in Latin bluntly starts with a list of conceptual definitions for a philosophy of mind. *Mens*, *cogitatio*, *actio*, *passio*, *voluntas*, and *sententia* are defined one after another in a systematic manner, as a combinatorial structure where more complex concepts are defined by reference to and combination of simpler ones used as building blocks. A combinatorial structure because, as soon as the first folio and much more in those following, Leibniz works and reworks, refines his system of concepts, his systematic philosophy of mind.

From the sixth folio onward, the pieces and blocks that Leibniz moves around grow bigger and more numerous, accumulating and combining with one another. One fragment of the manuscript leading to the following, the first definitions are followed by conceptual queries that are to be treated demonstratively. The style, from purely definitional becomes demonstrational and Leibniz's short work becomes a syllogistic theory.

Defining, refining, redefining simple, discrete, and universal concepts, combining them in turn to produce more complex ones, and finally building with these complex concepts a combinatorial structure that is to become a solid system,

Leibniz is thus laying, with his *De Affectibus*, part of the conceptual foundations for his *characteristica* hence for his *scientia generalis*. And it is all the more salient that *affectūs* play a central role in the unfolding of series of thoughts hence in the unfolding of such computation as that rendered possible and fostered by the *characteristica universalis*.

Ultimately, what Leibniz called "blind thinking [*cogitatio cæca*]"[68] is the self-reliance of symbolic thinking within a set of computational procedures, prescribed by algebraic combinatorics, that enable the analysis of any philosophical proposition, as well as the synthesis by combination of all true propositions. Quite paradoxically, blind thinking relies on the sole consideration of the form of propositions ("*vi formæ*") with no concern for their content. True knowledge achieved this way approaches a fully-developed form of *scientia generalis*, or a general method for the discovery and invention of all possible knowledge.

As we saw, these computational procedures are embodied in scriptural know-how, in the manipulation of symbols, as units of writing, on the surface of paper. They serve as the rules of a grammar of thought that allows for the practical automation of reasoning. Unveiling the rules of Leibniz's spatial and algebraic combinatorics of writing – as revealed on the surface of the paper he used to develop his affective theory of mind –, we are able to better understand how such a peculiar use of paper as a thinking tool shapes this peculiar form of rationality: one that aspired toward a computational reason that renders thought ever more analytic, and the world ever more monadic.[69]

### Leibniz's paper mind

In 1696, Leibniz wrote in a letter to Vincent Placcius: "*qui me non nisi editis novit, non novit*  [who knows me only through my published works, knows me not]."[70] Hence, the wide-ranged scholarship on Leibniz does not only rely on the few books and many articles he published, or on his rich and prolific correspondence, but most importantly it relies extensively on his *Nachlaß*. That is a profusion of personal papers of any sorts – drafts, notes, loose sheets, diaries, annotated books… – that led to the post-mortem publication of most of his renowned works. The extent and the heterogeneity of this *Nachlaß* is such that, since the beginning of the twentieth century, it has been arranged and published little by little in the *Akademie Ausagabe* that is hard pressed to date and label every single slice of paper.

Despite its reliance on such sources, I reckon that the scholarship on Leibniz does not particularly take into account the specific – and material – features of his *Nachlaß*. Here, let us attempt a slightly less literal interpretation of the previous quote and take the word "*editis*" as meaning "edited" in a narrower sense: in order to know Leibniz, it would be necessary, not only to turn to his unpublished work but, moreover, to study his unedited papers, thus to delve into the handwritten materiality of his personal archive.[71]

Indeed, during the early-modern period, the authorial economy of the publication draft is much different from the scholarly economy of grey literature such as the working papers. The manuscript "ready for printing" is the trace of a phase transition in the scholar's work, the operation of solidification or fixation of his or her results for publication then circulation. It is indeed one of the last steps in the making

of an immutable mobile: the form of the production has to be compatible with social as well as mechanical constraints of legibility and organization.

As was documented by Chartier, the editor during the early modern period is almighty.[72] Not to mention the successive works of proof-readers, censors, translators, and finally typesetters, it is along the lines of the process of drafting, printing, and publishing that the scholar becomes an author – if only the publication was not drafted by an amanuensis. Drafting, printing, and publishing thus define a space of negotiations between the scholarly world and the editing world. Negotiations that, by dissociating the scholar from the author, alienate the former's work from the latter's publication. Editing necessitates a long work of intellectual trimming or thought deburring.[73] This alienation the scholar is subjected to before the printing press is nonetheless of epistemological necessity provided that he wants to produce an immutable mobile, that is early-modern knowledge.

On November 14, 1716, Leibniz dies intestate in Hannover, leaving behind him a disordered heap of personal papers, letters, official and administrative documents, bills… These papers are the space where Leibniz's own thought can unfold and, nonetheless, remain plastic or fluid. Indeed, these inscriptions are far from being immutable mobiles that could circulate without alteration[74] – hence exhibiting such characteristics of modern science as neutrality and objectivity, be they written by the author or read by the scholar – but are rather mutable immobiles – that is these torn papers filled with inscriptions written upside down with crossing-outs, figures, lone words, drawings.

Even though the historian is faced with a static and fixed source, these papers exhibit strong traces of an extremely dynamic thought process that is far from being linear. We can follow Leibniz's reflection hesitate, try, follow a path that will soon reveal to be a dead end, then retrace its steps to a crossroads where it can make another choice. Some other times, an epiphany strikes and it may seem that traces appear where there was no path before.

Therefore, working papers eventually reveal themselves as bearers of an embodied and tacit knowledge that has taken the form of written inscriptions through the bodily gestures of eyes and hands. Working papers are not a simple exteriorization of the mind; they are rather a complex externalization of it: without paper and ink, scholars would not be able to think the way they think. Working papers are not traces of thinking, they are thinking.[75]

Then if we bluntly transcribe manuscripts, even respecting the layout, keeping the corrections, copying the drawings, we are bound to lose too many inscriptions worth studying. Then what I am particularly interested in are all these tiny clues and small traces *lost-in-transcription* and that are symptomatic of a form of thinking. Working papers may thus help us depict the work of early-modern scholars as constrained and enabled by the materiality of their paper minds.

Leibniz was acutely aware that inscriptions are not simple intermediaries, not only transitional traces or temporary media, not only supplements to memory or communication tools. They do not just "alleviate" cognitive practices, but are rather a tendency, a leaning or a disposition of the scholar's mind and body, they are an intellectual as well as a manual practice.

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Insisting on their medial structure, working papers can be construed as *camere obscure* closed in on themselves and at once open onto the world, for "only through the looking glass of some paper sheets – be they a travel journal or a notebook – are we able to contemplate the world and see the light of nature."[76] And indeed, the Hobbesian idea that thoughts cannot exist without the sensible support of "signs" – written inscriptions on material media – has always pervaded Leibniz's work.[77]

Strongly influenced by Ramist spatialization of knowledge, the reappraisal of atomistic philosophies, and Lullist combinatorics as well,[78] Leibniz thus readily externalized his *trains* of thought, setting them down on paper as a way to present them to the senses. Yet, writing is not a simple transcription of speech on a contingent material ground; it is more *and* less than that. By spatializing thoughts into a different *medium*, the heuristic use of paper opens the mind to a radically different topology than that of stream of consciousness: trains become assemblages of thought, and assemblages become ideas. Paper thus becomes a prosthesis to the mind, the scholar's material site of thought. Intellectual activity unfolds through many material practices and operations that we can trace on the working notes, betraying the practice-ladenness of theory. In other words, once thought to be immaterial and purely theoretical, Leibniz's mathematics and philosophy turn out to be concretely tangible and practical, as well as deeply-rooted in the materiality of pulp and ink.[79]

Leibniz attempt at theorizing a mechanical reason cannot therefore be properly understood without having recourse to the material substrate of an ink-and-paper combinatorics that reveals his attempt at automating reasoning. Indeed, between April 10th and 12th 1679, on the surface of his working notes, Leibniz strove to get rid of the last traces of a residual orality in his thinking by using symbols that could not be read anymore. This rooted Leibniz's reason in paper, more specifically in writing. Leibniz's supposedly immaterial and theoretical philosophy is therefore embodied in a practical economy of thought that relies on piecewise scriptural know-how. Insert, extract, cross-out, move around, superimpose, cut, paste, erase, archive, list, arrange, tabulate: these are the operations of Leibniz's practice of theory. [80]

As we have seen, the linguistic, the logical, and the material – or spatial – structure of the folio are but the three faces of Leibniz's piecewise and combinatorial way of thinking. The form of cognition he theorizes as mechanical series of thought unfolding along different topologies is shaped by his material use of ink and paper, and reciprocally. Thought and paper, theory and inscriptions are isomorphic for they are inextricably entwined, allowing, shaping, and constraining each other. These working papers are Leibniz's paper mind: there can be no thinking without writing, there is no mind without ink, paper, and quill. As Eberhard Knobloch already noted when studying a series of mathematical papers: "For [Leibniz], thinking was thinking *in* writing. Text was his instrument of thinking."[81] Thus, if *affectŭs* played a central role in the theoretical mechanizing of cognition, reciprocally, paper played an essential role in the practical automation of reasoning.

**Conclusion**

During the early-modern period, due to the boom in the production and circulation of writings of all kinds, erudite readers in Europe had the feeling to be drowning in words and inscriptions.[82] In 1680 still, Leibniz himself complained in his pessimistic "Préceptes pour avancer les sciences" about the dangerous profusion of books and authors.[83] Numerous paper technologies were invented and put to use in order to facilitate the collection, synthesis, and organization of information:[84] manuals and collections, dictionaries and encyclopaedias,[85] index cards,[86] and files.[87]

On the one hand, this progressive transition from a culture of recollection to a culture of oblivion, symptomatic of modernity for Yeo,[88] translates into a shift in the status of writing: from simple tool dedicated to enhance memory, it becomes a genuine extension, and externalization of it. On the other hand, the many paper tools and associated practices devised to navigate such a paper realm furthered the analytic trend, initiated centuries before, that increasingly allowed for piecewise consultation and compilation of bits of information.

Although he has one of Placcius' commonplacing cabinet, Leibniz uses the surface of his working papers with great freedom, almost unconstrained by the humanist manuals on note-taking that backed the practice of Baconian science. Aiming at gathering and unifying all possible knowledge in a universal encyclopaedic library, responding to the diplomatic needs of a general archive playing the role of inventory of all particulars, he was convinced of the necessity to automate reasoning as a way to cope with information and produce knowledge, *i.e.* to shift from knowledge management to an information economy. Using loose sheets rather than bound notebooks, getting rid of headings and topics, widening his reflection to the combinatorial possibilities opened by the bidimensionality of paper, Leibniz turns his working papers into paper minds – that is thinking tools or cognitive prosthesis rather than simple paper memory or repositories.

Going hand in hand with his conceptual mechanization of cognition, this new way of using paper as a thinking machine – an analytic and combinatorial one – was made possible by a wider change in practices that led from the notebook as a memory aid to a simple repository, a forgetting machine.[89] Following Cevolini and shedding light on the Leibnizian *pas-de-deux* between material and intellectual – that is on the isomorphism between a practical automation of reasoning and a conceptual mechanization of cognition –, I tried to show that the early modern transition from knowledge management to information economy "must be re-described as a shift in the structural coupling of communication from consciousness to machines."[90] At this stage, the demonstration is incomplete and would need a more thorough study of the emergence of Leibniz's general analysis by providing a more detailed archaeology of his technical *medium* of thought.[91] The present paper can therefore be conceived as a plea for a media-historical approach of Leibniz's working papers taken as such that, overcoming the divide between hardware and software, between history of technology and history of mathematics, would allow us to unearth his quill-and-paper algorithmic thinking.

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[1] Pasini, E., "Segni e algoritmo nell'analisi leibniziana", in *Geometria, Flussioni e Differenziali. Tradizione e innovazione nella matematica del Seicento*, ed. M. Panza and C.S. Roero (Naples: La Città del Sole, 1995), 329–352.

[2] Rabouin, D., "Introduction", in Leibniz, G.W., *Mathesis universalis. Écrits sur la mathématique universelle*, ed. D. Rabouin (Paris: VRIN, 2018), 39sq.

[3] *Quo facto quando orientur controversiae, non magis disputatione opus erit inter duos philosophos, quam inter duos Computistas. Sufficiet enim calamos in manus sumere sedereque ad abacos, et sibi mutuo (: accito si placet amico :) dicere: calculemus.* [If controversies were to arise, there would be no more need of disputation between two philosophers than between two calculators. For it would suffice for them to take their pencils in their hands and to sit down at the abacus, and say to each other (and if they so wish also to a friend called to help): let us calculate.] (Gottfried Wilhelm Leibniz, "De arte characteristica ad perficiendas scientias ratione nitentes," in *Leibniz: Sämtliche Schriften und Briefe (Akademie–Ausgabe)* (thereafter AA)*, Reihe VI, Band 4, ed. H. Schepers, M. Schneider, G. Biller, U. Franke, and H. Kliege-Biller (Berlin: De Gruyter, 1999), 909–915, 913.)

[4] Such a reductivism was not widespread during the 17th and 18th century and only Hobbes and Leibniz shared this view then (Jones, M.L., *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago: Chicago University Press, 2016), 4–5).

[5] "Algorithm" is a word Leibniz himself uses in his correspondence as soon as the 1670s to characterize a certain method of thinking. Summarized by Marciszewski on the basis of two letters from 1675 and 1678, "an *algorithm* is a recipe for a procedure pertaining to a definite class of tasks (e.g., addition of sequences of figures), which in each case guarantees the obtaining of the correct result after the performance of a finite number of operations" (Marciszewski, W. and R. Murawski, *Mechanization of Reasoning in a Historical Perspective* (Amsterdam: Rodopi, 1995), 108). Later, Leibniz used it to describe his newly invented mathematical analysis in an article published on August 23rd, 1694 in the *Journal des sçavans*. See also Schrecker, P., "Leibniz and the Art of Inventing Algorisms", *Journal of the History of Ideas* VIII/1 (1947): 107–116.

[6] Jones, M., (2016). Although only Hobbes and Leibniz embraced it during the 17th century, the will to automate wisdom by developing a fully-fledged propositional calculus reducing the mind to a simple reckoning machine was later renewed, starting the 19th century, by pervading dreams of computers and universal machines.

[7] Kittler, F., *Aufschreibesysteme 1800/1900* (Munich: Wilhelm Fink Verlag, 1985).

[8] Histories of computing and computation often start with the figure of Leibniz (Davis, M., *Engines of Logic: Mathematicians and the Origin of the Computer* (New York: Norton, 2000)), seen ever after as a "saint of cybernetics" (Wiener, N., *Cybernetics: or Control and Communication in the Animal and the Machine* (Cambridge: MIT Press, 1985)), "the patron of computationalism" (Golumbia, D., *The Cultural Logic of Computation* (Cambridge: Harvard University Press, 2009), 8), and as "the godfather of the modern algorithm" (Steiner, C., *Automate This: How Algorithms Took Over Our Markets, Our Jobs, and the World* (London: Penguin, 2012)).

[9] Gottfried-Wilhelm-Leibniz-Bibliothek (thereafter GWLB), Leibniz Handschriften (thereafter LH) IV, 7B, 5, Bl.1—10.

[10] Gottfried Wilhelm Leibniz, "De Affectibus", in AA, VI, 4, 1410–1441.

[11] Jones, M.L., *The Good Life in the Scientific Revolution: Descartes, Pascal, Leibniz and the Cultivation of Virtue* (Chicago: Chicago University Press, 2006), 250.

[12] GWLB, LH IV, 7B, 5, Bl.15–24.

[13] For Leibniz, human beings are distinguished from animals in that they have a rational soul, *i.e.* a mind. I will therefore use soul and mind interchangeably.

[14] Garber, D. and S. Roux, "Introduction", in *The Mechanization of Natural Philosophy*, ed. D. Garber and S. Roux (New York: Springer, 2012), xi–xviii.

[15] Garber, D., "Remarks on the Pre-history of Mechanical Philosophy", in *The Mechanization of Natural Philosophy*, ed. D. Garber and S. Roux (New York: Springer, 2012), 3–26.

[16] Joy, L.S., "Scientific Explanation from Formal Causes to Laws of Nature", in *The Cambridge History of Science: Vol.3 Early Modern Science*, ed. L. Daston and K. Park (Cambridge: Cambridge University Press, 2006), 70–105.

[17] Bertoloni Meli, D., *Mechanism: A Visual, Lexical, and Conceptual History* (Pittsburgh: University of Pittsburgh Press, 2019).

[18] Leibniz, "De Affectibus", 1426.

[19] Leibniz may have been influenced by Pascal's manuscripts in conceiving the human being as a natural automaton (Robinet, A., "Leibniz, l'automate et la pensée", *Studia Leibnitiana* 4/3-4 (1972): 285–290).

[20] Marciszewski, W. and R. Murawski, (1995), 77–78.

[21] Roinila, M., "Leibniz on Emotions and the Human Body", *Natur und Subjekt. IX. Internationaler Leibniz-Kongress*, 3 (2011a): 925–936; and Andrault, R., "Passion, action et union de l'âme et du corps. Leibniz face à ses lecteurs cartésiens", *Für unser Glück oder das Glück anderer. X. Internationalen Leibniz-Kongress* 1 (2016): 197–209.
See also Anfray, J.-P., "Leibniz, le De Affectibus et les passions de l'âme." Paper presented at the colloquium "Les Passions de l'âme et leur reception philosophique" held by the Fondation Singer-Polignac, Paris, France, June 11-13, 2014 ; Giolito, C., "L'éradiction d'une argumentation cartésienne : Leibniz à la lecture des Passions de l'âme", in *Descartes et l'argumentation philosophique*, ed. F. Cossutta (Paris: Presses Universitaires de France, 1996), 187–216; Mercer, C., "Knowledge and Suffering in Early Modern Philosophy: G.W. Leibniz and Anne Conway", in *Emotional Minds: The passions and the limits of pure inquiry in early modern philosophy*, ed. S. Ebbersmeyer (Berlin: De Gruyter, 2012), 179–206; Roinila, M., "Uneasiness and Passions in Nouveaux essais II, xx", *Natur und Subjekt. IX. Internationaler Leibniz-Kongress* 3 (2011b): 937–946; Roinila, M., "Leibniz on Hope", in *Emotional Minds: The passions and the limits of pure inquiry in early modern philosophy*, ed. S. Ebbersmeyer (Berlin: De Gruyter, 2012), 161–178.

[22] Ebbersmeyer, S., "Leibniz on the Passions and the Dynamical Dimension of the Human Mind", in *Emotional Minds: The passions and the limits of pure inquiry in early modern philosophy*, ed. S. Ebbersmeyer (Berlin: De Gruyter, 2012), 139–160.

[23] Cognates of the French *affect* or *affection* are nowhere to be seen, though. In the course of two decades, then, the time for Leibniz to finish his *Nouveaux essais*, the Latin *affectûs* entirely disappeared and the French *passion* was relegated to the passive potentiality to be acted upon, leading to pain and suffering.

[24] Noble, C.P., "The Soul as Spiritual Automaton in Leibniz's Synthetic Natural Philosophy" (PhD Dissertation, Villanova University, 2016), 21–22; see also Noble, C.P., "Immaterial Mechanism in the Mature Leibniz", *Idealistic Studies* 49/1 (2019): 1-21.

[25] Rabouin, D., *Mathesis universalis. L'idée de « mathématique universelle » d'Aristote à Descartes* (Paris: Presses Universitaires de France, 2009).

[26] Waldow, A., "Reconceptualising Affect: Descartes on the Passions", in *Before Emotion: The Language of Feeling (400–1800)*, ed. J. Feros Ruys, M. Champion, and K. Essary (London: Routledge, 2019), 199–211.

[27] Adam, C., *Vie & Œuvres de Descartes. Étude historique* (Paris: Léopold Cerf, 1910), 577–580.

[28] The genitive singular form "*affectuum*" also appears on the title page of the index: "*Index Passionum sive Affectuum Anima*".

[29] Henri Desmarets was not particularly versed in the subtleties of a Cartesian philosophy whose linguistic stringencies we know well, and only on request of his father Samuel – then professor of theology at the University of Groningen and praised for his knowledge of Descartes whom he knew personally – did Henri undertake at short notice the task of translating the *Passions de l'âme*, in place of his father.

[30] Leibniz, "De Affectibus", 1416.

[31] Leibniz, "De Affectibus", 1417.

[32] Leibniz, "De Affectibus", 1417.

[33] Leibniz, "De Affectibus", 1417.

[34] Leibniz, "De Affectibus", 1418.

[35] Leibniz, "De Affectibus", 1417.

[36] Leibniz, "De Affectibus", 1418.

[37] Leibniz, "De Affectibus", 1411.

[38] Leibniz, "De Affectibus", 1412.

[39] Which cuts against Roinila's assertion regarding Leibniz's only developing a moral philosophy (Roinila, M., (2015)).

[40] Leibniz, "De Affectibus", 1424.

[41] Leibniz, "De Affectibus", 1428–1429.

[42] Series of thought are defined as a number of thoughts ordered by a given rule (Leibniz, "De Affectibus", 1426).

[43] E.g., a simple association of ideas is only confused whereas a causal chain is clearer and embraces a broader reality.

[44] Leibniz, "De Affectibus", 1429.

[45] Contrary to some Renaissance humanists (Essary, K., "Passions, Affections, or Emotions? On the Ambiguity of 16th-Century Terminology", *Emotion Review*, 2017), *affectūs* and *passiones* are not synonyms here but distinguished concepts used in a systematic rather than in a rhetorical manner.

[46] Di Bella, S., *The Science of the Individual: Leibniz's Ontology of Individual Substance* (Dordrecht: Springer, 2005), 99–100; see also Di Bella, S., "Le De affectibus leibnizien : de la dynamique des passions à la constitution de la substance individuelle", in *Les passions à l'âge classique*, ed. P.-F. Moreau (Paris: Presses Universitaires de France, 2006), 193–208.

[47] Schepers, H., "De affectibus. Leibniz and der Schwelle zur Monadologie. Seine Vorarbeiten zum logischen Aufbau der möglichen Welten", *Studia Leibnitiana* 35/2 (2003): 133–161.

[48] Roinila, M., "Affects and Activity in Leibniz's De Affectibus", in *Leibniz's Metaphysics and Adoption of Substantial Forms Between Continuity and Transformation*, ed. A. Nita (Dordrecht: Springer, 2015), 73–88, 73n1.

[49] Leibniz, G.W., "Letter to Baron von Beuneburg", in *Opuscules et fragments inédits. Extraits des manuscrits de la Bibliothèque royale de Hanovre*, ed. L. Couturat (Paris: Alcan, 1903 []), 29–30.

[50] AA, VI, 1, 346.

[51] Antognazza, M.R., *Leibniz: An Intellectual Biography* (Cambridge: Cambridge University Press, 2009), 6.

[52] Leibniz, G.W., *Dissertatio de Arte Combinatoria* (Leipzig: Joh. Simon Fickium et Joh. Polycarp. Seuboldum, 1666).

[53] Hofmann, J.H., *Leibniz in Paris 1672–1676: His Growth to Mathematical Maturity*, trans. A. Prag and D.T. Whiteside (Cambridge: Cambridge University Press, 2008 [1949]).

[54] If Leibniz is mostly renowned for his mathematical inventions, his philosophical treatises, and his political correspondence, most of his life was in fact officially devoted to the *res bibliothecaria* (Palumbo, M., *Leibniz e la res bibliothecaria* (Rome: Bulzoni, 1993)) in different courts of the Holy Roman Empire. From 1668 to 1673, before his departure for Paris, Leibniz was

librarian for the Baron Johann Christian von Boyneburg and organized and indexed in four volumes the 9,800 entries of the courtly library in Mainz.

[55] Antognazza, M.R., (2009), 214sq.

[56] Antognazza; M.R., (2009), 225–226.

[57] AA, I, 3, n° 27 and n° 40.

[58] In 1678 already, Leibniz had written the Duke Johann Friedrich about his "Thoughts on public administration [*Gedanken zur Staatsverwaltung*]" (AA, I, 2, no 70) and among them, more specifically his "Thoughts on archives [*Gendanken zum Archivwesen*]" (Ibid., no 71). Indeed, the 1648 treaties of Westphalia had brought about the fragmentation of the German common archive (*Samtarchive*) while ensuring the sovereignty of the States of the Holy Roman Empire (Lodolini, E., "Archivio e Registratura (Archivistica e Gestione dei Documenti) nel Pensiero di Leibniz", *Rassegna degli Archivi di Stato* 58/2–3 (1998): 245–267).

[59] AA, IV, 3, p. 350.

[60] Yale, E., "With Slips and Scraps: How Early Modern Naturalists Invented the Archive", *Book History* 12 (2009): 1–36; and Daston, L., (ed.), *Science in the Archives: Pasts, Presents, Futures* (Chicago: The University of Chicago Press, 2017).

[61] Waldhoff, S., "Leibniz bibliothécaire", *Revue de la BNU* 10 (2014): 23–31 ; see also Schneider, U.J., "Quel système de savoir ? Du "jardin des livres" de la bibliothèque du duc Auguste au catalogue de Leibniz", *Matériaux pour l'histoire de notre temps* 82/2 (2006): 8–14.

[62] Garberson, E., "Libraries, memory, and the space of knowledge", *Journal of the History of Collections* 18/2 (2006): 105–136.

[63] Mori, M., (ed.), *Leibniz e la cultura enciclopedica* (Bologna: Il Mulino, 2019).

[64] Or rather, *scientia scientiae* since the vernacular "science" did not exist, yet.

[65] Not to be conflated with his *mathesis universalis*, the Leibnizian concept of a *scientia generalis* has a tumultuous history as well. For details on the links between *mathesis*, *scientia*, and *characteristica* during the period 1679–1684, see Rabouin, D., (2018), 59–60.

[66] Benveniste, É., "Catégories de pensée et catégories de langue", in *Problèmes de linguistique Générale, 1* (Paris: Gallimard, 1976 [1958]), 63–74 ; and Derrida, J., "Le supplément de copule. La philosophie devant la linguistique", in *Marges. De la Philosophie* (Paris: Éditions de Minuit, 1972 [1971]), 209–246.

[67] Blair, A., *Too Much To Know: Managing Scholarly Information before the Modern Age* (New Haven: Yale University Press, 2010), 93 – 101.

[68] Krämer, S., "The 'eye of the mind' and the 'eye of the body': Descartes and Leibniz on truth, mathematics, and visuality", in *Sensory Perception: Mind and Matter*, ed. F.G. Barth, P. Giamperi-Deutsch, and H.-D. Klein (Vienna: Springer, 2012), 369–382.

[69] Garber, D., *Leibniz: Body, Substance, Monad* (Oxford: Oxford University Press, 2011).

[70] Schrecker, P., "Qui me non nisi editis novit, non novit", *Library Chronicle of the Friends of the University of Pennsylvania Library* XX (1954): 23–30.

[71] This somewhat anti-philological movement is akin to Leah S. Marcus' "un-editing" of the Renaissance (Marcus, L.S., *Unediting the Renaissance: Shakespeare, Marlowe, Milton* (London: Routledge, 1996)).

[72] Chartier, R., *La main de l'auteur et l'esprit de l'imprimeur. XVIe-XVIIIe siècles* (Paris: Folio, 2015).

[73] In bookbinding, trimming is the operation consisting in guillotining the bound sheets so that no paper stick out.

[74] Latour, B., "Les "vues" de l'esprit", *Réseaux* 5/27 (1987): 79–96.

[75] As the anthropologist André Leroi-Gourhan put it, instruments are a genuine secretion of the body – and this progressive secretion has a history from the antique arts of memory to contemporary cloud computing –, instruments are exuded organs calling for a genuine biology of technique (Leroi-Gourhan, A., *Le Geste et la parole 2. La Mémoire et les Rythmes* (Paris : Albin

Michel, 1965)). Building on this anthropology, Hélène Mialet studied the case of the physicist Stephen Hawking too often seen as the perfect disembodied scholar dealing with Platonic ideas. She showed instead that he is a distributed-centred subject diffusing in and pervading his wheel-chair, his computer, the diagrams on the blackboard as well as his colleagues, students and nurses. Eventually, Hawking's disability acts as a magnifying glass for the scholar's body and his extended mind. Working papers are themselves nodes in the network of the distributed-centred subject: as exuded organs, they are part of the scholar's extended mind and as such have to be studied carefully (Mialet, H., *Hawking Incorporated: Stephen Hawking and the Anthropology of the Knowing Subject* (Chicago: University of Chicago Press, 2012)).

[76] Bourguet, M.-N., "A Portable World: The Notebooks of European Travellers (Eighteenth to Nineteenth Centuries)", *Intellectual History Review* 20/3 (2010): 377–400.

[77] Antognazza, M.R., (2009), 93.

[78] Vega, A., P. Weibel, and S. Zielinski, (eds.), *DIA—LOGOS. Ramon Llull's Method of Thought and Artistic Practice* (Minneapolis: University of Minnesota Press, 2018).

[79] Although Leibniz's computationalism was initially intended to infuse domains such as moral philosophy and justice, only in the field of mathematics did he fully achieve his programme through the development of his rational calculus of differential analysis. Refining and extending the symbolic notation inherited notably from Viète and Descartes (Serfati, M., *La révolution symbolique. La constitution de l'écriture symbolique mathématique* (Paris: Éditions Pétra, 2005)), Leibniz succeeded in automating calculus procedures and algorithmize the nascent field of mathematical analysis. In addition, fashioning his invention as "blind thinking", Leibniz planted the seeds of a mathematical idealism that still pervades today's epistemology, one that eschews the materiality and embodiment of cognitive reason (Hacking, I., *Why Is There Philosophy of Mathematics At All?* (Cambridge: Cambridge University Press, 2014)).

[80] Tellingly, a recent project jointly led by Siegmund Probst at the Leibniz-Archive, the MusterFabrik, and Fraunhofer IPK aimed at piecing together Leibniz's loose slips of paper using forensic software inspired by methods previously used by the Stasi to recover shredded documents (https://www.gwlb.de/projekte/digitale-rekonstruktion/).

[81] Knobloch, E., "Leibniz and the Use of Manuscripts: Text as Process", in *History of Science, History of Text*, ed. K. Chemla (Dordrecht: Springer, 2004) 51–80.

[82] Rosenberg, D., (ed.), "Early Modern Information Overload", *Journal of the History of Ideas* 64/1 (2003).

[83] Leibniz, G.W., "Préceptes pour avancer les sciences", in *Die Philosophische Schriften*, Band VII, ed. C.I. Gerhardt (Hildesheim: Olms, 1960 [1680]), 159–160.

[84] Note that the word "information" is used by historical actors themselves during the early-modern period and designate, quite vaguely, particulars, specific facts, reports, news, book excerpts… (Yeo, R., *Notebooks, English Virtuosi, and Early Modern Science* (Chicago: University of Chicago Press, 2014), 71.)

[85] Yeo, R., *Encyclopaedic Visions: Scientific Dictionaries and Enlightenment Culture* (Cambridge: Cambridge University Press, 2001).

[86] Krajewski, M., *Zettelwirtschaft: Die Geburt der Kartei aus dem Geist der Bibliothek* (Berlin: Kulturverlag Kadmos, 2016 [2002]); and Bert, J.-F., *Une histoire de la fiche erudite* (Villeurbanne : Presses de l'ENSSIB, 2017).

[87] te Heesen, A., *Der Weltkasten: Die Geschichte einer Bildenzyklopädie aus dem 18. Jahrhundert* (Göttingen: Wallstein, 1997).

[88] Yeo, R., (2014).

[89] Cevolini, A., (ed.), *Forgetting Machines: Knowledge Management Evolution in Early Modern Europe* (Leiden: Brill, 2016).

[90] Cevolini, A. (ed.), (2016), 12–13. Yet, contra Cevolini, I contend that concepts such as the "extended mind" or Leroi-Gourhan's "externalization" are actually the lynchpin of the understanding of such a coupling.

[91] Or an "ecology" of such an "ink-and-paper milieu", see Dumas Primbault, S., "Un milieu d'encre et de papier. Brouillons, notes et papiers de travail dans les archives personnelles de Vincenzio Viviani (1622–1703)", *Cahiers François Viète* III/10 (2021) : forthcoming.