LEIBNIZ AND THE IDEAL OF ADEQUATELY EXPRESSED GENERAL SCIENCE

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> "I have realised that all the human thoughts are reduced to very few, like the simple ones. And if they are given characters, the characters of the derived notions could be formed from here." (G. W. Leibniz)

Abstract: *Being receptive at the epistemological debates which are at the centre of the concerns of the intellectual media of his time, Leibniz goes along with the current of ideas that propose to transform science into a means of theoretical research and aplicative vocation, which should offer impulse to the development of human knowledge, as a whole, too divided and restricted by old and unproductive thought patterns.With extraordinary initiatives, by its manner of holistic conceiving and sometimes of accomplishment as such, he tries to create a programme which will unite metaphysics (extending theology), mathematics and logics, which will supply the language of expression (characteristica universalis) and the means of accomplishment (calculus ratiocinator), conceived in sinergy.A project, even if rediscovered later in some of its underlying facets, through its achievements and remarcable promises, never ends to startle and fascinate the contemporary researchers who still have time to halt upon the sources, if not foundational, at least inspirational and reevaluating.*

Keywords: *universal language, „alphabet of the human thought", encyclopedia, logical calculus, formal inventivity.*

Background

The idea – and ideal – of creating a totalizing science represented in a symbolical and mathematical manner seems to be old and must have been encouraged by the circumstance that enough of the ancient peoples (Phoenicians, Jews, Greeks, Romans, etc.) used the same graphic signs to represent the letters and figures/numbers. Moreover, the latter were understood not only in their purely quantitative aspect of axiologically neutral "units", but they were also invested with qualitative values which were often magical and occult, able to express the essence of reality and to determine always desirable effects, through the manipulation driven by precise norms.

In Europe, the project may be found ever since the Pythagoreans, for which

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the ratios, the combinations and arithmetical equations are not only the principle (*arché*) of the organized cosmos, but also accounts for the close interlacing between the kingdoms of the divine, natural and human. Plato has the same cognitively extended ambitions: episteme means the unlimited exercise of intellection freed from "passion" and "desire", a consistent and unified explanation of the world, structured deductively on the grounds of a reduced number of primary truths.[1] On a neoplatonician line, such an epistemological vision is traced back to Proclos.[2] Human knowledge is not presented, for Aristotle either, as an un-homogenous and unconnected plurality, but as a set of sciences which have analogue principles, the same conceptual apparatus and the same formal configuration.[3] After a short while, Euclid's *Elements* will develop in geometry a remarkable axiomatic system which, subsequently, will not stop from being admired, imitated and extrapolated to other fields.

In the stoical school, Chrysippos and his followers manifested some interest in what will later be called *ars combinatoria*, trying to determine the number of distinct complex sentences that may be created – for instance, based on the use of the conjunctive operation – starting from a mall number of simple sentences.[4] In a similar direction are also headed the efforts of Syrianus, who takes into account quality and quantity criteria of judgment, while Boethius, himself seduced by the promises of systematicity and exhaustiveness, pays attention to the type of modality, quality and number of terms involved.[5]

In an extra-European context, the esoteric doctrines of the Gnostics and cabbalists seek their grounds in what was called *gematria*, a combinatory procedure using both numbers and works with the declared intention of deciphering the hidden causes of things, as well as the obscure attributes or divine intentions. Intellectual interest of the type of arithmosophia may be identified in the developments of some of the Fathers of the Church, such as Augustine, Ambrose and Jerome.[6] In the 11th century, the idea of calculus is found in the works of Garland the Counter, the author of a small treaty called *Computus*. Around the same time, the trigonometric tables set up by the Arab mathematician Al Horezmi, the one whose name will later create the term of *algorithm*, are diffused in Europe.

Wishing to transform theology in a science *more geometrico demonstrata* capable of "convincing" any heretic or pagan – through the evidence of its truths – the French Alain of Lille and Nicholas of Amiens apply in their writings the axiomatic method, exposing the "arguments of faith" in an ordered manner, as

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[1] Léon Robin (1996).*Platon*, Bucharest: Editura Teora, p. 161.

[2] Anton Dumitriu (1975). *Istoria logicii*, 2nd edition, Bucharest: Ed. Didactică şi Pedagogică, p. 816.

[3] Jonathan Barnes (1996).*Aristotel*, Bucharest: Humanitas, pp. 51-52; cf. Robert Blanché (1970).*La logique et son histoire d'Aristote* à *Russell*, Librairie Armand Colin, Paris, p. 51.

[4] William Kneale; Marta Kneale (1974).*Dezvoltarea logicii*, vol. I, Cluj-Napoca: Ed. Dacia, p. 179.

[5] A. Dumitriu (1975), p. 282, p. 287.

[6] Alexandrian (1994).*Istoria filozofiei oculte*, Bucharest, Humanitas, pp. 120-122 *passim*.

definitions, postulated, dissociations and assertion-deducing concatenations.[7] Towards the end of the Middle Ages, the Spaniard Raymond Lully develops an ingenious *ars magna*, understood as a general and supreme science meant not only to discover the (explained) "principles" and the (defined) "initial terms" of all intellectual disciplines, but also to combine them mechanically in order to build a virtually unlimited and complete set of truthful assertions. Then and subsequently, Lully's technique finds many admirers and followers, among them being more or less illustrious names, such as Giovanni Pico della Mirandola, Jacob Faber Stapulensis, Nicholas of Kues, Bessarion, Johannes Trithemius, Cornelius Agrippa von Nettesheim, Giordano Bruno, Iulius Pacius.[8]

After Roger Bacon had dreamt in the 13th century to a total synthesis of philosophical, scientific and religious knowledge which would constitute a true bond of coherence in an "universal society"[9], in the 18th century, René Descartes proposes the conception of the *mathesis universalis*, a "science" which, through its analytic technique, was meant to provide the methodological key to a large range of investigations in various perimeters, apparently divergent – from astronomy to music, from mechanics to geometry, from optics to metaphysics – all reunited under the species of "order and measurement".[10] At the same time, John Amos Comenius was meditating to *pansofia*, a comprehensive wisdom which would reunite within it a vast set of knowledge, organised mathematically and conveyed through a universal language. [11] During the same baroque century, starting from suggestions from the work of the Stagirite, Bartholomew Keckermann saw logic as a *system* of theoretical construction in the service of any discipline seeking harmony and self-rigour.[12] Animated by the desire to set the basis for a *characteristica universalis*, Joachim Becher and Athanasius Kircher proceeds to assigning numbers to the Latin words and to those in other languages, and then, according to strict rules, write texts expressed in figures and likely to be "read" by any person who knows the codifying conventions set up, irrespective of the ethnical and linguistic space to which such person belongs. [13] Similar intentions may be found in the works of English John Wilkins and George Delgarno, both of them convinced that a language built on simple principles and having a uniform grammar would considerably facilitate inter-human communication, in general, and the communication between scholars, in

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[7] Étienne Gilson, *Filozofia în Evul Mediu. De la începuturile patristice până la sfîrşitul secolului al XIV-lea*, Bucharest, Humanitas, 1995, pp. 288-289; p. 293; cf. Emile Bréhier (1997).*Histoire de la philosophie*, vol. I, 8ème éd., Paris: Quadrige/P.U.F., pp. 528-529.

[8] W. Kneale, M. Kneale, (1974), p. 261; cf. R. Blanché (1970), pp. 165-166

[9] Donald Rutherford, *„Philosophy and Language"*. In Nicholas Jolley (ed.), *The Cambridge Companion to Leibniz*, Cambridge, Cambridge University Press, 1995, p. 233.

[10] John Cottingham, *Raţionaliştii: Descartes, Spinoza, Leibniz*, Bucharest: Humanitas, 1998, p. 57.

[11] Constantin Noica, *„Elemente pentru o scientia generalis la Leibniz"*. In *Concepte deschise în istoria filozofiei la Descartes, Leibniz şi Kant*, Bucharest: Humanitas, 1995, pp. 75-76.

[12] André Robinet, *„Lexicographie et caractéristique universelle"*. In Abel Günter, Engfer Hans-Jürgen and Hubig Christoph (eds.), *Neuzeitliches Denken. Festschrift für Hans Poser zum 65 Geburtstag,* Berlin: de Gruyter, 2002, pp. 169-170.

[13] Paolo Rossi, *Logic and the Art of Memory. The Quest for a Universal Language,* Chicago, University of Chicago Press, 2000, p. 73.

particular.[14] In Oxford and London, small intellectual groups concerned with *pansofia* (general knowledge) are set up, the mutual connections causing them to be reunited under the collective name of "Invisible College".

At that age, the conviction that the power of science depends on the manner in which it is expressed is shared, hence the search for the originally-Adamic universal language, before Babel (frequently associated to Hebrew) or at least the desire to rebuild it, even though artificially. Suggested by the construction of Euclid's *Elements*, the requirement of reflection and exposure conducted *more geometrico* determined Baruch Spinoza to write the main chapters of his *Ethics* on the last of demonstration of theorems and corollaries starting from definitions and axioms. Not without a certain naivety which credited the words of the natural languages with the operational function of the numbers, he may have through that he may convert the language of philosophy into "verbal mathematics".[15] From the standpoint of nominalist empiricism, which claims the primacy of experience in knowledge and the purely conventional character of the linguistic-semiological premises on which human thoughts are exercised, the English Thomas Hobbes tested the reasoning as a manipulation of signs and a calculus, which may be reduced to the operations of addition and subtraction performed on the notions and sentences, "ideas" in general. Thus, the science became a mechanical game - directed by strict rules - with symbols, a labour consisting in finding the consequences resulting from the passage from one linguistic structure to another.[16]

Commitments on one's own road

These are, in summary, some of the theoretical moments which anticipate and (eventually) prepare the outstanding contributions belonging to Gottfried Wilhelm Leibniz. Intimately reverberating and solidary with the innovating spirit of the time he lived in, it would have been impossible for him to remain indifferent to such concerns. He will adopt them diligently and dedicate to them reflections which spread throughout his intellectual career; he will diversify, nuance and deepen them, enriching them in an unprecedented and daring manner, assuming positions which, critically compared to tradition and anticipating later developments, are often close to genius. The thousands of manuscript pages kept in the library of Hannover, published only posthumously – and, especially, too late – are a direct testimony to a mind ahead of its century, which managed to generate perplexity among the contemporary logistics scholars, who found their starting points and ongoing labour in the ideation of an illustrious predecessor, even suggesting fruitful investigation paths.

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[14] Laurence Jonathan Cohen, „On the Project of a Universal Character". In James Logue (ed.), *Knowledge and Language. Selected essays of L. Jonathan Cohen*, Dordrecht: Kluwer, 2002, p. 6.

[15] George Steiner, *Language and Silence*, 11th ed., London/Boston: Faber and Faber, 1990, p. 38.

[16] Cees Leijenhorst, „Insignificant Speech: Thomas Hobbes and Late Aristotelianism on Words, Concepts and Things". In Eckhard Kessler and Ian Maclean (eds.), *Res et Verba in der Renaissance*, Wiesbaden: Harrasowitz Verlag, 2002, p. 345.

What model should be observed and valorised? With a constant interest in the field and as a creator of infinitesimal calculus, he praises himself the higher virtues of mathematics, the representation of clarity and evidence, of simplicity and concision, of rigour and precision, of safety and efficiency of though, as well as the ideal of the intelligence determined to supervise itself while being exercised. Engaged in the effort to explore the world, such science strives from the very beginning to discern between reality and appearance, truth and falsity, certainty and illusion. On the background of rationality asserted as *princeps* value, it wants to be as emancipated as possible from the interference and tribulations – both disturbing and mystifying – of the various (and variable) human sensitive and affective dispositions. Mathematics, together with its analytic procedures and its formal-deductive structure in which any assertion is demonstrated in a stringent manner and without any shred of doubt, represents the highest guarantee of objectivity and certainty of human knowledge, and, at the same time, the means to set up a viable reporting standard for all the sciences. Because, irrespective of their research object, any of them has recourse, in one manner or another, to quantities or ratios which are likely to be expressed in numbers and subject to calculus. Moreover, the Hannover philosopher sees a glimpse of the possibility of extending the scope of such a method up to the rank of a *scientia generalis* in which mathematics and logics go together amicably in order to intellectually manage, not only the Cartesian kingdom of "size", "order and measurement", but also the one of "forms and formulas", i.e. the qualities and relationships (the essences, substances and their properties, the relations of inclusion and identity, congruence and similitude, determination and causality, generation and ingeneration, continuity and discontinuity, need and contingency, etc.).[17]

The new investigation technique may prove to be useful and productive in taking over certain theoretical and practical spaces among the most varied, from mathematics to metaphysics, from moral to jurisprudence, as it would be able to contribute in a decisive manner to solving certain current political and doctrinal issues, such as determining the procedures for choosing the king of Poland or solving the disputes between the Christian states and churches.[18] Even the bitter controversies dividing and poisoning the intellectual or academic environments of the time would definitively end if, based on the science to which mathematics and logics are applied, the opposing interlocutors would simply sit at the table, take the feather in their hands and the use the abacus, and, in the presence of a possible witness, they would start to "calculate" the ideas they support.[19]

In addition, thanks to the ability of the permutation and combinatory calculus to extensively cover the investigated object, the entire approach would have the inestimable virtue of *ars inveniendi* ("art of invention") since the author thinks it would lead to the discovery of truths to which our mind has not yet thought about, thus enlarging – rapidly, considerably and efficiently – the area of

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[17] C. Noica, 1995, pp.108-109.

[18] Franklin L. Baumer, *Modern European Thought. Continuity and Changes in Ideas. 1600-1950*, Macmillan Publ. Co., New York, London, 1977, p. 113.

[19] Wolfgang Lenzen, „Leibniz's Logic".In Dov M. Gabay; John Woods, *Handbook of The History of Logic,* vol.3, Amsterdam/San Diego/Oxford/London: Elsevier, 2004, p. 1.

human knowledge. And then, the *possible* of ideas would convert as it by itself to the reality of the thought systematically and operatively lead until it deciphers the Universe's most hidden secrets. This would be an excellent manner of summoning and forcing the depths of the nature of the divinity and man to reveal and decrypt them, answering the questions that an algorithm-subject and comprehensive mind – even if it is a human and limited one – asks surprisingly, but not less imperatively.[20] Enlarging the perspective, he does not reject even the connections between such incongruous domains as theodicy and politics.[21]

Indisputably, the ideal is generous, but reaching it requires titanic efforts of intellection and innovation, of reconsideration of the previous exercises and exploration of unwalked paths, to which is added the considerable difficulty of surpassing the strictly technical problems. The hyper-optimistic view entwined in his young years makes Leibniz estimate that, if it would be transposed into action by a few "chosen people", the project could be fulfilled within five years; subsequently, as he grows older and more experiences, he becomes more and more reserved, he admits to his own failures and mentions the relative lack of interest of the scholars of the time, then, as he confesses to Sophia of Hannover in a letter in March 1706, he ends up concluding that "humanity is not mature enough" to understand the importance and advantages its achievement could bring.

In the synthesis provided by Umberto Eco (2002)[22], the monumental edifice, at the same time scientific, philosophic, linguistic and logical, forming the program assumed by Leibniz, with repeated attempts of achievement throughout his life, includes four *fundamental moments*: (a) identifying a primitive system of terms organized in an "alphabet of human thought"; (b) building an "ideal grammar", simplified and easy to use; (c) possibly, formulating a set of rules which would direct the character pronunciation; (d) elaborating a lexicon of real signs on which to apply a calculus leading to the automated assertion of truthful sentences. The above division is somewhat didacticist and is aimed at facilitating the understanding, but, according to the opinion of other authors, as well, the above mentioned "moments" are so tight related to each other that setting up borders to separate them is hazardous. It must also be noted that, in the perspective of the reputed Italian semiotics scholar, maybe a little rushed and severe in its reasoning (contradicted by other historical investigations), the only truly relevant contribution is along the line of the last sub-point.

The intention of building the "general science" of encyclopaedic sizes, a science unifying and reconciling a multitude of particular disciplines under the spectrum of the same fundamental principles and of the same *organon* germinates and is fruitful in the philosopher's mind from an early age, finding a first manifestation in the small work *Dissertatio de arte combinatoria*, which is printed in 1666, when Leibniz was barely turning 20. *In nuce,* the "moments" Eco

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[20] Nicholas Rescher, „Leibniz's Interpretation of his Logical Calculi". In *Nicholas Rescher collected papers, vol.10 (Studies in the History of Logic),* Frankfurt, Ontos Verlag, 2006, p. 141.

[21] Gabriela Pohoață, *G.W. Leibniz de la politică la teodicee*. In „Revista de filosofie a Academiei Române", tom LVIII, nr.3-4, 2011, pp.359-371.

[22] Umberto Eco, *În căutarea limbii perfecte*. Iaşi, Polirom, 2002, pp. 216-217.

summarized may already be found and we follow them in the lines already sketched.

The start point is the conviction that all the truths may be deduced from a small number of simple and indemonstrable assertions, and by multiply combining them, complex ideas, assertions the grounds of which may not be questioned as long as the norms of correct derivation are observed, shall be obtained. Each sentence concatenates a subject and a verb, and, as a result, in its practical aspect, the method resided in discovering all the possible verbs of a given subject and of all the subjects for which a certain property may be expressed through a verb, respectively. Of course, applying this procedure also implies finding the most elementary concepts, which cannot be reduced to others and are un-decomposable, representing a first class of terms. They will be noted through signs, the most conformable ones being the natural numbers (interpreted here as "definitions") and, by associating them two by two, other notions, forming a second order, will result. Then, by combining them three by three, terms forming a third category will be achieved, and so on. The compounds thus obtained are symbolically represented by products of the numerical values initially postulated or by fractions in which the numerator indicates the order position of the term in the category to which it belongs and the denominator designates the category number.[23]

The two reverse calculation manners interfering—*analysis* and *synthesis* – are expressed by Leibniz through the arithmetic operations of decomposition in prime factors and multiplication. For instance, if 3 symbolizes "rational" and 7 "animal", the complex term "man" will be represented by the product 21. Reciprocally, given this latter concept, it may decomposed in prime factors of its symbol, reaching the notions of "animal" and "rational" and implicitly to the deduction of the sentence that "the man is a rational animal".[24] The belief – due to traditional logic – that any composed concept must represent a conjunction of attributes (a juxtaposing of common nouns and adjectives) is a harsh simplification of the so subtle processes of human discursiveness and, at the same time, it faces major stales in symbolic representation. The philosopher himself must have realised the insufficiencies and inadequacies of the system he proposed when young and this is why he will return and will obstinately try to perfect it, as it results from a series of other works he published, as well as from the large number of disparate notes which were published posthumously, especially through the praiseworthy effort of editorial and exegetical restitution made at the beginning of this century by Louis Couturat.[25]

In essence, the principles of the first attempt – detecting the primitive concepts, classifying and assigning them numbers, introducing signs to express the combinations and relations between them – will be kept subsequently unaltered, but the accent of the new vision will shift to an organised

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[23] A. Dumitriu, 1975, p. 833.

[24] Marcelo Dascal, *„On Knowing Truths of Reason"*. In Albert Heinekamp, *Leibniz. Questions de logique,* Stuttgart: Steiner Verlag, 1988, p. 31.

[25] *La Logique de Leibniz*, Alcan, 1901 and *Opuscules et fragments inedits de Leibniz*, Alcan, 1903.

discursiveness, understood not only as an algebra calculation, but as a "universal language" able to subsume an encyclopaedia of human knowledge accumulated historically, reconfigured and integrated into a system of signs and operations performed diversely based on them.

Scientia and *characteristica*

The fact that science cannot be indifferent to the manner in which it is expressed was remarked from the ancient times and recurrently, hence the concerns for creating "perfect languages". It must be however specified that the "baroque" century brings an important change in perspective: in the effort of seeking and imposing means of communications as wide and efficient as possible, without fully disappearing, the religious inspiration is considerably reduced, giving way to utilitarian reasons. The tone is set by the protestant, empiricist and pragmatic Albion, where the pretext for rejecting Latin is found, not only as the official language of the Catholic Church, but also so different, syntactically and phonetically from English. Then extrinsic considerations dictate, either mercantile (facilitating the commercial exchanges on a international market in continuous expansion), educational (such as improving teaching in schools and universities, the process of access to studies of the deaf-mutes) or directly scientific (the requirements regarding more appropriate lists for transposing the new findings in the fields of astronomy, physics, chemistry, etc.). As for the intrinsic motivation, it resides in the need to reform natural speech and writing, to free it from its multiple irregularities and anomalies, equivoques and inaccuracies, redundancies and unneeded rhetorical efflorescence, fall into solecisms and barbarisms, hidden prejudices (for Francis Bacon, *idola fori*), to turn it into am accurate vehicle for conveying ideas, which would work in a uniform grammatical and univocal semantic manner, exactly and rigorously, economically and efficiently. Among those denouncing the major lacks, handicaps and limitation of the daily and scholar and academic expression in the British Isles are, *inter alia*, Thomas Hobbes, John Locke, Cave Beck, John Wilkins, George Delgarno, Francis Lodwick, Thomas Urquhart (in a parodist manner), John Webster.

Thus, in the magnanimous intention of *linguistic therapy* manifested now, the interest is aimed not so much at the discovery of a claimed universal ("Adamic") language which disappeared in the meantime, but at simply inventing *a new, artificial, philosophical and/or scientific language*, one which would ensure the full concordance between thought and word, meaning and reference, content and expression. In principle, this must be the bearer of a certain formal-inner "logic" which would be set up beforehand (independently from natural languages), then systematically exploited. According to which rationality model? Of course, one which would make obvious the minimum of incertitude and contestability and then, ever more insisting looks analyze the composition of the mathematical disciplines.[26]

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[26] Dominique Berlioz, *„Langue adamique et caractéristique universelle chez Leibniz"*. In Dascal Marcelo and Yakira Elhanan (eds.)*, Leibniz and Adam,* Tel Aviv: University Publishing Projects, 1993, pp. 153-168.

Including and especially for Leibniz, the symbols are indispensable for cogitation to the extend to which they ensure the intuitive understanding, they guide it and facilitate the intellect's labour, and he even gives such great significance to finding good notations that he believed that even his own discoveries in the mathematical fields are owed to them (for instance, the invention of infinitesimal calculus). Enough of the manuscript schemes kept show us Leibniz's consistent efforts to find the best list of symbols, his attempts stopping successively on the arithmetic figures and geometrical figures, the Chinese ideograms and Egyptian hieroglyphs, the signs used by chemists or astronomers, event the notations used for representing musical sounds.[27]

The general linguistic representation of each concept (of popular or academic use), *characteristica universalis* (in French, *spécieuse générale*) is understood at the same time as a "philosophic language" (in direct relation to real objects) and as a "logical language" (disposing of a rigorous grammar), a "rational writing" which would serve as infallible instrument of the human mind engaged in knowledge. Its comprehensive span entitled exegetes to characterize it as a pasigraphy, a system of writing in which every symbol represents a concept/an idea, not only a word or a sound, this is why it will be intelligible for all the individual of the human species, irrespective of the nation to which they belong and the language they speak.[28]

Algebra provides a good example in the work of building it, but, since it only applies to numbers, is far from the ideal of universality. Or it is necessary to create a characteristic which is able to fix any mental approach and product. This is why Leibniz's efforts will be headed in the direction of substituting the natural languages used in exposing the various sciences by intuitive symbols, with the express purpose of making the relationship between the concepts and the logical operations with them as obvious as possible, so to reproduce as faithfully as possible what is thought, without having to verbalize it. In principle, the graphic formula is likely to express in a genuine manner the subtleness of the idea, while the oral assertion is merely an approximation, more or less accurate. Consequently, on the back ground of the scission stated between speech and writing, the emancipation of the former from the servitudes of the latter is desired, work which is only possible by replacing the phonetic signs with ideographic characters and the empiricist-historical grammar by a rational syntax system. Drawn up in this manner, transformed into "work" which occupies a space on paper, the discourse becomes silent, addressing not so much to the ears as to the eyes.[29] As a commentator noticed,[30] we assist to the shaping of a theory of the language-image (present, for instance, in Wittgenstein's work), in which the name of the designated entity will be somewhat isomorphic with its own definition included in the inventory-list of primitive terms, so that, out of the simple

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[27] C. Noica, 1995, p. 105.

[28] Olga Pombo, *„Leibnizian Strategies for the Semantical Foundation of the Universal Language"*. In Klaus D. Dutz şi Stefano Gensini, *Im Spiegel des Verstandes. Studien zu Leibniz*. Münster: Nodus Publikationen, 1996, p. 167.

[29] R. Blanché (1970), p. 203.

[30] William Kneale, *„Leibniz and the Picture Theory of Language"*. In *Revue Internationale de Philosophie*, nr.76-77, 1996, pp. 206-207.

examination of the symbol used, the informed reader will immediately realise (without having to resort to any dictionary) the structure, properties, relationships and behaviours of the denoted object.[31]

The natural languages serve this purpose too little, since, when subject to a continuous process of abstractization and generalization, they lost contact with the concrete things they originally represented. This is why, in the new artificial language build, the common words must give place to the "real characters", the "figures significant through themselves", the *suggestive signs* and not mere indicators.[32] Of course, the requirement that the symbol resemble exactly the designated entity is difficult to satisfy and then, it will not be possible to avoid a certain arbitrary in choosing them, under the more relaxed condition of keeping the analogy between the two's manners of existing or "forms". Against the conventionalist positions of nominalist essence manifested mainly in the British philosophical environments, Leibniz will accept the existence of the "natural" signs together with the artificial ones, and, in addition, he will consider that the complex symbols will not be the fortuitous products of the imagination exercise, but will be built according to the initially introduced elementary signs and in compliance with strict combination rules. It may be observed that syntactic imperatives are added to those of semantic nature, thus being possible not only to rebuild the entire science on solid grounds, but also to organize the knowledge in vast - yet synthetic and concise - theoretical and demonstrative constructions.[33]

From alphabet to encyclopaedia

Under Lully's older and Descartes' newer influence, the Hannover thinker meditates to the means through which the ideas and the relation between them (no matter how complicated) may be represented and analysed, and the solution he finds consists in decomposing them in simple elements, relatively reduced in number and forming the "alphabet of human thought" (*alphabetum cogitationum humanarum*): an inventory, A catalogue formed of the indefinable primary components, a specific notation, a symbol or an icon corresponding to each one of them and designating them in an absolutely unambiguous manner. Not only will they be easily learned by anyone (without recourse to the dictionaries), but - as virtually organizing particles - they are subject to certain precise norms of composition and/or synthesis, a virtually indefinable number of assertions being obtained by calculation.

For instance, let us follow the approach in *Generales inquisitiones de analysi notionum et veritatum* in 1686. It begins by categorising the terms into "integral" (or "perfect") and partial ("or imperfect") and, whether they are un-decomposable or composed, with autonomous meaning or context-dependent, connection particles or subjects and verbs of judgement, categorematic or syncategorematic, whether they are of external origin (perceptual, such as the notions of colours) or

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[31] George H. Parkinson, *"Philosophy and Logic"*. In Nicholas Jolley (ed.), *The Cambridge Companion to Leibniz*, Cambridge, Cambridge University Press, 1995, p. 212.

[32] Dan Bădărău, *G.W. Leibniz. Viaţa şi personalitatea filosofică*, Ed. Ştiinţifică, Bucharest, 1966, p. 84.

[33] Cornel Popa, *Analiza limbajului la Leibniz, Boole şi Frege*, în *Limbaj, logică, filozofie*, Bucharest, Ed. Ştiinţifică, 1968, p. 91.

internal (rooted in our native heritage: *existens, durans, distans, material, individuum, ego*, etc.), it proceeds with investigating their relations of "coincidence" ("containing") and, depending on the covering, it reaches the taxonomy of the four types of categorical sentences of the classical logics. These are suitable for formally related according to nine "principles" and to consequently acquire a multitude of other certain assertions.

Providing the list of primitive terms of the concerned lexicon, the material on which to perform the combinatory art afterward and from which would result in order a comprehensive set of scientific knowledge represented a constant concern for Leibniz, which he never left during a brilliant intellectual career. As it results from manuscripts such as *Initia et specimina scientiae generalis or De organo sive arte magna cogitandi (both drawn up around 1679 or 1690), in other circumstances,* mathematics serves again as example full of precious suggestions, since, from few figures, all the other numbers are derived.[34]

But, not at all "absolute", the start entities are a sort of postulates adopted based on considerations of calculation convenience, without being possible to always pretend that they are prime, atomic and irreducible. In the end, we never know for certain that the terms to which we reach by decompositions are not suited to continue with the divisive-analytical operation, his metaphysical vision itself – the one according to which every particle contains and reflects an entire universe (the thesis of the equivalence between micro- and macrocosmos) – advising him to be circumspect. This is we will content to have a conventional recourse to the "most general concepts" we currently have, and, as the knowledge advances, expands and deepens, we will progressively add new categories to the initial heritage. At the same time, identifying the primitive terms does not precede building the universal characteristic as much as it accompanies it as a parallel achievement, since we are dealing with a calculation apparatus means to invent ideas, and not with a simple means of docilely expressing thought.[35]

In such a context, under the influence of a generous pansophic aspiration, the ideal of the *encyclopaedia* germinates, a genuine comprehensive, multidimensional *image* of the cosmos and its possible worlds, a vast enterprise destined to systematize, make consistent and set on fully rational grounds the body of human knowledge and its fields, from Grammar, Logic, Mnemonic and Topic to Moral and Metaphysics. The erudition and profession of librarian he had for many years in Hannover makes the project linger in the mind and concerns of the German thinker, being resumed in multiple texts published throughout his life or posthumously. Not only all the knowledge will be set beforehand thanks to certain sentences accurately designed and rigorously linked in a demonstrative manner, but we would also be in the possession of a highly flexible practical instrument, suited for the various epistemic needs and easy to handle, able to allow the control over the immense edifice of science to anyone.[36]

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[34] D. Berlioz, 1993, p. 161.

[35] U. Eco, 2002, pp. 222-223.

[36] Oscar M. Esquisabel, „¿Lenguaje racional o ciencia de las fórmulas? La pluridimensionalidad del programa leibniziano de la Característica General". In *Manuscrito. Revista Internacional de Filosofia,* vol.25, nr.2, 2002, p. 153.

With an untiring dedication and curiosity, he will research scientific areas among the most varied (physics, biology, mathematics, logic, technical and engineering disciplines, history, philology, law, political science, metaphysics and so on), nurturing the conviction of the need to surpass the tendency – obvious during his age – towards fragmentarism and dispersion in knowledge. The setoff theoretical or practical discoveries of humanity must be gathered in the common body from which all proceeded and, moreover, logically restructured according to a unique methodology of research and exposure. During his youth, he planned to draw up an *opius Photianum* which would be made up of excerpts on various topics picked up from the writings of the most valuable ancient authors, both medieval and modern. At maturity, he will abandon this plan, now contemplating an encyclopaedia which would include only the fundamental principles of the various sciences. At the old age, he will further diminish the dimensions of the project, reducing it to the proportions of a general conception of the world, both scientific and religious. He has not overlooked the possibility of setting up a society of scholars who would deal with the inventory of all the knowledge stored over the centuries, in hope of acquiring the necessary support by addressing – without much success, however – to both the academies in the great European capitals and to those of the crowned heads who manifested interest for cultural development.[37]

How will such knowledge, chapters, and articles of science be organized? Noting in a sharp manner that the theoretical and metaphysical criterion and the pragmatic and utilitarian one of division/composition do not coincide punctually, a simple hierarchical disposition seems insufficient and inefficient, so, in *De la division des sciences*, he proposes a structuring achieved including on a horizontal level, so that the subjects addressed proliferate not only by distributing them from gender to species, but by also taking into account the intentional properties of the composing terms (specific, gender, accident), confronting them with other ones, either similar, different or opposed and, also, referencing them to causes, actions, passions and relations. In subsidiary, the norms of correct operations are formulated. The encyclopaedia must be accompanied by an index which would guide the virtual reader to the catalogued sub-sections, allowing to easily identify the topic of interest, to consider it not only nominal and intrinsic, but also situated in various locations and attacked (possibly reconsidered) from various approach angles, even at the risk of being constrained to detail the initial limitative definition. We will proceed comfortably and easily, like when, wishing to consult a certain book in the library, we go precisely to the shelf on which it is found, saving painful efforts of confused search.[38]

Calculus ratiocinator and the heuristic stake

The overwhelming majority of our concepts and ideas are composed (collections of conjunct properties), consequently, they may be analyzed and re-synthesized by flawless logical procedures, which would discourage – even forbid - the insinuation of

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[37] W. Kneale; M. Kneale, 1974, pp. 352-353.

[38] Hans Burkhardt, „Aggregate". In *L'actualité de Leibniz:les deux labyrinthes*. Edited by Dominique Berlioz and Frédéric Nef, Stuttgart: Franz Steiner, 1999, pp. 309-310.

slips and failures. This is Leibniz's conviction which founds the program of the so-called *calculus ratiocinator*, a symbolic thinking by excellence; based on "iconic" signs which explicitly include a set of manipulations previously determined according to the norms (because they bear the rules written in itself), able to explain clearly and accurately the chains of our thoughts in a methodical and exhaustive manner, always inter-subjectively verifiable, with full control over their validity and truthfulness. In other words, it is possible to isolate a relatively small number of initial hypothetical units and formulate the structural principles of their combination, permutation, replication, etc., as to happily obtain a consistent theorem body.[39] He anticipates the passion for notation and combination of Ch. S. Peirce (a pioneer in modern semiotics), G. Frege (with his "conceptual writing", *Begrifsschrift*) and G. Piano (the *interlingua* project), as well as of a long list of logisticians and computerists of the 20th century, from B. Russell, D. Hilbert, P. Bernays, R. Carnap. C. I. Lewis, J. Łukasiewicz, K. Gödel to Ch. Babagge, A. Lovelace, A. Turing, N. Wiener, H. Simon, A. Newell and others.

Well chosen and ingeniously structured, the "alphabet" to which the primary concepts are reduced allows to the mind to reveal all that allows to be derived deductively from the axiomatic body, permitting to make reasoning and demonstrations, implicitly to draw conclusions, through a calculus analogical to the arithmetic and algebric one. But a major difference must be underlined: if the mathematical demonstration has preferential recourse to the identity relationship (replacing the equivalent expressions which usually designate quantities), the new technique uses any type of relations (including qualitative ones: similitude, congruence, inclusion, etc.) and, due to their complexity, which may not be reduced to the simple size and proportion, the tautologies will only represent a particular case limited by interference.[40]

Essentially, the German philosopher wanted to replace the usual cogitation by a calculus understood as a sequence of algorithmic prescriptions, as a sequence of operations – intermediated by the artificial language built – which would reduce to the minim the contribution of through and open the perspective of mechanisation of the intellectual acts. By using such means of organization, systematization and logical processing of any idea content, out mind may aspire to objectivity and rigour, being guided to obtain viable, certain and unanimously accepted knowledge. And the calculus is likely to embrace not only the field of scientific and philosophical concepts, but also the sphere of moral norms or aesthetic feelings.[41] According to Leibniz's statement, it would include "in general, the thoughts and feelings of man, not only will it represent figures, but also complicated machines, the movement of the planet and the composition of the animals' body will be described through it, it will be possible to write poems and songs".[42]

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[39] Barry Smith, „Characteristica Universalis". In Kevin Mulligan (ed.), *Language, Truth and Ontology* (Philosophical Studies Series), Dordrecht/Boston/Lancaster: Kluwer, 1992, p. 51.

[40] D. Bădărău, 1966, p. 85.

[41] Leen Spruit; Guglielmo Tamburrini. „Reasoning and Computation in Leibniz", In *History and Philosophy of Logic,* vol. 12, nr.1, 1991, p. 10.

[42] *Apud* Ion Banu, „Gottfried Wilhelm Leibniz (1646–1716)". In *Istoria filozofiei moderne şi contemporane*, vol.I, Bucureşti, Ed. Academiei, 1984, p. 442.

The comprehensive power of the calculus consists in the combination rules it observes, and, like mathematics, it proves able to generate assertions the form of which prevails over the content. It may be performed accurately and rigorously on conventional symbols the significance of which is not necessarily known to us, clear and distinct; we only take them in their position of replacements of the things and raw material for exercising intellection.[43] As we find out from *De cognitione, veritate et idea*, a "blind thinking" (*cogitatio caeca*) *handles the signs independently from the corresponding ideas, and they can even be chosen and handled as genuine. For instance, it is not obligated to mentally run all the units subjacent to the notion of one "million", but it implies it in ordinary addition, subtraction, multiplication and division. Considering the* wonderful ability of the "characters" to restore and support the movement and articulations of reflection, it *will be freed from the deceiving and useless weight of the intuitions and sensible representations, of prejudices and hazardous conjectures. The structure of an assertion, its syntax of regulated composition - called habitudo - are more important than the meaning of the terms used, and merely observing it directly informs us of the alethic value it has*.[44] As Eco[45] noticed, "the philosopher of pre-established harmony could not have though otherwise."

The consequence does not surprise us: if it possible that algorithm and automation are applied to human reason, it cannot be taken over, including by artefacts of the type of clocks? In Leibniz's personality, the theoretical genius who anticipates some of the lines of contemporary logistics could only have been accompanied by the engineering one, no less anticipating in respect of certain spectacular technical achievements of today: somewhere around the year 1670, he considerably reflects to a devise able to perform elementary arithmetic operations, and he also builds it with the help of a (more) knowledgeable Hannover craftsman. The prototype will know significant improvements so, in 1673, before the members of the Royal Society of London - some disconcerted, other sceptical - he presents the so-called *machine racionatrix*. But, as Couturat informs us, a short notice dated in the following year, describing a machine which performs a few algebric operations, and, in 1979, he thinks about a machine which operates based on the principles of binary arithmetic which were the object of its attention at the time.

On the other side, genuine science is not resumed to a demonstrative and probationary technique, but resides in its directly heuristic, imaginative functions, creating on the field where the subjective fantasy of the researcher may freely manifest. The problem of discovery is found in the very core of "inventive logic" it proposes to build, and it maintains intimate relationship with the creation of a scientific language – not necessarily of universal span – which would constitute the instrument for achieving it. In the Dissertation (as well as in other ulterior works), the Hannover philosopher reflects to the maximum number of assertions

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[43] Giuseppe Giannetto, *„Mondi possibili e calcolo divino in Leibniz" Metalogicon, vol. 14,* nr.2, 2001, p. 188.

[44] Stefano Gensini, *„Leibniz on the Arbitrariness of Sign".* In Dominique Berlioz and FrédéricNef, *Leibniz et les puissances du langage,* Paris, Vrin, 2005, pp. 62-63.

[45] U. Eco, 2002, p. 226.

(either true, false and even lacking meaning) likely to be formulated starting from a predominant set of signs (let us say the 24 letters of the alphabet in use), concluding that, in principle, even though quantitatively finite, the possibilities of combination have figure values almost inconceivable: if 100 primitive symbols were used, it would reach a total which may be expressed through "1" followed by 7,300,000,000,000 zeros... He imagines words composed of 31 characters; it does not exclude the possibility of certain books containing a single phrase![46]

Of course, he is aware of the gigantic proportion of the calculation effort required to produce them (for instance, he estimates that it would requires one thousand people to works intensively during approximately 37 years), as he realizes the limited abilities of the human mind to read, understand and memorize them, but the projects seems fascinating through the promises that the use of such a wonderful method of complexions (this is how he calls it) hides in order to provide us with completely new assertion until them escaping the scope of concern of human intelligence.[47] As a whole, the art of setting up intuitive and suggestive signs, supported by the one of their ingenious and correct handling releases unexpected forces of creative fantasy, places us in possession of an unsuspected whole of theses, which will emerge by itself, revolutionizing, enriching and diversifying "the fundamental knowledge of all things".[48] And their grounding and truthfulness is guaranteed by the fact that, disposing of the list of start symbols and observing a certain generic property of them, a few are selected and, by combining them, according to the logical rules associated, it becomes possible to recognise the valid assertions by strict virtue of their form.

Conclusions

Reverberating in a deep and renewing manner to the intense unrest of the age he lived in, Leibniz offers the lines of an ample and generous program of epistemic reformation, designed for the sizes of a generic science aimed at taking the various theoretical and practical enterprises from their state of "provincial" fractionation and isolation, to unify and unite them under the sign of the same principles and norms of achievement, to free them from the traditions narrow thinking, illusions and prejudices, to put them down the path of idea certainty and applicative science. In his vision, such a science made whole must achieve the full concordance between the aspects of content (the encyclopaedia as such) and the ones of form (the characteristic language), without allowing them to stray and mutually obstruct, on the contrary. Bringing them to a convergent function and mutual cooperation dedicated to the same noble purposes of renewal of human knowledge.

Due to the multiple tares and constitutional limitations, the natural languages (including the officiously scholarly Latin) are incapable of responding

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[46] Jean-Baptiste Rauzy, „*Quid sit natura prius*?La conception leibnizienne de l'ordre", *Revue de Métaphysique et de Morale*, vol.98, nr.1, 1995, pp. 38.

[47] U. Eco, 2002, pp.218-219; cf.JaakkoHintikka, *Lingua Universalis vs. Calculus Ratiocinator. An Ultimate Presupposition of Twentieth-Century Philosophy. Selected Papers*, vol.2, Dordrecht, Boston, London, Kluwer Academic Publishers, 1997, p. 79.

[48] *Apud* B. Smith, 1992, p. 72.

to the project requirement, for which it shall prove necessary to artificially build new means of expression (standardized, rigorous, economic), preferable as appropriate to the object subject to investigation and easy as possible (as a result of subjacent rules) for handling in various academic and ordinary, public and private contexts. He will start from setting up the signs which will designate the primitive components of the "alphabet of human thought" and - thanks to the *racionator calculus* operating formally – they will develop into sets of more advanced and deeper knowledge. Even if exercised "blindly" (indifference to the significance of the technical and notion instruments used), the art of symbolizing and combination emphasizes the priceless heuristic valences, stimulating the creative and inventive availabilities of the mind and leading to the systematic discovery of new assertions, the truthfulness of which we cannot doubt.

Often returned to posterity relatively late and not always known even to those interested, we are dealing with amazing (if not genius) intuitions which announce and anticipate major developments of the logistics and artificial intelligence belonging to the 20th century.

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