Theory and History of Ontology (www.ontology.co) by Raul Corazzon | e-mail: rc@ontology.co

## Key Terms in Ontology: *Mathesis Universalis*. The Search for a Universal Science

### Contents

This part of the section Theory of Ontology includes the following pages:

The section History of Ontology includes some pages on the philosophy of René Descartes

## Introduction

"Preliminary remark: It is never quite clear what (the modern concept of *mathesis universalis* as such exactly signifies, let alone how it may be defined. The expression itself (1) is a composite of the Greek μάθησεως latinized by transcription to *mathesis*, and the Latin *universalis*. The latinized *mathesis*, generally meaning, according to the dictionaries, learning / knowledge / science (= *disciplina* or *scientia*), (2) more specifically designates *mathematic* (= *scientia mathematica*), though it can even mean astrology. Hence the first and general sense of *mathesis universalis* signifies no more than universal science (*disciplina universalis* or *scientia universalis*). However – and this will be very important – since this "science" has a rather mathematical ring to it, we should on second thoughts take it to be an equivalent of s *cientia mathematica universalis* (3) (or *generali*s or *communis*: due to the underlying Greek terminology, there is no difference between universal, general, or common in antiquity – things will have changed by Leibniz' time at the latest, of course). This more specific meaning, i.e., universal (or general or common) mathematical science or universal mathematic, is essential, and more or less the bottom line for most occurrences of the expression, though it still remains very vague. However, the emphasis of this paper lies, with regard to the concept of mathesis universalis not so much on the historical details as on the more general systematical outlines. Therefore it should suffice to begin our work with an understanding of *mathesis universalis* that implies not much more than universal (or general or common) mathematical science, which of course still allows for a range of diverse meanings. What matters is to remain true to the sense of *mathesis universalis* while not confusing the two very different notions somehow inherent in the Latin, i.e., that of universal mathematic on the one hand and that of universal science on the other. A clear line should be drawn between these two concepts, of which the former is mathematical (even though sometimes in a wider sense), the latter not. I trust that it will become clear in this paper that both for historical and systematical reasons it is not only justified, but even necessary, to draw this general distinction between universal mathematic and universal science in this way." (pp. 129-130)

### Notes

(1) The major work of reference with regard to the Renaissance and Early Modern history of *mathesis universalis* (mainly in the context of Paduans, Jesuits, and Humanists/Ramists) remains G. Crapulli, *Mathesis universalis*. Genesi di un'idea nel XVI secolo, Roma 1969 (as his focus is on the sixteenth century, Crapulli treats neither Descartes nor Leibniz, but only their predecessors). For the history of the term as such cf. R. Kauppi, "Mathesis universalis", in: J. Ritter/K. Gründer (ed.), *Historisches Worterbuch der Philosophie*, vol. 5: L-Mn, Basel/Stuttgart 1980, col. 937-938 and also J. Mittelstrass, "Die Idee einer Mathesis universalis bei Descartes", *Perspektiven der Philosophie: Neues Jahrbuch* 4 (1978), 177-178.
(2) Descartes himself was clear about the fact that not much can be gained from the word itself: hic enim vocis originem spectare non sufficit; nam cum Matheseos nomen idem tantum sonet pod disciplina (*Regula IV*, *Oeuvres* X, 377,16-18).
(3) D. Rabouin, "La 'mathematique universelle' entre mathematique et philosophie, dAristote a Proclus", *Archives de Philosophie* 68 (2005), 249-268, discusses the concept's ambiguous character between philosophy and mathematics. Cf. also his paper "Les interpretations renaissantes de la 'mathematique generale' de Proclus", to be published in the proceedings (ed. A. Lernould and B. Vitrac) of the International Conference on *Le Commentaire de Proclus au premier livre des Elements d'Euclide*, forthcoming from Septentrion (Presses Unversitaires de Lille) [Alain Lernould (ed.), *Études sur le Commentaire de Proclus au premier livre des Éléments d'Euclide*, Lille: Presses Universitaires du Septentrion, 2010].

From: Gerald Bechtle, "How to Apply the Modern Concepts of *Mathesis Universalis* and *Scientia Universalis* to Ancient Philosophy. Aristotle, Platonisms, Gilbert of Poitiers, and Descartes". In

Kevin Corrigan and John D. Turner (eds.), *Platonisms: Ancient, Modern, and Postmodern*, Leiden: Brill 2007, pp. 129-154.

---

"The design of mathesis universalis, for short MU, was stated in the 17th century as part of the rationalistic philosophy of this time including a program of mathematization of sciences (see Weingartner, 1983). However, the significance of MU is not restricted to that period. It belongs to main ideas of Western civilization, its beginnings can be traced to Pythagoreans and Plato.
Immediate sources of the 17th century MU are found in the 15th century revival of Platonism whose leading figure was Marsilio Ficino (1433-1499), the author of "Theologia Platonica". He was accompanied by Nicholas of Cusa (1401-1464), Leonardo da Vinci (1452-1519), also by Nicolaus Copernicus (1473-1543). All of them may have taken as their motto the biblic verse, willingly quoted by St. Augustine, Omnia in numero et pondere et mensura disposuisti, Sap. 11, 21. The core of their doctrine was expressed in Ficino's statement that the perfect divine order of the universe gets mirrored in human mind due to mind's mathematical insights; thus mathematics proves capable of the role of an universal key to the knowledge; hence the denomination mathesis universalis.
This line of thought was continued in the 16th century by Galileo Galilei (1564-1642) and Johannes Kepler (1571-1630); it penetrated not only mechanics and astronomy but also medical sciences as represented by Teophrastus Paracelsus of Salzburg (1493-1541). No wonder that in the 17th century the community of scholars was ready to treat the idea of MU as something obvious, fairly a commonplace, before Descartes made use of this term in his "Regulae ad directionem ingenii". "Regulae" did not appear in print until 1701, hence the term itself could not have been taken from this source. In fact, it was used earlier by Erhard Weigel, a professor of mathematics in Jena (Leibniz's teacher) who wrote a series of books developing the program of universal mathematics: "Analysis Aristotelis ex Euclide restituta", 1658 (an interpretation of Aristotle's methodological theory in the light of Euclid's practice); "Idea Matheseos Universae", 1669; "Philosophia Mathematica: universae artis inveniendi prima stamina complectens", 1693 (see Arndt, "Einführung des Herausgegebers", in: Christian Wolff, *Vernünftige Gedanken*, Halle (1713) edited by H. W. Arndt, Hildesheim: Georg Olms 1965).
The last of the listed titles involves one of the key concepts of the MU program: ars inveniendi, i.e. the art of discovering truths in a mathematical way. There were two approaches to this art, differing from each other by opposite evaluations of formal logic. According to Descartes, formal logic of Aristotle and schoolmen was useless for the discovery of truth; according to Leibniz, ars inveniendi was to possess the essential feature both of formal logic and of mathematical calculus, viz. the finding of truths in formae (in virtue of form)." (pp. 525-526)

From: Witold Marciszewski, "The principle of Comprehension as a Present-Day Contribution to *mathesis universalis*", *Philosophia Naturalis* 21, 1984, pp. 523-537.

### *Mathesis universalis* in Husserl

"Husserl finds in Gottfried Wilhelm Leibniz’s notion of mathesis universalis the first systematic attempt to unify the formal apophansis of Aristotle with the formal mathematical analysis deriving from Franciscus Vieta. According to Husserl, Leibniz saw the possibility of combining the formalized scholastic logic with other formal disciplines devoted to the forms that governed, for example, quantity or spatial relations or magnitude. Leibniz distinguished between a narrower and a broader sense of mathesis universalis. In the narrower sense, it is the algebra of our ordinary understanding, the formal science of quantities.
But since the formalization at work in algebra already makes conceivable a purely formal mathematical analysis that abstracts from the materially determinate mathematical disciplines such as geometry, mechanics, and acoustics, we arrive at a broader concept emptied of all material content, even that of quantity. When applied to judgments, this formal discipline yields a syllogistic algebra or mathematical logic. But, according to Leibniz, this formal analysis of judgment ought to be combinable with all other formal analyses. Hence, the broader mathesis universalis would identify the forms of combination applicable in any science, whether quantitative or qualitative. Only thereby would it achieve the formality allowing it to serve as the theory-form for any science, whatever the material region to which that science is directed.

According to Husserl, however, Leibniz does not give an adequate account of how this unity is achieved. Husserl's development of Leibniz's notion of mathesis universalis recognizes the identity of apophantic logic and mathematical logic insofar as both apply to the forms of judgments and of arguments at different levels of abstraction. Moreover, when the principles of a mathematical logic are applied to any object whatever, it becomes clear, given the identity of the judgment as posited and the judgments as supposed, that mathematical logic can also be understood as formal ontology. Formal ontology as the formal theory of objects is characterized in the first instance by its contrast with formal apophantic logic. Formal ontology investigates a set of forms – correlative to those we find in apophantic logic – forms that Husserl calls "object-categories" (Gegenstandskategorien). These categories include object, state of affairs, unity, plurality, number, relation, set, ordered set, combination, connection, and the like. Formal ontology, however, is united with formal logic, for logic concerns the state of affairs just as supposed in the judgment. This means that meaning-categories (*Bedeutungskategorien*) and object-categories are the same forms, but they are considered differently and named differently in the natural and critical attitudes." (pp. 129-130)

From: John J. Drummond, *Historical Dictionary of Husserl's Philosophy* Lanham: Scarecrow Press 2007.

---

"*Apophantics as a doctrine of sense and a logic of truth*. From the above said it emerges that formal logic, as classically conceived, reflects the attitude of that person who performs the critique but whose judging is not a direct one but a judgement about judgements. Formal logic is constituted like an apophantic logic, whose object is the predicative judgement. This should not constitute a limitation for logic - as in fact has been the case so far - says Husserl - for apophansis contains all the categorical intentional entities. In other words, classical formal logic kept on the apophantic level, abandoning the very aim of knowledge comprised in the "intentionality" of the judgement. However, says Husserl, judgements conceived of as "intentional entities" pertain to the region of sense. The phenomenological analysis of the sense-directed attitude leads Husserl to the following conclusions: there is a region of sense wherein a judgement is meaningful irrespective of whether or not it is exact. This shows that sense transcends the act of referring to the given subjects, sense is "transcendental" and senses are ideal poles of unity (*Formale und Transzendentale Logik,* p. 119). Hence it follows that pure logic has the following divisions: the doctrine of sense and the doctrine of truth, for we have seen that the sense of a judgement and its truth are two different things. Having thus examined the whole content of classical analytics, a content which though implied is yet not explicit, in his opinion, Husserl concludes that analytics, thus conceived, represents that Mathesis Universalis i.e. that universal science dreamt of by Leibniz which has four levels:
(a) as Mathesis Universalis, the systematic form of theories; (b) as pure Mathesis, of non-contradiction; (c) as Mathesis o f the possible truth; (d) as Mathesis of pure senses." (p. 367)

From: Anton Dumitriu, *History of Logic*, Volume III, Tubridge Wells: Abacus Press 1977.

---

"Husserl's analyses of the mathesis universalis, in keeping with their detailed presentation in *FTL* [*Formal and Transcendental Logic* 1929], continue to offer a durable foundation for more extensive phenomenological investigations of the formal sciences. Here Husserl makes a particularly important distinction, one of exemplary significance for the whole of phenomenological description. In the first place, the mathesis universalis understood as objectively existing science -- in Husserl's terminology as objective logic (26) -- is to be phenomenologically-descriptively analyzed. In the second place, these investigations directed toward objective logic are to be supplemented through a subjective logic i. e., (27) through analyses of the cognitive structures of mathematical or logical knowing. The problems Husserl takes on in *FTL* according to these terms are particularly, (i) the relation between formal logic and mathematics (their co-extension and distinguishability), and (ii) the inner structure of the mathesis universalis. Both problems will be briefly addressed in what follows.
The conception of the mathesis universalis that Husserl clearly grasps for the first time in the *Prolegomena* is barely altered in the *FTL* of 1928, which describes mathesis universalis as a science in which formal logic and mathematics blend together in the sense of *co-extension.* (28) In their respective traditional formal logic and mathematics possessed a clear thematic orientation, on the basis of which they were "undoubtedly separate sciences" [*FTL*, 80]. Since the "breakthough of algebra" however, abstract mathematics is no longer the science of number and quantity, and

abstract logic is no longer the science of the structures of content-related language that orients itself toward the grammar of natural language (a characterization that applies equally to the Brentanian understanding of logic as a general theory of correct [natural-language] reasoning). It would already have been problematic enough if the traditional logic now in the form of Boolean algebra had, as "apophantic mathematics" [*FTL*,77], become a field of abstract mathematics. But it proved additionally to be the case that ever further sectors of mathematics could themselves be seen as a (Boolean) algebra, which dissolved even the traditional division of disciplines within mathematics. What was left over was thus a comprehensive formal science on the basis of a comprehensive (algebraicized) methodology.

However, it is due not only to a methodological alignment that, after the "breakthrough of algebra," formal logic and mathematics blended together. The formula "a ? b = b ? a" can, for example, be easily reformulated in a first-order language, whereby the transition to formal logic is achieved. Yet the form-variables *a,b,...* are maintained in this transition, and consequently the logician has the same region of abstract objects in front of him, objects whose constitutive laws were initially considered by the mathematician. Thus the question arises whether and (when yes) in what sense formal logic is distinguishable from mathematics *at all*,(29) from the mathematics Husserl refers to as *formal ontology* -- is e., the science "of the possible categorial forms in which substrate objectivitis can truly exist." [*FTL,*145].

It is one of the most notable results of *FTL* that Husserl developed precisely the sense in which the two sciences are finally distinct from one another. In keeping with the two-fold character of phenomenological analysis, this distinction is based upon the results of subjectively as well as objectively directed phenomenological descriptions. The first direction leads to the concept of "critical attitude" [*FTL*, 45, 46], which permits a distinction between the attitude (*Einstellung*) of the logician from that of the mathematician. The critical attitude of the logician is tantamount with an act of reflection, which is the necessary condition for encountering a judgment as judgment. The mathematician, on the other hand, remains for the most part in an objectively-directed attitude even after he has carried out the abstraction from the material determinations of the object. In his characteristic reflective attitude, the logician directs his attention to the speaking about (abstract) objects, which makes it possible to isolate the structures of this speech. Thus even when logic, in a fashion analogous to formal ontology, speaks about an object-sphere, it refers to the objects and relations in this sphere through the judgment [*FTL*, 54].

Objectively this distinction in attitude reveals itself to the extent that the judgment is the fundamental concept of formal logic. In the reformulation of the group-axioms in a first-order language, the axioms stand before us as judgments that are grammatically well formulated in the sense of inductive definitions. Au introductory text-book on group-theory, for example, will normally introduce neither the syntax of formalized mathematical language nor a formal concept of proof. In other words, in contrast to formal logic, whose fundamental conceptual inventory includes "judgment" or "judgment-set", these concepts are never even issues in mathematics [cf. *FTL*, 24]. Mathematics (in its traditional and abstract form) remains in an unreflective attitude which does not in principle thematize the speaking about objects [cf. *FTL*, 546]. It is occasionally necessary of course, to adopt the critical attitude for the purpose of the fundamental mathematical activity of proof. For the mathematician, this "methodological exception" from the unreflective attitude is motivated by a methodical modalization of the judgment carried out in the direct attitude. We shall return to this in the last two sections.

Since the delimiting of formal logic and mathematics will play a decisive role in the understanding of mathematical incompleteness, this must be treated in somewhat more detail. In the *LI* [*Logical Investigations*] of 1900/01, Husserl draws a concise distinction between state of affairs (*Sachverhalt*) and judgment.(31) States of affairs are experienced as being in the world; they are the objective truth-maker of the judgment, hence an analogon to the objects of perception, to which the psychic acts of perceiving are directed. With this distinction;, Husserl clears up a problem that many thinkers toward the end of the 19th century struggled to resolve.(32) Husserl belongs for this reason alone among Bolzano and Frege as one of the pioneers of modern logic.(33) It is therefore very much in the spirit of Husserl when Tarski remarks in his 1935 essay that he intends to do justic, to the intentions expressed in the following dictum: "To say of what is that it is not, or of what is not that it is, is false, while to say of what is that it is, or of what is not that it is not, is true."(34) Logic in the period after Husserl lost sight, however, of what Brentano and Husserl called "descriptive psychology"(35)" (pp. 105-108)

**Notes**

(26) Husserl's concept of logic (in the objective sense) is at least two-fold. On the one hand Husserl speaks of a "fully developed formal logic" [*EJ*= *Experience and Judgment* 2], which, as mathesis universalis, would encompass abstract formal logic as well as abstract mathematics. On the other hand he speaks of formal logic as a special science, in which case it is up to the reader to distinguish on every occasion whether Husserl is referring to traditional (Aristotelian) formal logic or to modem mathematicized logic as discipline within the mathesis universalis.
(27) Husserl deals with the distinction between the objective and subjective aspects of logic in, for example, the *Introduction* to *FTL*.
(28) In and of itself, the idea of coextension is already present in the *Prolegomena*. In the *Ideen* it is made explicit, in *FTL* analyzed in detail.
(29) On formal ontology *FTL*, 24; III/1, 10. The problem here exposed was aptly described by Kleene 24 years later in the following way: "In a mathematical theory, we study a system of mathematical objects. How can a mathematical theory itself be an object for mathematical study?" (Stephen Cole Kleene, *Introduction to metamathematics,* Amsterdam, North-Holland, 1952, 59).
(30) Husserl distinguishes between judgments and the spoken or written expression of judgments (on this see *FTL*, 5). His concept of judgment not so far away from what is commonly referred to as "proposition" in the terminology of analytic philosophy. At the same time, it is important that the judgment (i. e., the proposition) be opposed not to the expression, but rather that the judgment (as proposition) be opposed to the object of the judgment (where of course the judgment itself can also be made into the object of a higher-level judgment through a particular act of reflection.) Since the judgment can only be given together with an expression (in phenomenological parlance: the judgment is founded on the expression), the presumption of ' Platonic' metaphysics is here unjustified. Dealing with the constitution of judgments would call for detailed phenomenological-psychological investigations into the phenomenology of spoken and written language, analyses that cannot be carried through within the confines of this essay.
(31) The talk of states of affairs can be found in Husserl's work wherever the question is one of truth and its subjective correlate evidence, thus, for example, in the fourth *LI*, 39. The term "Sachlage", however, should -- even when this expression is employed in the *LI* (e.g. iv .*LI*, 28) -- be regarded with a view to its decisive formulation in 59 of *EJ*. It is not to be confused with state of affairs.
(32) This is the result of the thoroughgoing historical investigation in Barry Smith "Logic and the *Sachverhalt*", *The Monist* 72 (1989), 52-69. On this see also the remarks on the roll of Stumpf, Brentano, Meinong, Twardowski, or Reinach in the development of the concept of *Sachverhalt.*
(33) Best known is of course the influence of Husserl's concept of "pure logical grammar" in Leśniewski and his followers (on this Yehoshua Bar-Hillel, "Husserl' conception of a Purely Logical Grammar." *Philosophy and Phenomenological Research* 17 (1955-57) 362-9).
(34) Adam Tarski (Der Wahrheistbregriff in den formalisierten Sprachen." *Studia Philosophica* 1 (1935), 261-465. English translation: H. Feigl, and W. Sellars, *Readings in Philosophical Analysis.* New York (NY): Appleton-Century-Crofts, 1949.

From: Olav K. Wiegand, "Phenomenological-Semantic Investigations into Incompleteness", In Olva K. Wiegand et al. (eds.), *Phenomenology on Kant, German Idealism, Hermeneutics and Logic. Philosophical Essays in Honor of Thomas M. Seebohm*, Dordrecht: Kluwer 2000, pp. 101-132.