Cambridge University Press
978-1-108-48875-4 — Space and Fates of International Law
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Excerpt
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Science and Law in the Seventeenth Century

Both Leibniz and Hobbes worked mainly in the seventeenth century. Therefore, this section provides a general context of scientific debates of the time, which is essential for the understanding and correct interpretation of their own views. Hobbes was born in 1588 and died in 1679. All of his works were published during the seventeenth century and are deeply imbued into the seventeenth-century debates.[1] Leibniz, on the other hand, was born in 1646 and died in 1716 and thus was influenced by a slightly different cohort of thinkers compared to Hobbes.[2] In fact, Hobbes himself had a lasting impression on Leibniz in several areas.[3] This influence of Hobbes on Leibniz is of a twofold manner. On the one hand, Leibniz was highly impressed by Hobbes's methodological rigor and as a consequence by some of his ideas that he adopted and reworked in his own thinking.[4] On the other hand, Leibniz sharply disagreed with some of Hobbes's premises and conclusions.

1 For an overview of Hobbes's life and work, see e.g., Aloysius P. Martinich, *Hobbes: A Biography* (Cambridge: Cambridge University Press, 1999).

2 On Leibniz's life and work, see e.g., Maria Rosa Antognazza, *Leibniz: An Intellectual Biography* (Cambridge: Cambridge University Press, 2009).

3 On Hobbes's influence on Leibniz in a variety of areas ranging from metaphysics and natural philosophy to law, politics, and history, see the volume edited by Marquer and Rateau: Éric Marquer and Paul Rateau (eds.), *Leibniz lecteur critique de Hobbes* (Montreal: Les Presses de l'Université de Montréal VRIN, 2017). On Hobbes's influence on Leibniz in relation to some specific issues, see e.g., George MacDonald Ross, 'Leibniz's Debt to Hobbes', in Pauline Phemister and Stuart Brown (eds.), *Leibniz and the English-Speaking World* (Dordrecht: Springer, 2007), 19–33; Howard R. Bernstein, 'Conatus, Hobbes and the Young Leibniz', (1980) 11 *Studies in History and Philosophy of Science*, Part A, 25–37; Catherine Wilson, 'Motion, Sensation, and the Infinite: The Lasting Impression of Hobbes on Leibniz', (1997) 5 *British Journal for the History of Philosophy* 339–51.

4 Two letters that Leibniz wrote to Hobbes, one of which never reached Hobbes, and another remained an unfinished draft, thus preventing direct exchange between the two philosophers represent a particularly powerful proof of this admiration Leibniz held for Hobbes. The first of these letters dated 13/23 July 1670 (A II.1, 90–4) is a completed letter that was even sent by

Therefore, he worked on disproving these in a variety of ways. This latter tendency is particularly visible in the area of law and is discussed in the corresponding chapter. In the current chapter, the main philosophical and scientific debates relevant to the issues discussed in this study but not fitting neatly into any of the subsequent chapters are presented first followed by a general overview of the legal and political climate in the seventeenth century.

1.1 MAIN RELEVANT DEBATES IN SCIENCE AND PHILOSOPHY

Seventeenth century is the century associated with the philosophical tradition of modernity and rationalism. It is commonly imagined as an age of reason and scientific enquiry. However, how exactly seventeenth-century philosophers understood reason and scientific enquiry cannot simply be assumed based on a contemporary lay understanding of these notions. One important feature of seventeenth-century intellectual life that often does not receive sufficient attention is the continuing relevance of religious doctrines and beliefs. Moreover, for many philosophers their particular view of God as well as their ability through their intellectual work to contribute to the glory of God and church are central guiding principles in all areas, including the sciences.[5] Even the most materialistic philosophers, such as Hobbes, could not and never did distance themselves completely from Christian teachings.[6] This is particularly visible in Hobbes's discussions in relation to law, for instance through his continuing inclusion of divine law as a part of natural law, which, as discussed in the corresponding chapter, often looks like a simple tribute to the requirements of his time.

Leibniz through one of his acquaintances for transmission to Hobbes. However, most probably Hobbes has never received the letter. See on this note in A II.1, 90. Another letter is an unfinished draft dating from Leibniz's time in Paris, 1674 (A II.1, 383–6). It is unknown if this letter was ever finished and sent to Hobbes (see note in A II.1, 383). See also a powerful statement in Leibniz's letter to Lambert van Velthuysen (letter of 6/16 April 1670, A II.1, 63), where Leibniz acknowledges that Hobbes is the philosopher of his century that he admires and respects the most. An interesting analysis of these two letters is Karl Schuhmann, 'Leibniz' Briefe an Hobbes', (2005) 37 *Studia Leibnitiana* 147–60.

5 For a general overview of the relationship between science and religion in the seventeenth century, see e.g., Gary B Ferngren (ed.), *Science and Religion: A Historical Introduction* (Baltimore: John Hopkins University Press, 2002), which contains several chapters dealing with the seventeenth-century context. Another good reading focusing on England is Richard S. Westfall, *Science and Religion in the Seventeenth Century England* (New Haven: Yale University Press, 1958).

6 See, for example, a powerful explanation of this impossibility in Douglas M. Jesseph, 'Hobbes's Atheism', (2002) 26 *Midwest Studies in Philosophy* 140–56, 152–5.

Even issues that at first sight appear to a contemporary reader free of religious influences remain in the seventeenth century deeply intertwined with religious views of particular scholars and influence their decisions on publication and dissemination of their writings. For instance, Hobbes had to defend himself against accusations of heresy and atheism. For this reason, he also had to flee his place of residence on several occasions. According to researchers, Hobbes was able to avoid prison, punishment, and some more serious consequences only thanks to the protection of his powerful supporters.[7] The reaction to the publication of the English text of *Leviathan* in 1651 is one telling example. Hobbes becomes not only 'Monster of Malmesbury' and arch-atheist but also '[h]is doctrines were cited by Parliament as a probable cause of the Great Fire of 1666'.[8] As a result, he is compelled to justify some of his positions against such accusations in an appendix to the Latin edition of *Leviathan* published in 1668.[9] Although he did not necessarily change his materialistic views, nonetheless, in order to avoid confrontation, he had to present them in a more acceptable way.[10]

Another telling example is the relatively recent discovery of religious motivations and the underlying Christian worldview of Newton, a scholar who is traditionally celebrated as an exemplary pioneer of pure rational scientific investigation.[11] For this reason, religious underpinnings of Leibniz's and Hobbes's work as well as the general religious environment within which they worked cannot be ignored. In some instances, it is possible to detach

7 For biographical details, see e.g., the above mentioned Martinch, *Hobbes*.

8 For a detailed overview of contemporary reactions in England to Hobbes's works with a particular emphasis on his materialism and moral philosophy, see Samuel I. Mintz, *The Hunting of Leviathan. Seventeenth-Century Reactions to the Materialism and Moral Philosophy of Thomas Hobbes* (Cambridge: Cambridge University Press, 1962). This quotation is at vii.

9 The appendix has three chapters. One of them (chapter 3) is entirely devoted to refutation of objections and attacks on his English version of *Leviathan*. These refutations are all of theological nature. For a more detailed study of the appendix and its link to Hobbes's religious views, see e.g., Georges Wright, 'The 1668 Appendix and Hobbes's Theological Project', in Patricia Springborg (ed.), *Cambridge Companion to Hobbes's Leviathan* (Cambridge: Cambridge University Press, 2007), 392–409.

10 While some authors would argue that Hobbes's materialism was weaker in the Latin version of *Leviathan*, more plausible is the argument that he simply presented his claims in a form more acceptable to his contemporaries without weakening the nature of his argument. See Anne Staquet, 'Comment Hobbes tente de rendre son matérialisme acceptable dans les appendices du *Léviathan*', *Les Dossiers du Grihl* (online), Les dossiers de Jean-Pierre Cavaillé, Les limites de l'acceptable, 8 November 2011, visited 11 December 2018: http://journals.openedition.org/dossiersgrihl/4791.

11 Some of the links between Newton's religious views and his conceptualisation of space are discussed in the introductory section of Chapter 2.

specific ideas from religious considerations and contexts without affecting their functionality and sense. On the other hand, there are instances where this detachment is not possible at all without a distortion of the underlying thesis. In some of these instances, it is possible to supress the underlying religious motivation or justification, but oblivion will simply mean that the religious underpinnings will continue to operate in the subconscious. The present research therefore does not discard the religious side of various theories and conceptualisations examined but evaluates the status of religious ideas and motivations within the context of the specific topic discussed.

From the point of view of developments in philosophy and science, the seventeenth century can be characterised by a constant search for 'new philosophies', which would provide a more coherent alternative to the traditional scholastic Aristotelianism.[12] The emergence and dominance of the mechanical philosophies[13] during the seventeenth century are the result of this search for 'new philosophies' and represent the overarching achievement of this epoch. Given the importance – although in very distinct ways – of mechanical philosophies for both Hobbes and Leibniz, major tendencies of these philosophies need to be sketched. One common trait of mechanical philosophies was the endeavour to explain all natural phenomena through matter and motion.[14] In this sense, as will become clear in the course of this book, Hobbes might be viewed as one of the

[12] For a summary of this development, see Stephen Menn, 'The Intellectual Setting', in Daniel Garber and Michael Ayers (eds.), *The Cambridge History of Seventeenth-Century Philosophy*, Vol. 1 (Cambridge: Cambridge University Press, 1998), 33–86.

[13] It is partially misleading to talk about 'the mechanical philosophy' in the singular. Although many of the new philosophies 'taking their origins from an incongruous mixture of Archimedian mechanics, chemical and medical traditions, humanist Epicureanism, scholastic voluntarism and nominalism, and many other philosophy new and old' share some common motivations and characteristics, they still represent a group of competing 'new philosophies'. Ibid., 73–4. Similarly, Helen Hattab, 'The Mechanical Philosophy', in Desmond M. Clarke and Catherine Wilson (eds.), *The Oxford Handbook of Philosophy in Early Modern Europe* (Oxford: Oxford University Press, 2011), 71–95: 'to be a *mechanical* philosopher meant different things in different contexts' (72, emphasis in the original) with further references.

[14] For a brief introductory overview of mechanical philosophies, see e.g., Hattab, 'The Mechanical Philosophy', 71, or Alan Gabbey, 'Mechanical Philosophies and Their Explanations', in Christoph Lüthy, John E. Murdoch, and William R. Newman (eds.), *Late Medieval and Early Modern Corpuscular Theory* (Leiden: Brill, 2001), 441–64, Margaret J. Osler, 'Mechanical Philosophy', in Gary B. Ferngren (ed.), *Science and Religion: A Historical Introduction* (Baltimore and London: Johns Hopkins University Press, 2002), 143–52; for a more complex but brief overview that traces the emergence of mechanical philosophies from philosophical debates of the previous century, see Menn, 'The Intellectual Setting'. For a more detailed discussion, see e.g., Marie Boas Hall, *The Mechanical Philosophy* (New York: Arno Press, 1981), or Daniel Garber and Sophie Roux (eds.), *The Mechanization of Natural Philosophy* (Dordrecht: Springer, 2013).

exemplary mechanical philosophers. He explains through matter and motion not only natural phenomena but legal and political developments as well. However, there are significant differences in the approach to the explanation of the world in many philosophers who either claimed themselves to be mechanists or who were associated with this tradition by others. As Helen Hattab demonstrates, the initial idea and ideal that could be placed at the origin of mechanical philosophies is the rediscovery of the Platonian image of the universe as an intricate machine.[15] Since mechanics of a machine can be studied and understood in depth using mathematical methods, this leads to the perception of the superior value of mathematical, including geometrical, demonstrations for the study of any natural phenomenon. For many philosophers, this also led to a particular view of matter – most importantly, matter as a passive extended substance that can only be moved by an external force.[16] The many disputations on the nature of matter and substance were central preoccupation of the seventeenth-century philosophy and produced a range of divergent opinions, some of which continue to be debated today.[17] Leibniz's theory of substance and the ensuing understanding of matter is one of the most intriguing legacies of this period.[18] As this book demonstrates, it is a cornerstone to the understanding of connections between space and law in Leibniz's work. For our purposes, it is not necessary to go into detail of the many particular manifestations of the mechanical philosophies in the seventeenth century. The insight or consequence of mechanical philosophies that needs to be discussed in more detail here is the belief in the power of mathematical and more specifically geometrical method.

The geometrical method[19] had a significant impact on both Leibniz and Hobbes. Moreover, the geometrical method influenced their approach not

[15] Hattab, 'The Mechanical Philosophy', 75–6.

[16] The does not mean that divergent views of matter did not exist even among philosophers who proclaimed themselves to be mechanists. See on this e.g., John Henry, 'Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory', (1986) 24 *History of Science* 335–81.

[17] For an overview of discussions on matter, see e.g., Gideon Manning (ed.), *Matter and Form in Early Modern Science and Philosophy* (Leiden: Brill, 2012). On substance in seventeenth century, see e.g., Roger S. Woolhouse, *The Concept of Substance in Seventeenth Century Metaphysics* (New York: Routledge, 1993), or Joshua Hoffman and Gary S. Rosenkrantz, *Substance: Its Nature and Existence* (New York: Routledge, 1997), which draws on seventeenth-century philosophers without being limited to them. A voluminous literature discussing specific views of substance of various individual seventeenth-century philosophers also exists.

[18] Interpretation of several aspects of Leibniz's theory of substance remain subject to debate. Leibniz's theory of substance as it informs analysis in this book is presented in Chapter 2.

[19] On the impact and different uses of geometrical method in relation to law and theories of state from Hobbes as the founder of the method through Leibniz to Thomasius, see

only in such areas as physics, natural philosophy, or metaphysics, but also and most importantly in legal and political matters. In a widely known account of Hobbes's life, his encounter with the geometrical method is described as follows:

> He was forty years old before he looked on geometry; which happened accidentally. Being in a gentleman's library, Euclid's Elements lay open, and 'twas the forty-seventh proposition in the first book. He read the proposition. 'By G', said he, 'this is impossible!' So he reads the demonstration of it, which referred him back to such a proof; which referred him back to another, which he also read. Et sic deinceps, that at last he was demonstratively convinced of that truth. This made him in love with geometry.[20]

Hobbes then established as his project the development not only of the study of philosophy, but also of politics and law following the same rigorous method he discovered in the *Elements of Geometry*.

Euclid's *Elements of Geometry* or simply Euclid's *Elements* is an ancient Greek treatise on geometry in thirteen books attributed to Greek mathematician Euclid of Alexandria, who lived approximately from mid-fourth century BC to mid-third century BC.[21] Its main feature, which attracted Hobbes and many other philosophers of the seventeenth century, is its method. This method consists in a step-by-step proof of a particular proposition starting from a relatively small number of postulates (axioms) and some common notions. The axioms were themselves composed of simple basic terms defined in advance. For example, one of the postulates in book one of the *Elements* is the following: 'That all right angles are equal to one another.'[22] This postulate relies on the definition of a right angle, which is formed 'when a straight line set up on a straight line makes the adjacent angles equal to one another, each of the equal angles is right'.[23] This definition is dependent upon

Wolfgang Röd, *Geometrischer Geist und Naturrecht. Methodengeschichtliche Untersuchungen zur Staatsphilosophie im 17. und 18. Jahrhundert* (München: Verlag der Bayerischen Akademie der Wissenschaften, 1970). In English-language literature, geometrical method is more actively discussed in relation to Spinoza. See e.g., Edwin Curley, *Behind the Geometrical Method: A Reading of Spinoza's Ethics* (Princeton: Princeton University Press, 1988).

20 John Aubrey, 'The Life of Mr Thomas Hobbes, of Malmesburie', in John Aubrey, *Brief Lives*, Vol. 1 (Oxford: Clarendon Press, 1898), 322–403, 332.

21 For a good overview of his life and work placing it in its historical context, including reception of Euclid's *Elements* not only in Europe but also other parts of the world, see Peter Schreiber, *Euklid* (Dresden: Teubner Verlag, 1987).

22 Euclid, *The Thirteen Books of Euclid's Elements*, Thomas Heath, trans., Vol. 1 (Cambridge: Cambridge University Press, 1908), Book 1, postulate 4, 154.

23 Ibid., definition 10, 153.

a previous definition of a straight line as 'a line which lies evenly with the points on itself'.[24] This in turn depends on definitions of a point as 'that which has no parts' and a line as 'breadthless length'.[25] Although we did not yet consider how propositions are dependent on postulates and definitions, this example already provides a good illustration of the type of progression from simple and obvious terms, to first definitions and from them to more complex statements.

The interest in mathematical method as a way to achieve certainty in knowledge was widespread in the seventeenth century but manifested itself differently in various authors.[26] For Hobbes, the possibility of achieving certainty using the geometrical method is limited to the science of mathematics and civil philosophy that included politics and as a consequence law. In the realm of natural science according to Hobbes, this method leads only to probability, not certainty. This is due to the different nature of the object of study in both areas. As Hobbes clarifies,

> the science of every subject is derived from a precognition of the causes, generation, and construction of the same. . . . Geometry therefore is demonstratable, for the lines and figures from which we reason are drawn and described by ourselves; and civil philosophy is demonstratable, because we make the commonwealth ourselves. But because of natural bodies we know not the construction, but seek it from the effects, there lies no demonstration of what the causes be we seek for, but only of what they may be.[27]

Geometrical bodies or political bodies (states) are created by humans. Therefore, by reconstituting the process of these bodies' construction, we attain certain and clear knowledge of them, which is not possible with regard to natural phenomena. Hobbes applied this method in his works on civil philosophy with remarkable rhetorical consistency, although the degree of success of this method is rather ambiguous and to what extent Hobbes really faithfully followed this method can be questioned.[28] Despite all possible

[24] Ibid., definition 4.
[25] Ibid., definitions 1 and 2, respectively.
[26] For an overview of different manifestations of the mathematical method in the seventeenth century, mostly in relation to natural philosophy, see Peter Dear, 'Method and the Study of Nature', in Daniel Garber and Michael Ayers (eds.), *The Cambridge History of Seventeenth Century Philosophy*, Vol. 1 (Cambridge: Cambridge University Press, 1998), 147–77.
[27] Thomas Hobbes, *Six Lessons to the Professors of Mathematics*, EW, Vol. 7, 181–356, 184.
[28] For a critical assessment of both aspects, see e.g., Jeremy Valtentine, 'Hobbes's Political Geometry', (1997) 10 *History of the Human Sciences* 23–40, and Hardy Grant, 'Geometry and Politics: Mathematics in the Thought of Thomas Hobbes', (1990) 63 *Mathematics Magazine* 147–54. For an overall assessment of different views on Hobbes's articulation of

shortcomings of practical application of the method, its theoretical importance for Hobbes's work cannot be overestimated. Therefore, it forms part of the discussion in the assessment of Hobbes's views on law and politics in the subsequent chapters of this book.

As mentioned previously, the rigour of method in Hobbes is one of the most admirable for Leibniz aspects of Hobbes's work.[29] It is no surprise then that Leibniz himself worked with significant dedication on questions of method. One of the central issues that will determine his approach to law and justice relates to the capacity of the human mind to discover truths that are certain, as well as methods required for such a process of discovery. Leibniz indeed believed that humans are capable of achieving certain and definitive knowledge in many areas, including the realm of law and justice. To achieve this, however, methodological rigor is central. In terms of his development of method, Leibniz held views very similar to those of Hobbes. On many occasions, he insisted on the centrality of definitions for the attainment of knowledge and truth. For instance, on several occasions he insisted that demonstration is nothing but a chain of definitions.[30] However, Leibniz's view of method was more complex than the Hobbesian position on the matter.

Leibniz's project of *scientia generalis* and the associated development of *characteristica universalis*, as well as the resulting general encyclopaedia, are particularly telling in this regard.[31] Although Leibniz never completed either

politics as science, see Noel Malcolm, 'Hobbes's Science of Politics and His Theory of Science', in Noel Malcolm, *Aspects of Hobbes* (Oxford: Clarendon Press, 2002), 146–55.

29 In both of his letters to Hobbes, Leibniz highlighted Hobbes's rigor of method (A.II.1, 91, 384). In his first letter, he added, 'There is nothing more polished and better adapted to the public good than your definitions. Among the theorems which you deduce from them there are many which will remain established' (L 105).

30 This thesis is for example defended in Leibniz's correspondence with Conring (A.II.1, 153, 580, 599–600, 687). One of the relevant letters (dated 19 March 1678) is translated in L 186–91. This thesis also appears in Leibniz's *Elementa juris naturalis* (A.VI.1, 460–461) and *De Principiis praecipue contradictionis et rationis sufficientis* (1686/87) (A.VI.4.A, 803–6; translated in L 225–7). This defence of the same principle in relation to a variety of contexts, here specifically in relation to law and science, confirms that Leibniz viewed it as a broadly relevant methodology for discovery of truths.

31 The literature on these three interrelated ideas of Leibniz is quite rich if we include consideration of these notions by authors writing on Leibniz's logic (see, for instance, a chapter on *scientia generalis* in Louis Couturat, *La logique de Leibniz d'après des documents inédits* [Paris: Alcan, 1901]). In this sense different authors' interpretations are not always in agreement. However, most recent literature criticises this reduction of e.g., *scientia generals* to logic. The below short summary of the main traits of these three concepts is based on the most recent research on the subject, which does point towards a common denominator regarding the general orientation of Leibniz's thought on these topics. The most important secondary sources in this regard are Arnaud Pelletier, 'The *Scientia Generalis* and the Encyclopaedia', in Maria Rosa Antognazza (ed.), *The Oxford Handbook of Leibniz* (Oxford: Oxford University

of these endeavours, he was highly passionate about them and only the immensity of the task prevented him from completing them. One of the most telling statements highlighting both Leibniz's continuing interest in the topic as well as the golden thread of his thoughts on the matter is contained in a letter written in March 1716, shortly before his death: 'My big historical work prevents me from accomplishing my idea which I have to put philosophy into demonstrations … because I see that it is possible to invent a general characteristic which could achieve in all types of research capable of certainty what Algebra does in Mathematics.'[32]

Scientia generalis was thought by Leibniz as a universal science that forms the basis of all other sciences in a twofold manner: it presents in a manner ordered according to specific methodological principles all existing knowledge, and simultaneously it establishes certain logical and methodological principles that ensure rational thinking that leads to invention and certainty of knowledge, including the scientific certainty about the truth of inventions.[33] In this latter aspect of *scientia generalis*, the very creation of the logical steps that lead to invention and discovery was as important as truth of thus obtained new knowledge. This twofold manner in which *scientia generalis* formed the basis of all sciences is connected to the way method was treated traditionally in the seventeenth century. As a part of logic, method had two meanings: (1) 'method as an overall ordering of a subject-matter (*ordo*)' and (2) 'method as a logical technique of discovery (*methodus*, properly so called)'.[34] However, if in traditional logic these two

Press, 2018), 162–76; Paul Rateau, 'La philosophie et l'idée de l'encyclopédie universelle des connaissances selon Leibniz', (2018) 81 *Archives de philosophie* 115–41. On *characteristica universalis* more specifically, see Hans Burkhardt, 'The Leibnizian Characteristica Universalis as Link between Grammar and Logic', in Dino Buzzetti and Maurizio Ferriani (eds.), *Speculative Grammar, Universal Grammar, and Philosophical Analysis of Language* (Amsterdam and Philadelphia: John Benjamins Publishing Company, 1987), 43–63; Christian Leduc, 'The Epistemological Functions of Symbolization in Leibniz's Universal Characteristic', (2014) 19 *Foundations of Science* 53–68; Martin Schneider, '"Leibniz" Konzeption der Characteristica universalis zwischen 1677 und 1690' (1994) 48 *Revue internationale de philosophie* 213–36.

32 Eduard Bodemann, *Der Briefwechsel von Gottfried Wilhelm Leibniz in der königlichen öffentlichen Bibliothek zu Hannover* (Hannover: Hahn'sche Buchhandlung, 1889), 15–16. This is an unpublished letter of which Bodermann reproduces only this part. Original French: 'Mon grand ouvrage historique m'empeche d'executer la pensée que j'ay de metre philosophie en demonstrations … car je voy qu'il est possible d'inventer une caracteristique generale, qui pourroit faire dans toutes les recherches capables de certitude, ce que l'Algebra fait dans les Mathematiques.'

33 See e.g., Paul Rateau, 'L'encyclopédie universelle', 134, who in this regard speaks of the double function of *scientia generalis*: architectonic and methodological.

34 Peter Dear, 'Method', 148.

steps were still separable, in Leibniz one is intimately dependent and linked to the other because the ordering of available scientific concepts was at the same time an indispensable tool for invention and discovery.

Characteristica universalis as a tool for *scientia generalis* exemplifies this specifically Leibnizian view of method. *Characteristica universalis* can be understood first of all as a type of universal language that Leibniz attempted to develop. This language would bring mathematical clarity to all areas of knowledge through an introduction of a system of signs, which will allow making thinking and argumentative process akin to calculation. Obviously, mathematics, and more specifically algebra, served as a model for this type of calculation as the first quotation on the topic confirms.[35] However, Leibniz also intended to enrich it with the possibility to use formulas and signs for calculating not only quantity, which is a usual procedure in mathematics, but also quality, or similarity and dissimilarity, which is a more unusual procedure.[36] *Characteristica universalis* served the purpose of invention and introduction of such a system of signs. An important basic premise of this system of signs was its non-arbitrary character. The signs according to Leibniz should represent adequately not only each individual concept, but also the relationships between concepts.[37] For this purpose, Leibniz worked very intensely for several years on defining basic concepts and establishing links between them. The basic concepts of science are those that cannot be further partitioned into a combination of other concepts. These basic concepts would function as primary numbers. All other concepts are a product of these primary numbers or basic concepts.

This brief discussion of Leibniz's work on methodological issues demonstrates the centrality of reliance on precise definitions and relationships between them, which Leibniz and Hobbes share. According to some authors, Leibniz has more debt towards Hobbes in this regard than he is able to admit.[38] This centrality of definitions for scientific enquiry links both Leibniz and Hobbes to the geometrical method and the tradition of

35 See text on note 32 above.

36 On this aspect of Leibniz's work, see Martin Schneider, 'Funktion und Grundlegung der Mathesis Universalis im Leibnizschen Wissenschaftssystem', in Albert Heinekamp (ed.), *Leibniz: Questions de logique: Symposion organise par la Gottfried-Wilhelm-Leibniz Gesellschaft E.V. Hannover, Bruxelles, Louvain-La-Neuve 26 au 28 aoûte 1985* (Wiesbaden: Franz Steiner Verlag, 1988), 162–82.

37 This double function of characteristics universalis is well discussed in Schneider, 'Characteristica universalis', 206–8, in particular.

38 Marine Picon, 'Leibniz, Hobbes et les principes des sciences', in Éric Marquer and Paul Rateau (eds.), *Leibniz lecteur critique de Hobbes* (Montreal: Les Presses de l'Université de Montréal Vrin, 2017), 53–73.