

Some remarks on Leibniz's criticisms to mechanics

Algunas observaciones sobre las críticas de Leibniz a la mecánica

ROBERTO CASALES GARCÍA¹
UPAEP, Universidad
roberto.casales@upaep.mx

ABSTRACT

The main purpose of this paper is to analyze some of Leibniz's critics of mechanics in order to understand its limitations, particularly those that help to clarify the distinction between the machines made by human beings and machines of nature. To understand Leibniz's critics of mechanics, we divided them into three kinds: 1. critics of the Cartesian conception of extension; 2. Leibniz's mill argument; and 3. the irreducibility of living being too simple machines or artifacts.

Keywords: force, mechanics, machine of nature, perception, body.

RESUMEN

El objetivo principal de este artículo es analizar algunas de las críticas de Leibniz al mecanicismo, con la intención de comprender sus limitaciones, particularmente aquellas que nos ayudan a esclarecer la distinción entre las máquinas fabricadas por los seres humanos y las máquinas de la naturaleza. Para entender las críticas de Leibniz al mecanicismo, las hemos dividido en tres: 1. las críticas a la concepción cartesiana de extensión; 2. el argumento leibniziano del molino; y 3. la irreducibilidad de los seres vivos a simples máquinas o artefactos.

Palabras clave: fuerza, mecanicismo, máquina de la naturaleza, percepción, cuerpo.

Introduction

In a famous letter to Nicolas Remond, dated on January 10th of 1714, Leibniz mentioned that, after studying some modern philosophers and

¹ ORCID: <https://orcid.org/0000-0003-4189-7961>

thinkers at the age of fifteen, he went to the Rosetal to deliberate whether to preserve substantial forms or not. Even when he chooses mechanics over metaphysics at that moment, his further investigations on the ultimate grounds of mechanics and the laws of motion lead him to conclude that “they could not be found in mathematics but that I should have to return to metaphysics”.² A statement that can also be found in his *New System of the Nature and the Communication of Substances* of 1695, where he argues that

after trying to explore the principles of mechanics itself in order to account for the laws of nature which we learn from experience, I perceived that the sole consideration of *extended mass* was not enough but that it was necessary, in addition, to use the concept of *force* [...] although it falls within the sphere of metaphysics.³

These biographical notes let us see that his adscription to mechanics was ambiguous since he, on one side, state that every natural phenomena could be explained mechanically, at the same time that he, on the other side, affirms that “the principles of mechanics themselves cannot be explained geometrically, since they depend on more sublime principles which show the wisdom of the Author in the order and perfection of his work”.⁴

Even when Leibniz is considered as a relevant precursor for computing and artificial intelligence,⁵ especially for his improvements in mathematics and logic, his developments for the mines of Harz, and his calculator, his ambiguous adscription to mechanics reveals some of the limits not only of this account of nature but also of our technological improvements. The main purpose of this paper is to analyze some of Leibniz’s critics of mechanics in order to understand these limitations, particularly those that help to clarify the distinction between the machines made by human beings and machines of nature. To understand Leibniz’s critics of mechanics, we divided these into three kinds: 1. critics of the Cartesian conception of extension; 2. Leibniz’s mill argument; and 3. the irreducibility of living being too simple machines or artifacts.

² Loemker, 655. All references from Leibniz and Descartes will be quoted according to the canonical style of citation.

³ Loemker, 454; GP IV, 478.

⁴ *Tentamen anagogicum*, Loemecker, 478; GP VII, 272; see also: *Extrait d’une lettre de M. de Leibniz sur la question, si l’essence du corps consiste dans l’Etendue*, Lamarra 204-205.

⁵ CAMACHO NARANJO, L. (2019). “H. Dreyfus, R. Smullyan y G.W. Leibniz: sobre los límites de sistemas formales”, en CARVAJAL VILLAPLANA, A., *Leibniz. Máquinas inteligentes, multiculturalismo y ética de la vida*, Granada: Comares (Nova Leibniz Latina 2), pp. 5-28.

The insufficiency of the Cartesian conception of extension

Descartes notion of extension is quite relevant for mechanics not only because he sustains that extension constitutes the true nature or essence of all bodies,⁶ but also because, as Gilson noticed, it allows him to develop a form of "mathematicism", according to which all human knowledge can be molded in conformity "with the pattern of mathematical evidence".⁷ If the essence of all bodies consists in extension, then we can measure and describe every natural phenomena through the lengths of a mathematical equation. Even when Leibniz accepts that every natural phenomena can be explained mechanically, and thus by mathematical means, he clearly sustain in a brief text of 1677 that this account of nature only correspond to our cognitive limitations:

First of all, I take it to be certain that all things come about through certain intelligible causes, or causes which we could perceive if some angel wished to reveal them to us. And since we may perceive nothing accurately except magnitude, figure, motion, and perception itself, it follows that everything is to be explained through these four. But because we are now speaking of those things which seem to take place without perception, such as the reactions of liquids, the precipitations of salts, etc., we have no means of explaining them except through magnitude, figure, and motion, that is, through mechanism.⁸

According to Leibniz, extension and mechanics only correspond to how we can represent the external and phenomenical world through perception: every natural phenomena can be explained mechanically, through mathematical means, only because, as we can see in his correspondence with De Volder, "matter or extender mass is nothing but a phenomenon grounded in things, like the rainbow or the mock-sun, and all reality belongs only to unities".⁹ By giving a phenomenical character to all bodies, Leibniz is not saying that they lack of reality, but only that it is grounded in something else and, therefore, that the true essence or nature of bodies cannot consist only in extension. What Leibniz is denying is the substantial character of extension. One reason to sustain this is that extension is only a relative and incomplete concept, "an analyzable and relative concept, for it can be resolved into plurality, continuity and coexistence or the existence of parts at one and the same time".¹⁰ As a property of things, according to Leibniz, extension is not an absolute predicate but only an attribute relatively of what is extended

⁶ *Treatise on light*, Ariew 37; AT XI, 36.

⁷ GILSON, E., *The Unity of Philosophical Experience*, New York: Charles Scribner's Sons, 1950, p. 133.

⁸ *De modo perveniendi ad veram corporum analysin et resum naturalium causas*, Loemker, 173; GP VII, 265.

⁹ *Letter from Leibniz to De Volder from June 30th of 1704*, Loemker, 536; GP II, 270.

¹⁰ *Letter from Leibniz to De Volder from march 24th of 1699*, Loemker, 516; GP II, 169.

or diffused, which means that it cannot be separated from the thing that is extended or diffused.¹¹

In a second argument to deny the substantiality of extension, as we can see in a brief text from 1691, Leibniz state that if the true essence of bodies consists in extension, extension alone should be enough to explain every property of bodies.¹² Extension, as Laura Herrera noticed,¹³ is not enough to explain the transmission of movement that happens in the collision of two or more bodies, where the extension is completely indifferent, and the results of this collision would be, at most, explained by the mere geometric composition of movements, without explaining the ultimate causes of movement.¹⁴ Another reason to say that extension is insufficient to explain every property of bodies, specifically the ultimate causes of motion, is that “extension is an attribute which cannot make up a complete entity, no action or change can be deduced from it, it expresses only a present state, not at all the future and past as the concept of a substance must do”.¹⁵ According to Leibniz, on the contrary, “even by the laws of motion, a body is never affected by the impact of another except by virtue of its own elasticity, which comes from a motion which already exists within it”.¹⁶

Both reasons to deny the substantial character of extension aim to the same place, as Juan Arana notice: extension and mechanics insufficiency implies that if we need to

change the point of view from *foronomics* to *dynamics*. Alternatively, if desired, to pass from *describing* movement with exactitude to *explain* it. The distinction between describing and explaining seem unequivocal, as it can be seen when we confront rough descriptions and explanations that lead us to the ultimate causes.¹⁷

Even when we can explain everything mechanically, mechanics only represents one form to approach to nature, especially when we want to understand the realm of living beings, as we will see in Leibniz’s mill argument against mechanical materialism.

¹¹ “Nullum quidem librum contra philosophian Cartesianam...”, GP IV, 394.

¹² *Extrait d’une letter de M. de Leibniz sur la question, si l’essence du corps consiste dans l’Etendue*, Lamarra, 203.

¹³ HERRERA, L., “En torno a la concepción leibniziana del cuerpo”, en RODERO-CILLEROS, S. & SÁNCHEZ-RODRÍGUEZ, M. (Eds.), *Leibniz en la filosofía y la ciencia modernas*, Granada: Comares, 2010, p. 284.

¹⁴ *Extrait d’une letter de M. de Leibniz sur la question, si l’essence du corps consiste dans l’Etendue*, Lamarra, 203.

¹⁵ *Draft of a letter from Leibniz to Arnauld*, Mason, 88; Finster, 186.

¹⁶ *Draft of ‘New System for the Explaining the Nature of Substances and the Communication between them, as well as the Union of the Soul with the Body*, Woolhouse, 25; GP IV, 476.

¹⁷ Juan Arana 2013: 63.

Leibniz's mill argument against mechanical materialism

Beyond the Cartesian conception of extension and its applications to natural sciences, mechanics not only affirms that everything in nature can be measured and, therefore, described through a mathematical equation, but also that we can explain every single natural change by understanding two things: the parts that constitute the machine, i.e., the gears that make this machine work, and the way that these parts interact.¹⁸ Leibniz believes that we can only apply this mechanical criterion to explain the interaction of bodies, so "a body never receives a change in motion except through another body in motion which pushes it",¹⁹ since bodies, according to §79 of his *Monadology*, "act according to the laws of efficient causes or the laws of motion".²⁰ However, he also states that we cannot apply the same criterion to explain the inner activity of those simple substances that "enters into compounds",²¹ since their inner actions, as he states in §2 of his *Principles of Nature and of Grace, Based on Reason*, "can only be its *perceptions* –that is to say, the representations of the compound, or of that which is without, in the simple– and its *appetitions* –that is to say, its tendencies from one perception to another– which are the principles of change".²² By grounding mechanics in his dynamics and not only in extension, Leibniz not only states that "there is never a body without movement", as he states in the Preface of his *New Essays in Human Understanding* of 1710, but also "that in the natural course of things no substance can lack activity"²³ or, as he claims in the §1 of his *Principles of Nature and of Grace, Based on Reason*, "substance is a being capable of action".²⁴ while in bodies or compounds their activity consist in motion, the activity of monads consist in perception and appetite, two inner activities of this soul-like entities.

When Leibniz state that each body or compound is not one substance but an aggregate of substances,²⁵ he is also saying that the force that explains motion, considered as a derivative force, proceeds from an inner primitive force of these monads: "derivative forces are in fact nothing but the modifications and echoes of primitive forces".²⁶ According to this approach, as we can see

¹⁸ VELÁZQUEZ FERNÁNDEZ, H., ¿Qué es la naturaleza? Introducción filosófica a la historia de la ciencia, México: Porrúa, 2007, p. 87.

¹⁹ *Considerations on vital Principles and Plastic Natures*, Loemker, 587; GP VI, 541.

²⁰ Loemker, 651; GP VI, 620.

²¹ *Monadology*, Loemker, 643; GP VI, 607.

²² Loemker, 636; Robinet I, 29.

²³ AA VI, 6, 53.

²⁴ Loemker, 636; Robinet I, 27.

²⁵ *Communicata ex disputationibus cum Fardella, de serie rerum, corporibus et substantiis, et de praedeterminatione*, AA VI, 4B, 1668.

²⁶ *Letter from Leibniz to De Volder from June 20th of 1703*, Loemker, 530; GP II, 251.

in §11 of his *On Nature Itself* of 1698, we can only say that “bodies in themselves are inert” since “extension, or the geometric nature of a body, taken alone contains nothing from which action and motion can arise,” a passive force of resistance that he locates in *prime matter* or mass, “which is everywhere proportional in a body to its magnitude”.²⁷ Since action and motion are not something that can be derived from this *prime matter* or mass, Leibniz concludes that we need to presuppose something else in bodies that explain all these activities and, therefore, “that there must be found in corporeal substance a *primary entelechy* or first recipient (*prôton dektikôn*) of activity, that is, a primitive motive force which, superadded to extension, or what is merely geometrical, and mass, or what is merely material, always acts indeed and yet is modified in various ways by the concurrence of bodies”.²⁸ As we can see in §11 of his *New System*, these primary entelechies constitute the

real unities absolutely devoid of parts, that can be the sources of actions, and the absolute first principle of the composition of things, and as it were the ultimate elements in the analysis of substances...they have *something of the nature of life* and a kind of *perception*.²⁹

Even when we can explain every corporal movement by mechanical means, as the result of the impact of another body, this movement can be described, in Leibniz’s opinion, as an external expression of the inner force of things, something that depends on the existence of monads. This soul-like entities, as primary forces, also are subject to change, a change that “is continuous in each one” and that comes from “an *internal principle*”.³⁰ The inner action of monads, as we already state, consist in perception and appetite: while perceptions are the “*detail in that which changes*,” i.e., “the passing state”³¹ which express or represent what is outside (the external world) from the inside,³² as a mental state; appetites are “the action of the internal principle which brings about change or passage from one perception to another”.³³ Since monads are always acting, we can infer that they are always perceiving and passing from one perception to another, even when they are not aware of their own perceptions, as we can see in the Preface of his *New Essays*, when he introduced his theory of minute perceptions: “besides, there is in us an infinity of perceptions, unaccompanied by awareness or reflection; that is, of alterations in the soul itself, of which we are unaware because these impressions are either too

²⁷ Loemker, 503; GP IV, 510.

²⁸ *On Nature Itself*, Loemker, 503; GP IV, 511.

²⁹ Woolhouse, 16; GP IV, 482-483.

³⁰ *Monadology*, Loemker, 643-644; GP VI, 608.

³¹ *Monadology*, Loemker, 644; GP VI, 608.

³² *Letter to R.C. Wagner from June 4th of 1710*, GP VII, 329-330.

³³ *Monadology*, Loemker, 644; GP VI, 609.

minute and too numerous, or else too unvarying, so that they are not sufficiently distinctive on their own".³⁴ Monads always perceive something, even when they lack of any kind of consciousness or reflection, as we can see in those monads whose perceptions cannot reach the level of sensation.³⁵ All of this allow us to understand the ontological background of his mill argument against mechanical materialism, as we can see in §17 of his *Monadology*:

It must be confessed, moreover, that perception and what depends on it are *inexplicable by mechanical reasons*, that is, by figures and motions. If we pretend that there is a machine whose structure enables it to think, feel, and have perception, one could think of it as enlarged yet preserving its same proportions, so that one could enter it as one does a mill. If we did this, we should find nothing within but parts which push upon each other; we should never see anything which would explain a perception. So it is in the simple substance, and not in the composite substance or machine, that perception must be sought. Furthermore, this is the only thing –namely, perceptions and their changes– that can be found in simple substance. It is in this alone that the *internal actions* of simple substances can consist.³⁶

As Paul Lodge noticed, the key to understand Leibniz's mill argument is to recognize its target are mechanical materialists that affirm that every corporeal being is a mechanical system and, therefore, that material things are

entities whose behavior can be accurately and exhaustively explained by adverting to nothing other than the sizes and shapes of impenetrable particles that have the power to receive motion from other particles through impact or as a result of the direct activity of immaterial entities upon them.³⁷

If we pay attention to the ontological backgrounds of this argument, we will see that Leibniz agrees with mechanical materialists in saying that every corporeal natural phenomenon is prone to a mechanical explanation, something that, however, cannot apply to perception and appetite, the inner activity of monads, since they do not depend on any corporeal or geometrical thing. Mental states like perception and appetite, even when they could be related with sensation and, in this way, with the impressions that we receive through some of our organs, cannot be explained in mechanical terms since "they are not properties of mechanical material things".³⁸ By understanding the parts that constitute our body, conceived as a natural machine, and the

³⁴ AA VI, 6, 53.

³⁵ *Monadology*, Loemker, 644; GP VI, 610.

³⁶ *Monadology*, Loemker, 644; GP VI, 609.

³⁷ LODGE, P., "Leibniz's Mill Argument Against Mechanical Materialism Revisited", *Ergo*, vol. 1, num. 3, 2014, p. 81.

³⁸ LODGE, P., "Leibniz's Mill Argument...", p. 82.

way they interact, i.e., the way that they behave, we would never see something that explains our mental states:

sentient or thinking being is not a mechanical thing like a watch or a mill: one cannot conceive of sizes and shapes and motions combining mechanically to produce something which thinks, and senses too, in a mass where [formerly] there was nothing of the kind.³⁹

Machines of nature vs artifacts

As we can see at the end of §2 of his *New System*, Leibniz's concerns about mechanics are not only related to the Cartesian notion of extension but also with the opinion "of those who transform or demote animals into mere machines," something that he considers implausible and "contrary to the order of things".⁴⁰ Leibniz also makes this critic to Descartes when he explains, in §2 of his *Principles of Nature and of Grace, Based on Reason*, the distinction between perception and the reflective knowledge that only spirits can reach: by stating that all our perceptions are apperceived, i.e., that every mental state is conscious,⁴¹ "these same Cartesians think that only spirits are monads and that there is no soul in beast, still less other *principles of life*".⁴² In this way, Leibniz not only recognize that animals have souls but also that every living being have one, including plants, since they have perceptions and appetites: "the great analogy which exists between plants and animals inclines me to believe that there is some perception and appetite even in plants".⁴³ All of this means that even when Leibniz accepts a mechanical account of bodies, including the bodies of all living beings, "he strongly resists the Cartesian attempt to describe natural machines in terms of artificial ones".⁴⁴ The reason to sustain the irreducibility of living beings to artificial machines, however, is not only that living beings have a soul that guarantees the unity of the entire organism, since bodies without a soul can only be considered as mere aggregates of beings without any further *vinculum*⁴⁵ –while living beings are still the same being even when their body experiences some changes or modifi-

³⁹ *New Essays*, AA VI, 6, 66-67.

⁴⁰ Woolhouse, 11; GP IV, 478.

⁴¹ AT, VIII, 160.

⁴² Loemker, 637; Robinet I, 37.

⁴³ *New Essays*, AA VI, 6, 139.

⁴⁴ NACHTOMY, O., "Leibniz on Artifical and Natural Machines: Or What It Means to Remain a Machine to the Least of its Parts", en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, p. 65.

⁴⁵ "Nullum quidem librum contra philosophian Cartesianam...", GP IV, 395-396.

cations—,⁴⁶ but also because their complex structure, which make them quite different from artifacts, as we can see in §64 of his *Monadology*:

So each organic body belonging to a living being is a kind of divine machine or natural automaton infinitely surpassing all artificial automata. For machine made by human art is not a machine in each of its parts; for example, the tooth of a brass wheel has parts or fragments which are not artificial so far as we are concerned, and which do not have the character of a machine, in that they fit the use for which the wheel was intended. But machines of nature, living bodies, are still machines in their smallest parts, into infinity. It is this that makes the difference between nature and art, that is between the divine art and ours.⁴⁷

Even when Leibniz describes the structure of an organism in terms of a mechanism, as he asserts in his *New Essays* about the bodies of plants and animals,⁴⁸ he also elaborates “his own program to characterize living beings not as inert mechanisms but as animate active creatures”.⁴⁹ This program can be resumed in two aspects: first, that these machines of nature, contrary to artifacts, consist of an infinity of nested organs or parts involved in each other;⁵⁰ second, that “a natural machine is still a machine even in its smallest parts”.⁵¹ According to Nachtomý's approach to the first aspect, this infinity “is not the *number* of organs or machines but rather the very *structure* of a natural machine which involves machines within machines,” a structure that “develops *ad infinitum*”,⁵² something that helps us to understand in which sense Leibniz affirms, on one side, that “the soul only changes its body little by little and by degrees, so that it is never deprived of all its organs at once”,⁵³ and, on the other side, “that not only the soul, as mirror of an indestructible universe, is itself indestructible but also the animal itself, although its machine may often perish in part and cast off or take on particular organic coverings”.⁵⁴ In this way, as he states in his correspondence with De Volder,

when I Say that even if it is corporeal, a substance contains an infinity of machines, I think it must be added at the same time that it forms one machine

⁴⁶ *Leibniz a Foucher*, GP I, 391.

⁴⁷ Loemker, 649; GP VI, 618.

⁴⁸ AA VI, 6, 139.

⁴⁹ SMITH, J.E. & NACHTOMY, O., “Introduction”, en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, p. 2.

⁵⁰ “*Nullum quidem librum contra philosophiam Cartesianam...*”, GP IV, 396.

⁵¹ *New System*, Woolhouse, 16; GP IV, 482.

⁵² NACHTOMY, O., “Leibniz on Artificial...”, p. 73.

⁵³ *Monadology*, Loemker, 650; GP VI, 619.

⁵⁴ *Monadology*, Loemker, 651; GP VI, 620.

composed of these machines and that it is actuated, besides, by one entelechy, without which it would contain no principle of true unity.⁵⁵

Machines of nature, finally, not only differ from artifacts because they have an organic structure that suffer a number of develops that extend to infinity; they also differ by virtue of their parts: while artifacts are aggregates of things that are not always artifacts at the same time, smaller machines or artifacts, each machine of nature “is an aggregate of smaller corporeal substances”, organic bodies that “are in turn aggregates of even smaller corporeal substances, and so on to infinity”.⁵⁶ Each part of a living being, in this sense, is a smaller living being that is also composed of other even smaller living beings, conforming an aggregate of machines of nature that are integrated by virtue of an intrinsic teleological organization.⁵⁷

References

- CAMACHO NARANJO, L. (2019). “H. Dreyfus, R. Smullyan y G.W. Leibniz: sobre los límites de sistemas formales”, en CARVAJAL VILLAPLANA, A., *Leibniz. Máquinas inteligentes, multiculturalismo y ética de la vida*, Granada: Comares (Nova Leibniz Latina 2), pp. 5-28.
- DESCARTES, R., *Oeuvres de Descartes*, Adam, Ch. & Tannery, P. (Eds.), Paris: J. Vrin, 11 vols, 1964-1986.
- DESCARTES, R., *Philosophical Essays and Correspondence*, Ariew, R. (ed.), Indianapolis-Cambridge: Hackett Publishing, 2000.
- GILSON, E., *The Unity of Philosophical Experience*, New York: Charles Scribner's Sons, 1950.
- HERRERA, L., “En torno a la concepción leibniziana del cuerpo”, en RODERO-CILLEROS, S. & SÁNCHEZ-RODRÍGUEZ, M. (Eds.), *Leibniz en la filosofía y la ciencia modernas*, Granada: Comares, 2010, pp. 281-296.
- LEIBNIZ, G.W., *Der Briefwechsel mit Antoine Arnauld* (Franzosisch-deutsch), Finster, R. (Ed.), Hamburg: Felix Meiner Verlag, 1997.
- LEIBNIZ, G.W., *Die Philosophischen Schriften*, herausgegeben von C.I. Gerhardt, Hildesheim, 1965.
- LEIBNIZ, G.W., *Essais scientifiques et philosophiques. Les articles publiés dans les journaux savants*, Lamarra, A. & Palaia, R. (Eds.), 3 vols., Hildesheim: Olms, 2005.

⁵⁵ *Letter from Leibniz to De Volder from June 20th of 1703*, Loemker, 529; GP II, 250.

⁵⁶ PHEMISTER, P., “Monads and Machines”, en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, p. 41.

⁵⁷ *Animadversiones*, Dutens II-2, 144.

- LEIBNIZ, G.W., *Gothofredi Guillelmi Leibnitii... Opera Omnia*, Dutens, L. (Ed.), 6 vols. Geneva: De Tournes, 1768.
- LEIBNIZ, G.W., *Leibniz's 'New System' and Associated Contemporary Texts*, Woolhouse, R.S. & Francks, R. (Eds.), Oxford-New York: Oxford University Press, 1997.
- LEIBNIZ, G.W., *New Essays on Human Understanding*. Remnant, P. & Bennett, J. (Eds.). Glasgow: Cambridge University Press, 1996.
- LEIBNIZ, G.W., *Philosophical Papers and Letters*, Loemker, L.E. (Ed.), Dordrecht: Kluwer Academic Publishers, 1989.
- LEIBNIZ, G.W., *Principes de la nature et de la grâce fondés en raison. Principes de la philosophie ou monadologie*, publiés intégralement d'après des lettres inédites par Robinet, A., Paris, 1954.
- LEIBNIZ, G.W., *Sämtliche Schriften und Briefe*. Von der Deutschen Akademie der Wissenschaften zu Berlin, Darmstadt (1923 y ss.), Leipzig (1938 y ss.), Berlín (1950 y ss.).
- LEIBNIZ, G.W., *The Leibniz-Arnould Correspondence*, Mason, H.T. (Ed.), New York: Manchester University Press, 1967.
- LODGE, P., "Leibniz's Mill Argument Against Mechanical Materialism Revisited", *Ergo*, vol. 1, num. 3, 2014, pp. 79-99.
- NACHTOMY, O., "Leibniz on Artificial and Natural Machines: Or What It Means to Remain a Machine to the Least of its Parts", en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, pp. 61-80.
- PHEMISTER, P., "Monads and Machines", en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, pp. 39-60.
- SMITH, J.E. & NACHTOMY, O., "Introduction", en SMITH, J.E. & NACHTOMY, O. (Eds.), *Machines of Nature and Corporeal Substances in Leibniz*, Dordrecht-Heidelberg-London-New York: Springer, 2011, pp. 1-9.
- VELÁZQUEZ FERNÁNDEZ, H., *¿Qué es la naturaleza? Introducción filosófica a la historia de la ciencia*, México: Porrúa, 2007.