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Impossible Possible Machines

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Arguing against the current paradigm of computationalism, the article revisits Alexandre Koyré’s history of European techno-rationality and 17th-century figures like Descartes and Galileo. Here, one finds the machine emerging at precisely the time and place in history where the gap between mathematical-geometrical idealization and the reality of bodies and experiments first appeared. Historically, the machine is rooted in theatrical mechanics of simulation, illusion, fiction, and deception. Structurally, it appears in between subject and object, the ‘thinking’ and the ‘mechanical’ substances. With the machine, mathematical science becomes possible because it creates an outside or model to the theoretical inside of European science.

Keywords: Philosophy of Technology, Media Theory, Alexandre Koyré, Renaissance technology, History of Science, History of Technology

For the analysis of reality is possible only on the basis
of an appropriate access to what is real.
—Heidegger, *Being and Time*

When media theory and philosophy speak of machines in the context of science and technology, they often focus on machines *in reality*. Machines are often treated as being merely objectively present, as *possible machines*—something that might or might not work. Yet, as this text will argue, the topos of the machine within European history and theory of science and technology is located in a strange place that allows the "impossible real" to become a "possible reality." The machine complements that which would otherwise be impossible to symbolize, calculate, or compute. It also brings forth realities in which the impossible real continuously returns, in the form of machines that freeze, break down, or disrupt the realities they are supposed to make possible.[1]

Today, the machine is often addressed solely in terms of "computability." So far, nobody has ever built a Turing Machine that solved the halting problem. Yet, we often speak of computers as *if* there were no limit to what they can compute (equating them with Universal Turing Machines).[2] Or we speak of computers *as if* the theoretical limits that the Church-Turing thesis puts on any possible computer (its impossibility)

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[1] I equate "real" with "impossible" and "reality" with "possible." I.e., in number theory, we cannot identify the highest natural number, as there will always be a higher natural number. The "real," taken here as the impossibility of identifying the highest natural number, can certainly be symbolized, formalized, and even calculated, i.e., as *n+1* or *[…]*. But by doing so, we always also create some kind of left-over or surplus that in itself cannot be identified. *Any formalization of the real creates a surplus that escapes the formalization*. Reality, in contrast, is something constantly produced by subjects and machines, but only in terms of ideals or fiction. This reading of the impossible-real and possible-reality is inspired by the function Heidegger ascribes to the structure of Dasein and its forerunning towards the possibility of its own death—its own impossibility. This structure only becomes apparent to Dasein when the inner-worldly structure of *Zeug* (tools, equipment, machines, language…) breaks down. Cf. Martin Heidegger, *Being and Time: A Translation of Sein Und Zeit*, trans. Joan Stambaugh, SUNY Series in Contemporary Continental Philosophy (Albany: State University of New York Press, 1996), part 1, ch. 3. For a detailed discussion of the "impossible real" in Lacanian psychoanalysis, see Samo Tomšič, "Mathematical Realism and the Impossible Structure of the Real," *Psychoanalytische Perspektiven* 35, no. 1 (2017): 9–34. For a discussion of the mathematical real in Lacan's topology, see Michael Friedman, "Torus and Identification: The Beginning of Lacanian Mathematics" in *Psychoanalysis: Topological Perspectives: New Conceptions of Geometry and Space in Freud and Lacan*, ed. Michael Friedman and Samo Tomšič (Bielefeld: Transcript, 2016), 153-190.

[2] "So tritt zwischen Freud und Lacan der Computer, Alan Turings Universale Diskrete Maschine von 1936." Friedrich A. Kittler, "Die Welt Des Symbolischen, Eine Welt Der Maschine," in *Draculas Vermächtnis: Technische Schriften* (Leipzig: Reclam Verlag, 1993), 65.

do not matter *in reality* for the practical applications of computers, such as modeling human cognition with trained neural networks.[3]

But the computationalist's dream about unlimited possibilities of computing the real belongs itself to a long history of European techno-rationality that can be traced back to 17th-century figures like Descartes and Galileo. When revisiting the origins of the European machinery (a term that alludes to both the historical concatenations of technology and science in Europe and its former colonies as well as the metahistorical truth and power structures that came along with it), one finds the machine emerging at precisely the time and place in history where the gap between mathematical-geometrical idealization and the reality of bodies and experiments first appeared. Etymologically, the machine is rooted in theatrical mechanics of simulation, illusion, and deception. Philosophically, it appears at the very cut between subjects and objects, the "thinking" and the "mechanical" substances, the organic and non-organic. The machine operates at the cut that separates and conjoins the inside world (of psychology, cognition, or mind) and the outside world (of physics, biology, or matter).

Since Aristotle, there has been a division of labor between those who work with possibilities and those who work with impossibilities: the historian describes what has happened (one of many possibilities), while the poet conveys what should happen (in terms of fiction or impossibilities). One looks for something general to be found in the particular, while the other one accounts for something universal only to be found in the singular (something that is at the same time necessary, verisimilar, and impossible to achieve).[4] Historically and structurally, the European discourse on machines, from its beginnings in the 17th century to its latest formulations in terms of 21st-century computationalism, belongs to both.[5]

When Christian universities started to study Aristotle's *De Anima* in the 12th century, they faced a dilemma: the soul in Aristotle was not just the seat of human reason and will but also the principle of life in plants and animals. The soul was what moved the body—*any* body. Accordingly, some technical objects of the Middle Ages, such as clocks or church bells, wielded holy or diabolic powers. And because these bodies were considered to have an individual persona and a soul (literally, as the characteristic hollow recess that became animated each time a bell was intoned was called "anima" or "soul"), they could even be tried in court, flogged, or banned from

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[3] Cf. Aaron Sloman, "The Irrelevance of Turing Machines to Artificial Intelligence," in *Computationalism: New Directions*, ed. Matthias Scheutz (Cambridge, MA: MIT Press, 2002), 87–128.

[4] Cf. Aristoteles, *Poetik*, Werke in deutscher Übersetzung 5, ed. and trans. Arbogast Schmitt (Berlin: Akademie Verlag, 2008), pp. 13-14 [1451 b1-b5].

[5] This is also why media theory should not be reduced to history or to literature and fiction.

the city.[6] Within the Christian doctrine, living bodies and technical objects were supposed to be of the same substance. They were a metaphysical unit.

This changed with Descartes' mechanistic philosophy, which stripped the Aristotelian-scholastic soul from its vegetative parts and powers. He no longer needed to assume a soul to move a body. In *Discourse de la méthode*, he grounds the *l'âme raisonnable,* the rational soul, in human intelligence and passions, in faculties such as language and wit, by distinguishing them from the automatic, repetitive, programmable, machinic motions of clocks and automata.[7]

According to Hannah Arendt, the event that marked the Renaissance was the telescope, or rather Galileo's use of it. Technical objects mark events because, unlike ideas that "come and go," a technical object can be historically dated.[8] It might be more complicated, as we would have to add clockwork, which had already been invented in the 13th century, and other mechanisms to this "event" because, for Descartes, the machines that enabled him not only to rid the soul of its vital forces but also to state a clear cut between animals and humans were machines that could move themselves.[9]

With Renaissance automata also came mechanical simulation, theater, illusion, and deception. The work of Salomon de Caus, a Huguenot engineer, and architect, is of particular relevance here because his work on paper and in the form of

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[6] Cf. Daniel M. Zolli and Christopher Brown, "Bell on Trial: The Struggle for Sound after Savonarola," *Renaissance Quarterly* 72, no. 1 (2019): 54–96, 6.

[7] Cf. René Descartes, *Von der Methode des richtigen Vernunftgebrauchs und der wissenschaftlichen Forschung*, ed. and trans. Lüder Gäbe, Philosophische Bibliothek 261 (Hamburg: Meiner, 1990), 96.

[8] "In the realm of ideas there is only originality and depth [...] but no absolute, objective novelty; ideas come and go, they have a permanence, even an immortality of their own, depending upon their inherent power of illumination [...] Ideas, moreover, are distinguished from events, are never unprecedented, and empirically unconfirmed speculations about the earth's movement around the sun were no more unprecedented than contemporary theories about atoms would be if they had no basis in experiments and no consequences in the factual world." Hannah Arendt, *The Human Condition*, 2nd ed. (Chicago: University of Chicago Press, 1998), 259.

[9] On the role automata played within the Christian-scholastic context, see Christina Vagt, "Deus in Machina: Zur Sakralisierung der Mechanik im späten Mittelalter," in *Medien des Heiligen*, ed. Friedrich Balke, Bernhard Siegert, and Joseph Vogl, Archiv für Mediengeschichte (Paderborn: Wilhelm Fink, 2015), 31–42. Descartes is not completely coherent in his usage of the term "soul," though that should not be understood as contradictory: "When confronting his opponents, Descartes will insist that animals do not have souls, if by 'soul' is meant what the Aristotelian means. On the other hand, he will say: you may, if you wish, continue using the word 'soul' of something in animals—but then you must consider that the soul is only the blood, or the heat of the heart, and nothing more. Though philosophers occasionally misunderstand the tactic, and take Descartes to have contradicted himself, in context there is no confusion." Dennis Des Chene, *Spirits and Clocks: Machine and Organism in Descartes* (Ithaca, NY: Cornell University Press, 2001), 67.

built machines was well known by Descartes and his contemporaries.[10] De Caus designed the famous garden of the Palatinate in Heidelberg, where some of the stunning automata and water plays are still on display today.[11] These were machines in the modern sense because not only did they appear to be self-moving, but they also were able to simulate the movements of animals.

During the Middle Ages, machines were without a mechanism: the term "machina" was solely used to signify stable wooden constructions to reach inaccessible places; they were just scaffolds (*Gestell*). Simple mechanisms like pulleys and levers or more elaborate ones like mills were quite common, but they were not called "machines." Not until the 16th century did "machina" and "mechanae" merge into the modern concept of "machine," at which point the mechanism began to function as the model for cause and effect, and the many members of the machine created the appearance, simulation, or illusion.[12] From them on, the machine also signifies the difference between the inside and the outside world, between a hidden interior mechanism and the exterior effects it produces.[13]

This is crucial to understand how machines started to make the impossible possible. The "real" of the machine is this difference between interior mechanism and causality and its exterior appearance and materialization. To fulfill this function, it was not important that a particular machine design was actually operational and built. In fact, the most elaborate machine designs of de Caus were just that: designs, drawings, and mathematical calculations on paper that were never built and that could never have been built according to today's mechanical standards. But that didn't matter—because the machine demonstrated possibility. "De Caus' machines could or could not work, and that is all that was asked of them."[14]

The exterior of a calculated, precise, rational machine is crucial for understanding the coming of modern science. Only by means of the machine could modern science surmount the gap that had separated physics from mathematics ever

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[10] On the role of de Caus in Descartes' *Traîte de l'homme* and *Discours de la méthode*, see Des Chene, *Spirits and Clocks: Machine and Organism in Descartes*., 65ff.

[11] https://www.schloss-heidelberg.de/wissenswert-amuesant/persoenlichkeiten/salomon-de-caus [visited June 12th, 2022].

[12] Cf. Vagt, "Deus in Machina: Zur Sakralisierung der Mechanik im späten Mittelalter," 89-90.

[13] I learned this from Michael Dengler's dissertation on "Pius machines." Michael Dengler, "Zeitmaschinen, Sakralautomaten, Frömmigkeitsapparate: Die Produktion sakraler Zeiten im Kirchenraum der Vormoderne" (PhD diss., University of Konstanz, 2011), 24, http://nbn-resolving.de/urn:nbn:de:bsz:352-263349.

[14] My translation from Dennis Des Chene, "Imaginierte Maschinen und die wirkliche Welt," in *Spuren der Avantgarde: Theatrum Anatomicum: Frühe Neuzeit und Moderne Im Kulturvergleich*, ed. Helmar Schramm and Ludger Schwarte (Berlin: De Gruyter, 2011), 136.

since the inventions of Babylonian astronomy and Greek geometry. Before the Renaissance, sensory observation of (terrestrial) objects was not conceived of as something that could or should be described in terms of rigid, precise mathematical figures and laws.

When Galileo formulated his law of inertia, he did so by supposing a movement along a straight line. Yet, this straight line is based on neither experimental observation nor a retrospective reconstruction of experience. Instead, it asserts something that is strictly speaking impossible ever to realize.[15] Ergo, the real is explained by the impossible.[16]

According to Koyré, Renaissance science transferred the mathematics of astronomy to terrestrial physics, not according to, but *against* appearance and reason: "Physics is not applied geometry. Terrestrial matter can never exhibit exact mathematical figures; the 'forms' never 'in-form' it completely and perfectly. There always remains a gap. In the skies, of course, it is different; and therefore, mathematical astronomy is possible. But astronomy is not physics."[17]

Bodies on earth never move in straight lines or perfect circles because gravity always interferes. What was possible in astronomy—to describe the movement of bodies in rigid, regular, and precise mathematics—was impossible on earth: "These bodies moving in straight lines in infinite empty space are not *real* bodies moving in *real* space, but *mathematical* bodies moving in *mathematical* space."[18]

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[15] «Contrairement à ce qu'on affirme bien souvent, la loi d'inertie n'a pas son origine dans l'expérience du sens commun et n'est ni une généralisation de cette expérience, ni même son idéalisation. Ce que l'on trouve dans l'expérience, c'est le mouvement circulaire ou, plus généralement, le mouvement curviligne. On n'est jamais — sauf le cas exceptionnel de la chute, qui n'est justement pas un mouvement inertial — en présence d'un mouvement rectiligne. Et c'est pourtant le premier — le mouvement curviligne — que la physique classique va s'efforcer d'expliquer à partir du dernier. Curieuse démarche de la pensée, dans laquelle il ne s'agit pas d'expliquer le donné phénoménal par la supposition d'une réalité sous-jacente (ainsi que le fait l'astronomie, qui explique les phénomènes, c'est-à-dire les mouvements apparents, par une combinaison de mouvements réels), ni même d'analyser ce donné en ses éléments simples pour l'en reconstruire après coup (méthode résolutive et compositive, à laquelle — à tort à notre avis —, on réduit le nouveau de la méthode galiléenne); il s'agit, à proprement parler, d'expliquer ce qui est à partir de ce qui n'est pas, de ce qui n'est jamais. Et même à partir de ce qui ne peut jamais être. » Alexandre Koyré, *Etudes Galiléennes* (Paris: Hermann, 1966), 206.

[16] Cf. Alexandre Koyré, *Etudes Galiléennes* (Paris: Hermann, 1966), 207.

[17] Alexandre Koyré, "Galileo and Plato," *Journal of the History of Ideas* 4, no. 4 (October 1943): 422. For a detailed discussion of the "impossible real" in the writings of Koyré and Lacan, science and psychoanalysis, see Tomšič, "Mathematical Realism and the Impossible Structure of the Real."

[18] Koyré, "Galileo and Plato", 419 (emphasis in original).

For mathematical physics to arrive on earth, it was crucial to fill the gap between the actual, experienced movements of bodies and the geometrical-mathematical ideals derived from astronomy. Here, the machine is not just of historical relevance but of *structural* and *epistemological* importance when assigning physical reality to mathematical objects—because it allows the creation of an exterior to a theoretical interior. Before the Renaissance, mathematical objects such as geometric diagrams were not supposed to *represent* anything; they were simply eternal, ideal forms, just like the planets. For an empiricist such as Aristotle, any attempt "to explain the real by the impossible" would have seemed absurd. But the Renaissance world was becoming familiar with a type of material body that—unlike Galileo's counterfactual thought experiments with objects falling from the Leaning Tower of Pisa—behaves in regular and foreseeable ways: clocks and automata. Therefore, the objects that made modern mathematical science possible did not just stem from ideal mathematics but from the reality created by mechanics. After all, the production of precise scientific instruments, such as optical lenses for telescopes and then microscopes, required the construction of precise machines, like the machine designed by Descartes to manufacture parabolic lenses.[19]

Koyré's take on the abyss that separated Greek mathematics and astronomy from modern mathematical physics found its echoes across European theorists such as Kojève, Lacan, Heidegger, and Arendt. Henceforth, the order of succession between science and technology was reversed because from then on, the machine cannot simply be taken as a product or instrument of science; rather, it seems to function as its complement; one cannot operate without the other.

The machine was necessary for a science that forces terrestrial bodies into regular and precise geometrical-mathematical patterns, yet the supposed "real" it prescribes never appears in such regularity and precision *outside* of the machine. The machine, in this sense, writes something *impossible* and *necessary*—it has a poetic function because it writes what should happen. Machines could now serve as *models*

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[19] «Car, pour faire les appareils optiques il faut non seulement améliorer la qualité des verres que l'on emploie et en déterminer—c'est-à-dire mesurer d'abord et calculer ensuite—les angles de réfraction, il faut encore améliorer leurs taille, c'est-à-dire savoir leur donner une forme précise, une forme géométrique exactement définie: et pour ce faire, il faut construire des machines de plus en plus précises, des machine mathématiques qui, autant que les instruments eux-même, présupposent la substitution, dans l'esprit de leurs inventeurs, de l'univers de précision au monde de l'à-peu-près. Aussi n'est-ce nullement par hasard que le premier instrument optique a été inventé par Galilée et la première machine moderne - machine à tailler des verres paraboliques—par Descartes. » Alexandre Koyré, *Études d'histoire de La Pensée Scientifique* (Paris: Gallimard, 1973), 353.

for everything that moves on and beyond earth, as well as for the scientific method—rationality—as such.

Yet, the impossible real has kept haunting the possible worlds of modern science ever since. As Leibniz already noted, there seem to be bodies that resist *calculation*. These "living machines" require an infinite set of operations, both in their bodies and their souls. When he visited Den Haag in 1676, he met the gifted lens-grinder Baruch Spinoza and the equally gifted microscope builder Leeuwenhoek.[20] With its theory of folded matter, Leibniz's metaphysics would be called *bio-inspired* because it was inspired by the microorganisms Leeuwenhoek showed him under the microscope. Leibniz started out as a Cartesian, but after seeing the microorganisms in Leeuwenhoek's microscope, he took the metaphysics of machines one step further: In his *Monadology* from 1715, he describes the soul as an immaterial monad, an automated or self-acting capacity to execute a code.[21]

Today, we tend to treat a law inscribed in the soul like a computer program as an *algorithm*. Yet, a computer does not have to interpret; its activity is divided into an exact number of predefined steps that have to be performed one after the other. Leibniz's division of living infinite machines and man-made finite machines reduces the problem of impossibility to the question of calculability.

This leads back to the beginning of this text and the observation that media theory and philosophy often speak of machines as merely objectively present in terms of the possible. Instead, a media theory of possible-impossible machines would have to take the logical and mathematical impossibilities of machines into account. Part of this work would pertain to the history of the failures, breakdowns, errors, and mishaps, as well as the death-by-machine that made the modern world by sheer missionary and colonizing zest. The other part would have to ask about the fantasy of the machine, its necessary impossibilities, whose structure we can only find by attempting to write that which continuously fails to be mechanized, calculated, described, or addressed by means of machines. It would have to deal with the difference between a scientific theory and its machinic exterior, a gap that keeps reappearing between that which can be written in logic, topology, or fiction but which cannot be computed.

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[20] Cf. Alessandro Becchi, "Between Learned Science and Technical Knowledge: Leibniz, Leeuwenhoek and the School for Microscopists," in *Tercentenary Essays on the Philosophy and Science of Leibniz*, ed. Lloyd Strickland, Erik Vynckier, and Julia Weckend (Cham: Springer International Publishing, 2017), 47-79.

[21] Cf. Gottfried Wilhelm Leibniz, *Monadologie* (Berlin: Akademie Verlag, 1714), paragraph no. 64.

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