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Heidegger, Physics and the Question of Technique

Abstract: Heidegger's position on technique has been analyzed in very many papers. Heidegger departed from Husserl's position that gives only instrumental value to technique and to science. Heidegger, as well known, discussed a non-instrumental, non-technical role of technique, but rather revealing of being. Heidegger's discourse has always remained strange and abstract to the eyes of his interpreters: it becomes understandable if it is read as a phenomenological, philosophical, elaboration of Bachelard's *phénoménotechnique*.

1. Modern Science and Technique

Modern science is very different from ancient and medieval science. In the Renaissance there was a definitive revaluation of practical activities, despised instead by the ancients and left to slaves or subordinates. The ancient ideal of life was contemplative; under the transformative impulse of Western societies by Christianity, the modern ideal of life was linked to action, activity. Action had a cognitive function, that is, the privilege of accessing reality, which pure thought could not have. Action was the "testing ground" in which thought could be considered true or denied.

In modern science, the methodical and systematic action on Nature through technical tools became a way of knowing it, which replaced the pure passive and receptive, contemplative experience of Nature. The experience was not only limited, but could be rhapsodic in its attention to Nature, changing from species to species, from individual to individual and from situation to situation, and had the character of unrepeatability and individual and specific singularity. With technical instruments it is possible to produce mechanical phenomena that simulate natural phenomena, or to produce new artificial phenomena.

Systematic technical activity thus becomes the constitutive "experimental method" of the physical knowledge of Nature, practical-technical knowledge becomes a constitutive part of physics on which the theoretical knowledge of modern science is based: mechanics starting as a technical knowledge becomes a fundamental part of modern science. Technique becomes the foundation of modern science, but it changes its objective. William Gilbert (1544-1603), Thomas Harriot (1560-1621), Galileo Galilei (1564-1642), founders of the experimental method, defunctionalize

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the technique and its tools, which are no longer used to modify Nature and obtain human advantages, but for knowledge.[1]

The *modern scientific technique* changes status and meaning: it is no longer a practical knowledge, functional to human advantages, but it becomes an integral and founding part of modern science, revealing Nature. It takes on a sense that goes beyond human interests, it becomes a way in which Nature reveals itself. The telescope of Harriot and Galileo was an instrument for the knowledge of celestial bodies not visible to the human eye. It became a proof of the system of the Copernican world and therefore a mean to overcome anthropocentrism. Up to the radio-telescopes of the twentieth century that made it possible to "see" the cosmic microwave radiation of the big bang, the light of the creation of the universe.

The production of vacuum by experiments involved the collapse of Aristotelian physics and the acceptance of atomism; the production of the electromagnetic field involved the collapse of mechanical materialism; the production of new elementary particles and antimatter involved a new quantum-relativistic physics. Modern scientific technique thus reveals a "new heaven" and a "new earth", allowing us to understand the non-central role of man. Not only does it involve a new knowledge of Nature, but a new self-understanding of mankind in Nature.

However, the entry of technology into modern science was also a "Trojan horse". The scientific community changed and many technicians entered it. Technique tended to turn upside down the hierarchy that subordinated it to modern science and de-functionalized it, and subordinated modern science to technique, functionalizing it to human interests, giving a technical character to science itself. This reversal was planned almost immediately, in particular by Francis Bacon (1561-1626). For Bacon, modern knowledge, unlike the ancient one he despised, was productive-prolific of a "male birth of time" (*Temporis partus masculus*, 1603).[2] Bacon made modern science the means that established a society based on a patriarchal and male-dominated perspective and not only that: "knowledge is power". Modern science became the means for the absolute technical dominion of man over Nature, of man over other living beings and over other men, of man over woman. The *New Atlantis* (1624)[3] designed the utopia of a civilization governed by modern science subordinated to modern technique, which today seems to us more like a dystopia that is taking place today. In this perspective, modern science became the instrument and legitimation of the technical, economic and military domination of the Earth.

1 E. R. A. Giannetto, *Un fisico delle origini. Heidegger, la Natura e la scienza*, Donzelli, Roma 2010.

2 F. Bacon (1603), *Temporis partus masculus*, in *The Works of Francis Bacon I-XIV,* ed. by J. Spedding, R. L. Ellis & D. D. Heath, London 1857-1859, 1887-1892, reprinted by Fromann, Stuttgart 1962 and Garret Press, New York 1968, vol. III, pp. 527-539.

3 F. Bacon (1624), *New Atlantis,* in *The Works of Francis Bacon I-XIV,* ed. by J. Spedding, R. L. Ellis & D. D. Heath, London 1857-1859, 1887-1892, *op. cit.*

Modern science so subordinated to technique has become an instrument of death and extermination in the preparation of nuclear weapons: the history of the atomic bomb and the bombs thrown on Japan in August 1945 are significant and unfortunately they do not seem to have taught man much. The formula $E = m\,c^2$ of the theory of relativity by Henri Poincaré (1854-1912) and Albert Einstein (1879-1955) reveals (as emerged from experiments) that matter is energy of the field, that Nature is energy, but also is used as a means of mass extermination.

Modern science, which reveals that Nature is creative energy, has become *modern technical science* and as such has led to the maximum exploitation of Nature by man, who considered it a fund of energy reserves to be transformed into forms of energy for his own convenience and for its own uses, up to the current ecological catastrophe of climate change, intensive farming and the destruction of biodiversity. Also the perspective of renewable energy is also grafted into this exploitation paradigm. At least since 1953, when it was definitively clear that living beings are essentially information (DNA) and not just matter and energy, a new way of exploiting and killing other living beings has opened up, not only for food (matter-energy), but also for information. The latest pandemic arose for this, either for animals as food or as information to be manipulated for human benefit.

From this synthetic picture, it can be understood why the debate on modern science is still characterized by opposing attitudes. On the one hand, the scientists and philosophers of science who highlight the "modern scientific technique" as revealing Nature; on the other hand, the philosophers who denounce the faults of "modern technical science". They are both right, but they only see one side of the coin. The only thing to hope for is a return to a subordination of modern technology to science leading to a non-violent understanding of Nature.

2. Gaston Bachelard's phenomenotechnique

Gaston Bachelard (1884-1962) was the philosopher of science who most of all understood the revealing value of modern scientific technique.

While the phenomenology of Edmund Husserl (1859-1938)[4] was delineating a purely practical value of knowledge to the sciences and was spreading in France,[5] already, in the thirties, Gaston Bachelard was trying to understand the sciences for

4 E. Husserl, *Ideen zu einer reinen Phänomenologie und Phänomenologischen Philosophie. Erstes Buch: Allgemeine Einführung in die reine Phänomenologie*, in *Jahrbuch für Philosophie und phänomenologische Forschung*, Niemeyer, Halle 1913, II e III, Kluwer, Dordrecht 1952.

5 Maria-Luz Pintos-Peñaranda, *The Introduction of Pnenomenology into French 1900-1940*, https://reviews.ophen.org/2016/06/29/introduction-phenomenology-french-1900-1940/?fbclid=IwAR2iNmKhNRYdk0LD-JQNnd1aQhWPfcR_iIW69850T86LAiEeR-RqOFDtK4E,

https://reviews.ophen.org/wp-content/uploads/sites/7/2016/06/Pintos-Phenomenology-French.pdf

their cognitive value and introduced the term *phénoménotechnique* in a 1931-1932 paper on *Noumène et microphysique*,[6] paving the way for a major correction to Husserl's phenomenology.

For Husserl, doubt must lead to the suspension of judgment on all the previously given philosophies, and the prejudices of scientific theories must also be "put in parentheses" to return to the world of "pure experience". However, afterwards, following Husserl we must also question the world of pure experience and the judgments of common sense, which already presuppose a world of which the human being is a part. Then, the phenomena of Husserlian phenomenology are not objects or natural phenomena in their being given to the senses or in their existential singularity, but are "pure phenomena" independent of their presumed external existence. Pure phenomena are the "eidetic-transcendental reduction" of natural phenomena to essences (forms-ideas) as captured by an eidetic intuition of human consciousness. Therefore, it is not a question of those natural objects or phenomena whose existence we assume as obvious for our practical interest in them as entities "at-hand" (*Zuhandenheit*) in the world of pure experience, to which the same natural sciences refer. On the contrary, we have to consider eidetic objects that present themselves to theoretical intentional acts, to the disinterested theoretical gaze of philosophical consciousness, to a pure eidetic intuition that provides evidence without the need to be elaborated in a further intellectual understanding.

Husserl considers legitimate the alleged reduction (made by physics) of the world of Nature to a world of mere material things to be understood within a pure theoretical intentional attitude. Any consideration belonging to the affective-emotional sphere, to the ethical sphere of values, to the practical-instrumental sphere of use and interests, to the sphere of existential sense, is excluded.

On the other hand, the experimental dimension is considered as part of the theoretical one, which must be questioned, because things spontaneously show themselves as phenomena in human experience, but experiments do not allow things to show themselves, but they force them into an exclusive theoretical reduction.

Then, according to Husserl, in addition to the Kantian sensible intuition, there is a categorical intuition (not of the Kantian intellect) which allows access, beyond the empirical intuition, to the universal and a priori modes of being "objective" in which the experience is structured. Thus, we have an eidetic intuition from single empirical data to the "objective essences" ("objective, ontological transcendentals") of things, because the various modes of being, even if they are given only to the disinterested theoretical gaze, are not determined by the subject and they are independent of it.

The universality of the phenomena of phenomenology occurs by itself in the eidetic phenomena themselves and must not be added from the outside by the subject or be extrapolated by subsequent induction as in natural phenomena given

6 G. Bachelard, *Noumène et microphysique*, in *Recherches Philosophiques* vol. I (1931-1932), pp. 55-65.

to the senses from which it will never be possible to yield a universal certainty and of which you can never make a rigorous science.

Following the physical revolutions of the twentieth century, Bachelard too[7] questions all the previous scientific philosophies and theories,[8] but he believes that even experiments, like lived experiences, give direct access to physical reality and that their content is therefore not merely theoretical but constitutes the objective correlate of the theoretical intentional acts that translate themselves into experimental actions.

Within the experiments an "artificial" Nature shows itself, a Nature that does not give itself in direct human experience due to its limits, a Nature that does not exist naturally on Earth but perhaps elsewhere in the universe: a Nature that, in any case, we cannot encounter at macroscopic or mesoscopic dimensions of our human experience. Think, for example, of the vacuum produced in Robert Boyle's experiments through the use of a pneumatic pump that sucks air from a certain delimited area. This artificial Nature is actually produced in experiments by means of technical tools and operations.

Already in a 1932 paper on Spinoza, *Physique et métaphysique*,[9] this artificial Nature was called by Bachelard *Natura constructa* or *Nature factice*, translating in epistemological human terms Spinoza's double-sided theological conception of Nature as *Natura naturans* (God) and *Natura naturata* (Nature), which was for the first time introduced by Avicenna (Ibn Sina). Mathematical thought has to be considered as a *Natura construens* and its experimental realization as *Natura constructa*, which however is not detached from the *Natura construens*. *Natura constructa* is discussed by Bachelard as a third factor in the dialectics of creation, and this perspective resembles the more complex dynamics of creation with four faces

7 F. Bonicalzi, *Leggere Bachelard. Le ragioni del sapere*, Jaca Book, Milano 2007, in particular, pp. 73-104.

8 G. Bachelard, *La philosophie du non,* Puf, Paris 1940.

9 G. Bachelard, *Physique et Métaphysique*, in *Septimana Spinozana. Acta Conventus Oecumenici in memoriam Benedicti De Spinoza Diei Natalis Trecentesimi Hagae Comitis Habiti*, Nijhoff, La Haye 1933, pp.74-84. An Italian translation of *Physique et Métaphysique* under another title, *Metafisica della matematica,* was recently published with two introductory essays: G. Ienna, *Presentazione* a G. Bachelard, *Metafisica della matematica*, a cura di C. Alunni – G. Ienna, Castelvecchi, Roma 2016, pp. 5-23; C. Alunni, *Gaston Bachelard, ancora e ancora,* in G. Bachelard, *Metafisica della matematica*, a cura di C. Alunni – G. Ienna, Castelvecchi, Roma 2016, pp. 25-52; G. Ienna, *Natura constructa* et phénoménotechnique. Spinozisme et pensée des mathématiques chez Gaston Bachelard, in *L'épistémologie historique. Histoire et méthodes*, ed. by Jean-François Braunstein, Iván Moya Diez and Matteo Vagelli, Éditions de la Sorbonne, Paris 2019, pp. 43-58; M. R. Abramo, *Gaston Bachelard e le fisiche del Novecento,* Guida, Napoli 2002, pp. 180-193; M. R. Abramo, *Il razionalismo "induttivo" di Gaston Bachelard*, Università di Messina, Messina 2019, https://iris.unime.it/retrieve/handle/11570/3147124/253972/M.R.ABRAMO%2C%20Il%20razionalismo%20%C2%ABinduttivo%C2%BB%20di%20Gaston%20Bachelard%20%20Tesi%20di%20Dottorato%20in%20Filosofia%202019.pdf; M. R. Abramo, *Bachelard e lo* «spazio» *della fisica contemporanea,* in F. Bonicalzi – C. Vinti (a cura di), *Ri-cominciare. Percorsi e attualità dell'opera di Gaston Bachelard*, Jaca Book, Milano 2004, pp.81-96.

of the same Nature in John Scotus Eriugena: *Natura quae creat et non creatur, Natura quae creatur et creat, Natura quae creatur et non creat, Natura quae nec creatur nec creat.*[10]

It is important to point out that Bachelard assimilates (mathematical) thought to a form of Nature and does not assimilate Nature to thought: physics implies a "created", "natured" thought. Thus, he avoids every idealistic emphasis on a mathematical metaphysics or on a metaphyisics of mathematics; mathematical reason is always *aposteriori* in physical science, that in its hermeneutical circle modifies every *a priori* assumed mathematics.[11]

Therefore, there are phenomena that are not direct manifestations of Nature to human living experience, but rather are artificially produced in experiments, technically. In the mathematical representation of the experiments the *eidos* of these phenomena emerges and constitutes an objective transcendental, on the ontological level of physical reality, and the "noumenon" presents itself, as in the last Kant of *Opus Postumum*, as a "phenomenon of phenomenon".[12]

3. Bachelard and Heidegger

Some years later, in 1935, Heidegger discussed about the mathematical metaphysics of modern physics.[13] Since 1936, in his lessons on Nietzsche, Martin Heidegger[14] spoke about western modern metaphysics, accomplished by Nietzschean will-to-power, as realized by the technical dominion over *Physis*. For Bachelard, the extension of phenomenology to *phénoménotecnique* is therefore necessary[15] in

10 J. Scotus Eriugena, *Periphyseon (The Division of Nature)*, Eng. tr.by I. P. Sheldon-Williams and J. J O'Meara, Bellarmin, Montreal 1987; J. Scotus Eriugena, *Sulle nature dell'universo I-V*, latin text ed. by Peter Dronke, It. tr. by Michela Pereira, Fondazione Lorenzo Valla, Mondadori, Milano 2012-2017.

11 G. Bachelard, *Physique et Métaphysique*, in *Septimana Spinozana. Acta Conventus Oecumenici in memoriam Benedicti De Spinoza Diei Natalis Trecentesimi Hagae Comitis Habiti*, Nijhoff, La Haye 1933, pp.74-84.

12 R. Reicke & E. Arnoldt, *Ein ungedrucktes Werk von Kant aus seinen letzten Lebensjahren. Als Manuskript herausgegeben*, in *Altpreußische Monatsschrift* 19, pp. 66- 127, 255-308, 425-479, 569-629 (1882); 20, pp. 59-122, 342-373, 415-450, 513-566 (1883); 21, pp. 81-159, 309-387, 389-420, 533-620 (1884); I. Kant, *Opus postumum*, hrsg. von G. Lehmann, A. Buchenau, in *Kant's gesammelte Schriften*, hrsg. von der Königlichen Preußischen Akademie der Wissenschaften, de Gruyter, Berlin-Leipzig 1936-1938, Abt. III, voll. VIII and IX Handschriftlicher Nachlass, Bd. 21 and 22; E. Adickes, *Kants Opus postumum dargestellt und beurteilt*, Reuther & Reichard (*Kant-Studien*, Ergänzungsheft Nr. 50), Berlin 1920, reprinted by Topos, Vaduz 1995.

13 M. Heidegger (1935), *Die Frage nach dem Ding. Zu Kants Lehre von den transzendentalen Grundsätzen*, Niemeyer, Tübingen 1962.

14 M. Heidegger (1936-1946), *Nietzsche*, Neske, Pfullingen 1961.

15 G. Bachelard, *Physique et Métaphysique*, in *Septimana Spinozana. Acta Conventus Oecumenici in memoriam Benedicti De Spinoza Diei Natalis Trecentesimi Hagae Comitis Habiti*, Nijhoff, La Haye 1933, pp.74-84. See also: H.-J. Rheinberger, *Gaston Bachelard and the Notion*

both cases whether phenomenology is understood in the sense of a purely descriptive physical perspective (in the sense in which it is still used today by physicists) or in the sense of the descriptive eidetic science proposed by Husserl. This is the indication of an experimental physical (and therefore also mathematical) phenomenology, which, from Hugo Dingler onwards, will also be developed by other authors who come from the phenomenological field; therefore, there is a convergence of positions between Bachelard and Husserl's followers.[16]

In a 1938 conference on *Die Zeit des Weltbildes*,[17] Heidegger wrote about modern technique and modern science as defining the metaphysics of modern epoch which reduced the world to a mathematical representation or construction (*Bild*).

Heidegger also departed[18] from Husserl's position on technique: Husserl maintained this position until the end, giving instrumental value not only to technique but also to science.[19] Heidegger discussed a non-instrumental, non-technical role of technique, but rather revealing of being. This discourse by Heidegger has always remained strange and abstract to the eyes of his interpreters: it becomes

of "Phenomenotechnique", in *Perspectives on Science* (2005) 13 (3), pp. 313–328; C. Chimisso, *From phenomenology to phenomenotechnique: The role of early twentieth-century physics in Gaston Bachelard's philosophy*, in *Studies in History and Philosophy of Science Part A,* vol. 39, Issue 3, September 2008, pp. 384-392; E. Alloa, *L'apparato delle apparenze. Sul concetto di fenomenotecnica e la sua incidenza sull'estetica e l'epistemologia*, in *Rivista di estetica*, 63 (2016), pp. 36-55; C. D'Aurizio & F. Palombi, *Il senso di una frattura: la fenomenotecnica bachelardiana fra fenomenologia e psicoanalisi*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 1-19; G. Ienna, *Materialismo tecnico. Fra fenomenotecnica ed epistemologie regionali*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 21-36; M. Castellana, *Il pluralismo coerente della fenomenotecnica contemporanea in Gaston Bachelard*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 37-58; C. Alunni, *"La Valeur inductive de la relativité" contre la Phénoménotechnique*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 59-76; V. Bontems & T. Guy, *L'étude des lignées phénoménotechniques. De Bachelard à Simondon et aux Micromegas*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 109-120; F. Galofaro, *Semiologia trascendentale e semiotecnica. Discipline regionali e fondamenti del senso tra Husserl, Bachelard, Hjelmslev*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 137-191.

16 See also: L. Guidetti, *La costruzione della materia. Paul Lorenzen e la "Scuola di Erlangen",* Quodlibet, Macerata 2008, pp. 49-76.

17 M. Heidegger (1938), *Die Zeit des Weltbildes*, in *Holzwege*, Klostermann, Frankfurt am Main 1950.

18 M. Heidegger (1953), *Die Frage nach der Technik*, in *Vorträge und Aufsätze*, Neske, Pfullingen 1954, pp. 5-27; E. R. A. Giannetto, *Un fisico delle origini. Heidegger, la Natura e la scienza*, Donzelli, Roma 2010.

19 E. Husserl (1936-1937), *Die Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie*, in *Husserliana*, *Gesammelte Werke*, Bd. VI, Nijhoff, Den Haag 1954, 1959.

understandable if it is read as a phenomenological, philosophical, elaboration of Bachelard's *phénoménotechnique*.[20]

Heidegger, indeed, was able to have available the volume with Bachelard's *Noumène et microphysique*, since the translation of one of Heidegger's texts had been published too in the same issue of the journal, where Bachelard had published.[21]

Heidegger could have taken from Bachelard the idea of metaphysics as linked to the technical dominion over *Physis*, from the equivalence placed by Bachelard in that essay between metaphysics and metatechnique (*metatechnique*) as technically, experimentally realized metaphysics.

The metaphysics outlined by Heidegger as realized by the technical dominion is characterized as linked to an erroneous meta-technique, which conceives of the technique in an instrumental and anthropological / anthropocentric way, ignoring the sense of revelation of reality that emerged in the phenomenotechnique of modern physics, that is the ontological ("noumenical-phenomenical") implication of technique. Heidegger, here, wrote of being as production, a "produced Physis" by a technical provocation.[22]

There is no doubt that Heidegger could have been influenced by Werner Heisenberg and Carl Friedrich Von Weiszäcker,[23] but it was only Bachelard's epistemology which gave this fundamental, ontological role to technique and I think that a Bachelard' influence on Heidegger is very probable.

In this philosophical and epistemological context, one can understand the problem of matter in twentieth-century physics.

4. Heidegger and the Question of Technique and Physics

Edmund Husserl, while not criticizing modern science, considered it only as *modern technical science* and saw its meaning only as practical knowledge, useful for man. The use of mathematics and its idealizations is justified only for these practical purposes. Scientists have mistaken the mathematical method for reality.

20 See also: F. Bonicalzi, *Leggere Bachelard. Le ragioni del sapere*, Jaca Book, Milano 2007, pp.145-160; E. Castelli Gattinara, *Bachelard e Heidegger a confronto su tecnica, scienza e ontologia*, in *Il senso della tecnica. Saggi su Bachelard*, ed. by P. Donatiello, F. Garofalo, G. Ienna, Esculapio, Bologna 2017, pp. 77-94.

21 M. Heidegger, *De la nature de la cause,* in *Recherches Philosophiques*, vol. I (1931-1932), pp. 83-125 (Fr. tr. by A. Bassey of M. Heidegger (1929), *Vom Wesen des Grundes*, in *Wegmarken*, in *Gesamtausgabe*, vol. 9, ed. by F.W. von Herrmann, Klostermann, Frankfurt am Main 1976, pp.79-131).

22 M. Heidegger (1953), *Die Frage nach der Technik*, in *Vorträge und Aufsätze*, Neske, Pfullingen 1954, pp. 5-27; E. R. A. Giannetto, *Un fisico delle origini. Heidegger, la Natura e la scienza*, Donzelli, Roma 2010.

23 E. R. A. Giannetto, *Un fisico delle origini. Heidegger, la Natura e la scienza*, Donzelli, Roma 2010.

The knowledge of reality, on the other hand, can only be given by philosophy as theoretical knowledge, not subordinated to practical interests.

Martin Heidegger, although often remembered as a critic of modern science and modern technology and criticized in turn as an interpreter of modern science as subservient to modern technology, was also able to consider the non-practical, non-functional, non-instrumental, non-anthropological value of modern science and modern technology. *Modern scientific technique* reveals Nature (*Physis*, being) and must be considered from a non-humanistic perspective, that is, not linked to human interests.

Heidegger saw modern science and mechanical technique as two essential manifestations of the modern world: understanding modern science, as he explained as early as 1938 in *Die Zeit des Weltbildes,*[24] its metaphysical basis (in the sense of what the essence of entity and truth were for it, what the being of Nature was) is the key to understanding of the very essence of the modern world. Mechanics, the first fruit of modern technique, is an autonomous transformation of the praxis that requires an operative mathematical formalisation and is not merely a practical application of modern science.

It is well-known how Heidegger developed the idea of an effective *Geschichte*, that is, history as *res gestae* or real events, as opposed to the idea of *Historie*, that is history as *historia rerum gestarum*, namely as historiography: this meant passing from a subjectivist human historiography to a history in which it is the *being-of-the-world*, Nature, which is revealed first of all in history and in the history of thinking. Even the history of science is to be considered not in terms of discoveries, material inventions and human conceptual constructions, but as the history of the revelation to man of the being of Nature. Technique, too, needs to be reconsidered, no longer in terms that are subjectivist, anthropological and anthropocentric, instrumental and causal, linked to human means and ends, but as the revelation to man of Nature's being, albeit according to a human constriction that provokes and forces Nature into manifesting itself. A careful reading of *Die Frage nach der Technik* by Heidegger,[25] shows how he correlated the question of technique, via the concept of *Bestand*, with the physical paradigm of energy which was elaborated in the XIX century. Heidegger said that technique in XVIII century was as its purpose in effective history at the basis of XVII century science. It will be shown here how Heidegger's historical clarification was inexact, but how his view that modern science depended on modern technique works.

For both Plato and Aristotle, though with different and complex nuances that cannot be treated here, science as *episteme* was different from technique as *techne*, and, in the same way, physics (with all the limitations and uncertainties that make

24 M. Heidegger (1938), *Die Zeit des Weltbildes*, in *Holzwege*, Klostermann, Frankfurt am Main 1950.

25 M. Heidegger (1953), *Die Frage nach der Technik*, in *Vorträge und Aufsätze*, Neske, Pfullingen 1954, pp. 5-27.

it an uncertain science) was different from mechanics: for Plato and Aristotle technique imitated Nature, and, in Plato, machines are constructed copies of material and terrestrial copies of the eternal and unchanging Forms, for which there is science alone; mechanics could not be part of science, nor of physics as theoretical knowledge; mechanics was a technique, a practical knowledge of those static machines that had been known till then through a tradition that would develop independently (from Plato and from Aristotle), dating back as early as Archytas.[26]

Mechanical technique could not furnish any knowledge of Nature, because its purpose was to alter the natural course of events, in favour of man, saving him effort, like moving a weight with the help of a lever. Mechanics "deceived" Nature, and, through mechanical artifice, its operations caused the natural course of events to be deviated and, as a consequence, it could provide no knowledge of Nature in itself. On this aspect, the scientific historian Gian Arturo Ferrari has written that mechanics constituted a veritable "anti-physics" for the dominant Ancient Greek paradigm (and, it could be added, for the medieval paradigm, too).[27] To understand the reason for this expression and the reason why mechanics constituted a veritable "anti-physics", we should remember that according to Aristotle's physics all changes-motions were of two types: natural and violent or contrary to nature. Violent or contrary to nature are those changes which are neither spontaneous nor natural, whose "cause-origin" is external to the body that experiences it: all human intervention in Nature, intended to produce non-natural motions and changes, is violent; in particular, the mechanical method, which is always intended to produce non-natural motions-changes using machinery and mechanical tools, is violent, and its knowledge is of motions and changes that are contrary to nature. Here, we can clearly see the connotation of technique as an essentially violent activity, as violence that is deplorable from both an epistemological and ethical point of view, but also the connotation that Heidegger gives to it. Aristotle established a peculiar identification of natural motions for the various elements in a way that we no longer find acceptable (in the sub-lunar world, rectilinear translational motion downwards for heavy elements, like earth and water, and rectilinear translational motion upwards for light elements, like air and fire; circular or rotational translational motion for the immaterial aether of the celestial world, as the fifth element, neither heavy nor light, neither coming closer nor going away from the lowest point at rest, which is the centre of the world). Beyond recognising not the final naturalness of stillness as conceived by Aristotle, but the naturalness of motion and change, it is still possible to distinguish between natural and violent motions and changes, according to their genesis in an internal "origin" or in uncaused

26 E. R. A. Giannetto, *Un fisico delle origini. Heidegger, la Natura e la scienza*, *op. cit.*, chap. 7; E. R. A. Giannetto, *Saggi di storie del pensiero scientifico,* Sestante for Bergamo University Press, Bergamo 2005, pp. 63-87.

27 G. A. Ferrari, *Meccanica allargata*, in *La scienza ellenistica – Atti delle tre giornate di studio tenutesi a Pavia dal 14 al 16 Aprile 1982*, ed. by G. Giannantoni & M. Vegetti, Bibliopolis, Napoli 1984, pp.227-296, in particular pp. 234, 252, 282-283.

spontaneity (natural) and in an external "cause" (violent), respectively. In effect, Heidegger pointed out the difference between the Greek (Aristotelian) concept of *aitia* and the Latin of *causa,* which completely betrayed the original meaning: the Latin concept referred paradigmatically to human action aimed at determining an effect, which explains how, over the course of Western thinking, the quadruple Aristotelian typology of the "originating principle" (material, formal, efficient and final) has been reduced in modern times to the recognition of a single "efficient cause".[28] In the giving of natural events, as the Greeks and Heidegger saw it, there is never a cause that deterministically necessitates an effect, there is only the free origin of the poietic activity of *physis*, as the principal "non-causal" *poiesis* of the being of Nature, which manifests itself and is revealed in events. By contrast, in the Latin world, the "originating principle" of *aitia* has been reduced to a cause, considering Nature under the causal action of man's technical intervention; on the other hand, when Aristotle gave human examples, he intended human action to be considered in terms of the original manifesting of the being of Nature. From this perspective, technique is still violence, but its forcing provocation of Nature cannot control the latter and continues to depend upon the revelation of being in Nature. In truth, Nature contains within it even the violent motions and changes due to living beings like man, because nothing is external to the all-encompassing totality of Nature. Thus, technique forces Nature, provoking phenomena, motions and changes that would not otherwise happen, but which are, anyway, within Nature, which, anyway, "reveal" Nature: they reveal what Nature by itself keeps hidden (perhaps the meaning of Heraclitus' famous sense, according to which "Nature loves to hide itself", should also be understood as contrasting what manifests itself only via the violent provocation of man), what would not manifest itself in phenomena by itself; they reveal the "secrets" of Nature. This led Heidegger to his non-humanistic consideration of technique and, therefore, of modern science: fortunately, the violent aspect of technique is only superficial; the evil in violence has no roots, and can have no ontological roots, deep within the being of Nature, but only in the *hybris* and *metis,* in the violence and sly deceitfulness of man or other living beings that provoke certain phenomena; even the death or suffering of living beings in itself and for itself forms part of Nature, notwithstanding who is responsible for causing it artificially and violently, in an unethical way. From Nature's perspective, it is Nature that is provoked by technique – although the latter has been developed by man for exploiting Nature and with a heterogenesis of purpose – into manifesting, paradoxically, its recondite power, which is far greater than that normally experienced by man: in this way, the technical and mechanical actions, intended to control and dominate Nature, indeed, become actions of the experimental method by which there is the revelation of the immense divine power of Nature. Beyond its superficial violence, the essence of technique is not technical

28 M. Heidegger (1953), *Wissenschaft und Besinnung*, in *Vorträge und Aufsätze,* Neske, Pfullingen 1954.

but rather the revelation of the being of Nature. According to Heidegger, this was the profound link between modern science and modern technique, and comprehensible only from a non-humanistic perspective: beyond the violence of human technique and the subjectivist scientific representation, this was about a particular provocation, of a revelation of the being of Nature, making modern technique the basis of modern science.

Archimedes invented a new kind of geometry, mechanical geometry, which then was used by Galileo. Geometry, reconsidered in terms of mechanics by Archimedes, constituted a *lògos mathematikòs techniktòs* which was identified with a form of cunning intelligence, intended to deceive Nature, a *metis mechaniké*,[29] and was considered as blasphemous by followers of Plato and Aristotle: not only did it mean mixing science and mechanical technique, but also made geometry – used to describe the celestial world, the ethereal world of the star-gods – dependent on the material of machines of the terrestrial world, to which it was inappropriate – and therefore an epistemological mistake – to apply geometry; a material triangle could never be exact, perfect, but just an imperfect copy in matter of a celestial idea of the triangle. According to Plato, being was linked to the star-gods-ideas-numbers, to the celestial geometrical forms. Even if Plato could have been inspired by the knowledge of armillary sphere for his cosmological conception,[30] he considered it a mechanical copy of an intelligent motion of pure forms. In the case of Archimedes, it was a question of impiously denying the astral theology of Pythagoras and Plato: with Archimedes, theology was taken out of the mathematics (geometry) of that celestial world recognised by Pythagoras, Plato and Euclid.

In the Renaissance, mechanics became concerned with new machinery, such as the cannon, and turned to the kinematics and dynamics of the motion of projectiles, an argument also dealt with in physics: not by chance, modern science came into being through the fundamental treatment of war machines and projectile motion as the mirror, or maybe the tip of the *iceberg,* of the technical violence in mechanical methods. Apart from the incommensurability between the static perspective of Archimedes and the modern kinematic-dynamic perspective (pointed out, in another historical context, by Spengler),[31] Galileo drew upon Archimedes: the system of the Copernican world, as Giordano Bruno had shown, demanded a physics that no longer distinguished between a celestial world and a terrestrial one, and the dominant Christian theology no longer distinguished between heaven and earth.

29 M. Detienne & J.-P. Vernant, *Les ruses de l'intelligence – Les mètis des Grecs,* Flammarion, Paris 1974.

30 F. M. Cornford, *Plato's Cosmology. The* Timaeus *of Plato translated with a running commentary*, Routledge & Kegan Paul, London-New York 1937, 1971.

31 O. Spengler (1918, 1922), *Der Untergang des Abendlandes*, I. *Gestalt und Wirklichkeit,* Braumüller, Wien 1918, II. *Welthistorische Perspektiven,* Beck, München 1922, then, two volumes, Beck, München 1923, and finallly published by Deutscher Taschenbuch, München 1975.

In effect, the terrestrial world did indeed contain something exact: not natural of course, but a human artefact, such as an architectural construction, a work of art or a machine, built specifically according to precise calculations and measurements. The machines, although material, were built with geometrical exactness and, for this reason, there was no problem to describe them geometrically: they were already material geometrical constructions.[32] Mechanical phenomena could, therefore, be thought of as analogous to terrestrial physical phenomena, but treated geometrically. Though not the first to do so, Galileo reappraised mechanics as a new science,[33] transforming a technique into a science, and, using and developing the mechanics of Archimedes, systematically introduced the experimental mechanical method into the study of Nature, as a logical consequence. In truth, experimental method implied acting upon Nature with mechanical instruments and was nothing more than the extension of Archimedes' mechanical method in geometry. Uncertain and subjective human experience could not be the foundation of sure scientific knowledge, but experimentation, conducted by machine instruments, appeared to overcome the subjectivity of experience: experiments are repeatable because, under the same conditions, the machine instruments – considered just "objects" – always provide the same measurements, laying the basis for a presumed "objectivity". Yet, beyond the mechanical measuring instruments and the technical intervention upon Nature with machinery, it meant studying the natural world through imitation and simulation, by means of an artificial world of machines: the experimental mechanical approach was, and still is, above all, a method for the *simulation* of Nature (technique imitates Nature in a deceiving mimesis) in an artificial world of geometrically-made machines.

Physics was no longer a simple contemplative activity, but involved practical experimentation, which was nothing other than mechanical and technical practice. The mathematical treatment itself of physical problems came via the geometry imposed by mechanics. With mechanics insinuating itself inside geometry, theoretical knowledge itself became reinterpreted as technical practical knowledge, becoming dependent upon the elaboration of this technical practical knowledge. There was a complete reversal of the hierarchy between theoretical knowledge and practical knowledge.

Geometry could also be applied to matter, which, by now, also constituted the celestial world; and, in any case, the *Logos* of Christian theology had been incarnated in terrestrial matter: this was reflected into the human *lògos mathematikòs technikòs*.

32 A. Koyré, *Le philosophes et la machine* (1948) & *Du monde de l'<<à peu-près>> à l'univers de la précision* (1948), in A. Koyré, *Etudes d'histoire de la pensée philosophique,* Leclerc-Colin, Paris 1961.

33 G. Galilei, *Discorsi e dimostrazioni matematiche intorno a due nuove scienze attinenti alla mecanica ed i movimenti locali,* Elsevirii, Leida 1638, and then in *Le Opere di Galilei I-XX*, a cura di A. Favaro, Edizione nazionale 1890-1909, reprinted by Barbera, Firenze 1968, vol.VIII, pp. 41-318.

This fundamental new role for mechanics represented a complete overthrow of ancient and medieval science: mechanics, changing its epistemological statute, had been transformed from a technique into a fundamental physical science; there was no longer any distinction between modern science and technique. We now have the epistemologising of technique, the raising of *techne* to *episteme*, the reducing of science to technique; and the possibility of physics being a certain and exact "science" at the same time as it is linked, paradoxically and misleadingly, to a reduction to mechanical technique, to the "non-natural science" of a practical and efficient knowledge of machinery.

Galileo's modern science was, above all, a practical and technical knowledge, linked to geometrical and mechanical praxis. This explains and, in part, corrects Heidegger's reflection on the technical premises of modern science. However, we cannot use the Marxian categories of base and superstructure, with their basis in the material and ideology: modern science is not merely technical ideology, which would be – as Heidegger says, too – simply a conceptual premise; modern science is also technical practice and technical knowledge, not merely an ideal mirror of real processes, and as a modern scientific technique constitutes the revelation of being, the revelation of *Physis*.