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Nature and art, an ancient divide and still a hot topic.

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Manufacturing genetically modified crops, regenerating tissues, or cloning sheep and cows ... such practices challenge the traditional boundary between the natural and the artificial. It seems that it is the fate of technological progress to gradually blur the ancient dichotomy between nature and artefact. And this erosion of one of the main pillars of Western culture is not without raising societal issues. Undoubtedly a number of people who are protesting against GMO crops, or against medically assisted procreation are doing so because they consider such practices as *counter-natural*. Symmetrically, for techno-optimists the popular fears about technological innovations are just irrational prejudices due to a kind of fetishism of nature. Thus the dichotomy between nature and technology is the core of a confrontation between two radical attitudes of technophobia and technophobia-phobia,¹ which often hinders democratic debates about emerging technologies.

To what extent the distinction between the natural and the artificial can be considered as a popular prejudice, generating technophobia? Is the ancient divide between *phusis* and *technê* an obsolete category? The expression of the metaphysical views of a prescientific and pre-modern era that no longer makes sense in the twenty-first century when our environment, our bodies, our lifestyles are saturated with technology?

In briefly sketching the cultural roots of the distinction between nature and artefact, this paper emphasizes its relativity. Then it proceeds to argue that the notions of nature and artefact are interdependent and continuously reconfigured on the basis of a few historical examples. However, emphasizing the cultural and historical relativity of the notions of nature and artefact does not entail that they are meaningless. Despite its weakness from a rational point of view, this dichotomy has a normative power and plays a key role in the social acceptance of new technologies.

A Greek heritage

First of all, it is important to keep in mind that the dichotomy between nature and artefact as well as the divide between nature and culture are specific to Western culture. As French anthropologist Philippe Descola argues, our view of nature as distinct from human activities is not universal. It is a social and cultural construction, which makes sense only in the Western

¹ Rip A. (2006), "Folk theories of nanotechnologists". *Science as Culture* 15, pp. 349-365.

world. It is only one of the four various ontologies that this expert in Achuar cosmology has identified: totemism, animism, analogism and naturalism.² Naturalism, according to him, is:

simply the *belief* that nature exists, in other terms that some entities owe their being and their development to an external principle, which is not an effect of human will. Typical of Western cosmologies since Plato and Aristotle, naturalism generates a specific ontological domain [...] As naturalism is the guideline of our own cosmology and impregnates our common sense and our scientific principles, it has become a ‘natural’ presupposition which structures our epistemology and in particular our perception of other modes of identification.³

The Ancient Greek roots are clearly visible in Aristotle’s *Physics* Book II. “Technology, Aristotle claimed, imitates nature’. He did not provide explanation, presumably because it sounded like a common sense distinction. The analogy between art and nature turns around the role played by the final cause.

[A]rt partly completes what nature cannot bring to a finish, and partly imitates her. If, therefore, artificial products are for the sake of an end, so clearly also are natural products. The relation of the later to the earlier terms of the series is the same in both.⁴

Nevertheless, in another well-known passage from *Physics* II, where he introduced the distinction between form and matter, Aristotle drew a radical difference between nature and art. Natural beings have an internal principle of motion and rest while artificial objects – a bed or a coat, for example – do not possess any such innate tendency to change. ‘Man is born from man, but a bed is not born from a bed.’⁵ This sentence suggests an essential difference, a difference of kinds.

Based on this passage, a number of medieval scholastics used the distinction between form and matter to argue that there was an ontological difference between natural and technological products. They reinforced the ontological gap by claiming that it was impossible to create an essence by art. Only nature had the capacity to create a ‘substantial form’. As a consequence, scholastic thinkers condemned artisans, especially alchemists, for subverting the order of nature. In his comments on Aristotle’s *Meteorology*, the Persian philosopher and physician Avicenna reproved the ‘artificers’ (*Sciant artifices*).⁶ For him, there is an essential difference between natural gold generated in the mines and its artificial namesake, alchemist’s gold. The latter is counterfeit; an imitation of the real thing based on the appearance. For lack of substantial form, the products of human art are necessarily inferior to natural ones. Consequently, alchemists were condemned as charlatans or sorcerers displaying supernatural or demonic power.

For Thomas Aquinas, alchemy was neither altogether against nature nor supernatural in the sense of magic, but rather preternatural, from the Latin *praeter naturam*, meaning beside or outside nature. For Aquinas, the category of the preternatural covered a whole range of anomalies – monsters, marvels, prodigies, and comets – that were not part of the normal course of nature while they could not really be considered against nature either.⁷

² Descola, Philippe (2005) *Par delà la nature et la culture*, (2005). See also Lloyd, Geoffrey, « The invention of Nature » in *Methods and Problems in Greek Science* Cambridge, Cambridge University Press, 1991, pp. 417-434.

³ Philippe Descola, “Les cosmologies de Indiens d’Amazonie », *La recherche*, N° 292, novembre 1996 : 62-67, quot. p. 66 (my transl).

⁴ Aristotle, *Physics* II, Chapter 8.

⁵ *Ibid.*, Chapter 1.

⁶ Newman, William R. (2004) *Promethean Ambitions. Alchemy and the Art-Nature Debate*, Chicago, Chicago University Press. See also Emerton, Norma (2004), *The Scientific Reinterpretation of Form*, Ithaca, Cornell University Press.

⁷ Daston, Lorraine. “The Nature of Nature in Early Modern Europe,” *Configurations*, 6, 1998 : 149-172

The alchemists replied to scholastic attacks on their art with experimental demonstrations using analysis and synthesis to prove the authenticity of their products. They carefully demonstrated that they could produce artificial bodies identical to natural ones. They also developed rational arguments in favour of artefacts within the then dominant Aristotelian framework. For instance, Paul de Tarente came to alchemy's defence by using the scholastic distinction between primary and secondary qualities. The arts that work with only secondary qualities – colours, odours, etc. – can never hope to act on the nature or the essence of the substances they manipulate. By contrast, certain arts, like medicine, horticulture and alchemy, which work using the primary qualities – hot, cold, wet, dry – have the power to change the very essence or nature of the substance they act on, allowing them to modify natural species whether for better or for worse. The *Book of Hermes* attributed to Geber (Djabir) features as a staunch defence of alchemical arts.⁸ Without challenging the received wisdom that art imitates nature, the author claims that this imitation reproduces the essence of the natural substances in the artificial one. There is no essential difference because art uses the same means and the same processes as nature, and moreover has the advantage of being able to improve upon the natural model. Arts such as alchemy are only possible in so far as man can induce nature to produce the things it normally produces in different circumstances. Agriculture was cited as the example of an art where humans make use of natural phenomena, the growing and ripening of grain, in a productive context. Similarly alchemists make use of natural raw materials, and of natural reagents (fire) to make artificial products. In Aristotelian terms, the artificial differs from the natural only with respect of one of the four causes, i.e. the efficient cause, i.e. the designer. Thus medieval and Renaissance alchemists raised serious objections against the ontological distinction and featured as early advocates both of experimental methods and of technology.

Seventeen-century natural philosophers - especially Francis Bacon, René Descartes and Robert Boyle - further undermined the radical divide between the natural and the artificial while they promoted laboratory experiments as the optimal way to understand natural phenomena and unveil the laws ruling them. Descartes insisted that the bodies made by art were no different from natural ones:

And it is certain that all the rules of mechanics belong also to physics, of which it is a part or species, [so that all that is artificial is withal natural]: for it is not less natural for a clock, made of the requisite number of wheels, to mark the hours, than for a tree, which has sprung from this or that seed, to produce the fruit peculiar to it.⁹

As technology is based on natural laws, improving technology and better understanding nature are one and the same objective. Physics will “thereby make ourselves, as it were, the lords and masters of nature”.¹⁰ The rapprochement between the artificial and the natural secured and legitimized the domination of nature by humans. But it also went hand in hand with a reinterpretation of nature as a kind of machine, more precisely a clock designed by a supernatural clockmaker. On the basis of the analogy between automata and animal bodies Descartes developed a mechanistic physiology describing nerves as fountain pipes, muscles and tendons as springs....¹¹ In other terms, human arts became the model for our understanding of nature. While Aristotle described nature as a kind of model that human art had to mimic in order to complement or restore (in the case of medicine) nature, with the

⁸ *Liber hermetis*, attributed to Geber, edited and translated into English by William R. Newman, *The Summa Perfectionis of Pseudo-Geber* (Leiden: E.J. Brill, 1991) p. 11–12.

⁹ Descartes, *Principes de philosophie*, 1644, part 4, §203. Engl. Transl. <http://www.gutenberg.org/cache/epub/4391/pg4391.html>

¹⁰ Descartes, *Discours de la méthode*, 1637, Part 6: 44.

¹¹ Descartes, *De l'Homme Œuvres IX*, p. 120, 130-31

emergence of experimental philosophy in the seventh century nature was modelled upon technology.

Trapped in a circle?

Does this mean that we should reverse Aristotle's view and claim that nature imitates art? In his lectures *On nature* delivered in 1956, French philosopher Maurice Merleau-Ponty noticed the circularity: «We cannot think about nature without realizing that our idea of nature is impregnated with artefacts».¹² How are we to understand this statement?

Merleau Ponty did not just mentioned that nature is always impregnated with technology, that there is no genuine natural space on the Earth: everywhere in arctic ice, in deep oceans and in the wild forests we can find traces of the pollution generated by human activities. Merleau Ponty rather argued that our idea of nature is shaped by technology. Each age tends to interpret nature through models and canons derived from one of its most advanced technologies. Nature is not a metaphysical entity that can be defined *sub specie aeternitatis*. It is continuously redefined according to technological changes.¹³

At the turn of the eighteenth century when skilful artisans such as the French mechanics Jacques Vaucanson or the Swiss clockmaker Jacquet Droz were displaying a collection of clockwork androids, Nature was viewed as a “blind, deaf and dumb” clockwork automaton. Natural philosophers describing animals as machines also began to view machines as animated bodies, and to design them accordingly¹⁴.

At the turn of the nineteenth century, while steam engines were driving the industrial revolution, a number of chemists described animals as combustion engines. For Lavoisier, respiration was a kind of combustion, a combination with oxygen from atmospheric air releasing heat (caloric).¹⁵ Lavoisier approached animal respiration in a famous memoir “On heat” where he focused on the measurement of the amount of heat released by combustion and respiration with an apparatus the ice calorimeter.¹⁶ Combustion also provided the model for understanding animal nutrition. For Jean Baptiste Dumas and Jean Baptiste Boussingault, animals like engines consume fuel through their nutrition and release carbon dioxide into the atmosphere, while plants ‘fix’ carbon dioxide and release oxygen. The analogy between animals and with enabled scientists to describe the circulation of carbon through the three realms of nature – mineral, plant and animal.

In the twentieth century synthetic chemistry prompted a deep revision of the images and values attached to the natural and the artificial. The manufacturers of the earliest chemical substitutes – such as celluloid and Bakelite – which were meant to be cheap, flexible and multifunctional, struggled with the dominant view of nature as a rigid economy.¹⁷ Every natural material was praised for a unique function – wood for construction, cotton for clothing, for instance -, whereas the plasticity of synthetic polymers was depreciated. A few decades

¹² Maurice Merleau-Ponty, *La nature*, Cours 1956-57 p. 120 « Nous ne pouvons penser la nature sans nous rendre compte que notre idée de nature est imprégnée d'artifice » .

¹³ Bernadette Bensaude Vincent, William R. Newman, *The Artificial and the Natural. An Evolving Polarity*, Cambridge Mass : MIT Press, 2007.

¹⁴ Jessica Riskin “Eighteenth-century wetware » in Bensaude Vincent, William R. Newman, *The Artificial and the Natural. Op. cit.*, p. 239-274. *The Restless Clock*. Chicago, The Chicago University Press, 2015.

¹⁵ Frederic L. Holmes, *Lavoisier and the Chemistry of Life : An Exploration in Scientific Creativity*, Madison : University of Wisconsin Press, 1985.

¹⁶ Lavoisier et Laplace, Mémoire sur la chaleur (1780) in Lavoisier, *Œuvres*, vol. 2, Paris, Imprimerie impériale, 1862, p. 283- 298.

¹⁷ Robert Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*, Madison : University of Wisconsin Press, 1983.

later, following the mass consumption of nylon and synthetic polymers, flexibility, plasticity, lightness became positive values, markers of the ‘plastic era’. And nature came to be considered as a strictly limited stock of resources in stark contrast to the promise of wealth out of the chemical laboratory. The emphasis was on the limitations of nature viewed as a finite collection of products rather than as a continuous process of generation (*natura naturata* rather than *natura naturans*).

At the turn of this century nanotechnology and converging technologies once again reshaped the polarity between nature and artefact. While nature is investigated at the molecular level it is more and more described as a collection of molecular machines. At the nanoscale (10^{-9} metres) all boundaries between nature and artefact, between living and non-living seem to be blurred. Most natural systems are described as devices or machines; they are identified by what they do (functionalities) rather than by for what they are (structure and composition). They are praised for their performances and operations.

Organisms are reconceptualised in terms of the dominant computer technology, as machines operated by a program or software. This common metaphor underlies the research agenda of synthetic biology, which aims at redesigning life through changes in the program. Thus for the first time, “natural” and “living” cease to be synonymous: organisms are high-tech and all-purpose machines as Harvard synthetic biologist George Church claims:

biological organisms could be viewed as a kind of high technology, as nature’s own versatile engines of creation. Just as computers were universal machines in the sense that given the appropriate programming they could simulate the activities of any other machine, so biological organisms approached the condition of being universal constructors in the sense that with appropriate changes to their genetic programming, they could be made to produce practically any imaginable artefact. *A living organism, after all, was a ready-made, prefabricated production system that, like a computer, was governed by a program, its genome.* Synthetic biology and synthetic genomics, the large-scale remaking of a genome, were attempts to capitalize on the facts that biological organisms are programmable manufacturing systems, and by making small changes in their genetic software a bioengineer can effect big changes in their output.¹⁸

This brief historical overview clearly demonstrates the relativity of the art/nature divide. Not only nature and artefacts are ethnocentric notions limited to Western culture, but their representations are also mutually constructed entities. Like prey and predator defining their own identities through their relation, nature and artefact are continuously reconfigured through their changing relations.

Acknowledging the historical relativity of the divide between nature and artefact does not mean that the art/nature divide would be obsolete and has to be overthrown. We do not lose the memory of past notions. The public debates raised by emerging technologies suggest that pre-modern views of nature and artefacts are remarkably resilient and do not suddenly become obsolete or meaningless. In particular, many people express a fear of messing with nature while the view of organisms as reprogrammable computers is shared only by a few biologists. There is a multitude of images of the natural and the artificial co-existing in our societies. For instance, a global survey of the narratives of nature in articles about nanotechnology identified a wide spectrum of view: nature as an optimal engineer, nature as a source of inspiration of design principles, nature as a source of physical limits and constraints, as an order to be destroyed, as an environment to be conserved, nature as threatening the

¹⁸ George Church and Ed Regis, *Regenesi How Synthetic Biology will Reinvent Nature & Ourselves*, New York, Basic Books 2012, p. 4.

fragile human condition, nature as a fragile planet to be protected....¹⁹. Given the tensions and contradictions surrounding the notions of nature and artefact, it seems difficult to get rid of them because of their obsolescence. Are we to consider them as an ideological prejudice, a "*vue de l'esprit*", which is confounded by human activities?

A non-robust and still powerful dichotomy

Indeed, the distinction lacks a rational foundation. Admittedly, the dualism between nature and artefact refers to the temporal distinction between a primordial order and later transformations. Natural is a forest or a piece of land, which has not been used by humans for dwelling or agriculture or mining. Nature is perceived as kind of sanctuary where one can experience direct contact with so-called "primitive" nature, in Yellowstone or Yosemite natural parks. But this romantic view promoted by the advocates of the Wilderness movement has been easily debunked as a mythology, which has occasionally been imposed against native Indian cultures.²⁰

From a rational point of view, it is also easy to realize that the distinction between natural (extracted from nature) and synthetic (man-made) materials is equally ill-founded. We say that wood, cotton, and wool, are natural whereas plastics are artificial or synthetic. To be sure, wood, which is the archetype of all materials (etymologically *materies* meant the core-wood used by the carpenter) is the result of life processes achieved by plants according to natural laws. It did not grow out of human purposes out of man's design like the synthetic fibres of nylon for instance. However, the intuitive distinction between extracted from nature and designed by human art is far from clear. It's a weak dichotomy that does not resist any close examination. Many items that we consider 'natural' such as cotton, wool, or wine, are in fact the result of a long manufacturing process. If the boundary between natural and artificial were strictly and exclusively based on the distinction between extraction and man-made product, then it would be a quantitative difference, a matter of degree not of kind.

The elusive character of all references to nature is by no means a recent discovery. In the eighteenth-century, Jean-Jacques Rousseau quickly understood that wild nature was out of reach.²¹ He nevertheless promoted the state of nature as an intellectual construction, an indispensable fiction for ascertaining the foundations of political order.²² In thus emphasizing the strong normative power of the divide between nature and artefact despite its weakness at the descriptive level, Rousseau provides a sure guideline for getting out of the 'vicious circle' of fuzzy notions. We have to shift from the descriptive to the prescriptive, from factual evidence to norms.

For this purpose, a third concept has to appear on stage. In addition to the contrast between *phusis* and *technê*, Ancient Greek philosophers used the distinction between *phusis* and *nomos*, the social conventions or norms in order to fight against the Sophists. The power relations based on natural inequalities in strength and might do not rule the social world. They give way to laws and rules resulting from collective decisions taken in the agora. Remarkably while Descartes firmly rejected the distinction between nature and artefact he promoted the "great divide" between nature and society. This second dichotomy is a chief

¹⁹ Fern Wickson, "Narratives of nature and nanotechnology", *Nature Nanotechnology*, 3, June 2008: 313-316.

²⁰ J. Baird Callicott, Michael P. Nelson (eds), *The Great New Wilderness Debate*, University of Georgia Press, 1998.

²¹ Jean-Jacques Rousseau, *Rêveries du promeneur solitaire*, 7th promenade, *Œuvres complètes*, Paris, Bibliothèque de la Pléiade Gallimard, Vol. 1, p. 1070.

²² Jean-Jacques Rousseau, *Discours sur l'origine et les fondements de l'inégalité parmi les hommes* (1755)

characteristic of modernity according to Bruno Latour.²³ It disconnected the social contract, ethics and politics, from nature, and prompted the institution of humanities and social sciences as an independent culture.²⁴

Thus the divide between nature and artefact has been socially constructed and it is repeatedly reconstructed for normative purposes, for providing a criterion of action and of judgement. To be sure, the cursor arrow locating the boundary between natural and artificial products, or between natural and artificial procreations has significantly shifted over the centuries. However delineating a boundary is vital for several reasons.

The boundary matters not only for archaeologists who have to sort out *chopping tools* from rocks or stones eroded by nature. It matters not only for legal issues of intellectual property since patents rely on the distinction between discovery and invention. Today it matters above all for regulating technological innovations and achieving what is commonly referred to as “sustainable development”.

In the course of the twentieth century the distinction between nature and artefact gained a new normative power when a number of critics of technology – Lewis Mumford, Jacques Ellul for instance - claimed that there was no limit to technological development. On the other hand, environmental activists claimed that such development would quickly bring the death of nature, or in less emphatic terms, irreversibly destroy nature’s ecology. In this context, nature has been once again reconfigured. The image of the Earth as the fragile and vulnerable house (*oikos*) of humans has gained traction, along with the widespread fear that the pace of technological innovations threatens the future of mankind. Techno-optimists keep arguing that technological fixes to the damages caused by previous technologies will soon be available, for instance that geo-engineering will regulate climate changes. However more and more people around the world realize that there is no technological solution to the issues raised by technology, and that political measures, societal changes, are badly needed.

In this context, our western notions of the natural and the artificial may still provide useful conceptual tools, precisely because they are overloaded with layers of historical meanings. The great variety of images and values attached to the natural and the artificial enables us to understand and disentangle the various ways in which technologies relate to nature. Not all technologies aim at subduing nature to the power of a designer. Some of them aim at domesticating nature or operating *with* nature rather than *upon* nature. For normative purposes, it is important to go beyond the generic categories of nature and technology and to take into account the nuances between styles of technologies and their various ways to engage with nature.

To conclude, the ancient divide between nature and artefact is more than the vestige of a pre-modern era that would have been gradually undermined by technological advances. In reality, many claims about the continuum resulting from the increasing artificialisation of our environment are indirect strategies of naturalisation of technological progress. The issue raised by the concepts of nature and artefact is not the dilemma *dualism versus monism*, which serves to fuel endless confrontations between so-called technophobics and technophilics. The polarity *phusis* and *technê* is part of a triangular network of concepts, which involves *nomos* as a third summit. The boundary between nature and artefact is a

²³ Bruno Latour, *We Have Never Been Modern*, transl. from French by Catherine Porter, Cambridge, Harvard University Press, 1993.

²⁴ Michel Serres, *The Natural Contract*, transl. from French by E. MacArthur & W. Paulson, University of Michigan Press, 2012

matter of *nomos*, it is a useful guide for decisions about research directions and technological choices. It is an indispensable conceptual tool for regulating technological innovations.