

The Concept of Symbiosis Applied to the Human Technological Culture

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Abstract

This article examines the concept of symbiosis as a premise for elucidating the origin of the human-technology relationship. The starting point is the work of the biologist Lynn Margulis, who introduced the concepts symbiosis and symbiogenesis in the biological sciences. Her idea is that a long-lasting physical association that as symbiosis may be defined, will eventually by symbiogenesis lead to an evolutionary novelty. From this perspective the human-technology relationship is explained using philosophical ideas of Bernard Stiegler and Helmuth Plessner, who both considered this relationship essential for being human. I explain what is typical about the human life form as it is thought by them. Basically, the difference between the human and other organisms is that in the human, something is moved outside that in animals stayed within. I explicate that this exteriorisation, as it is called by Stiegler, at the same time is an interiorisation. This movement should be considered as a form of endosymbiogenesis by which the long-lasting use of tools was cognitively internalized in mind and body and became eventually a condition for the origin of an organism with a technological culture—the human.

Keywords: Symbiosis, (endo)symbiogenesis, prosthetic being, natural artificiality, exteriorisation, excentric positionality, dual aspect.

Introduction

The most powerful cause of alienation in the contemporary world resides in this misunderstanding of the machine, which is not an alienation caused by the machine, but by the non-knowledge of its nature and its essence, by way of its absence from the world of significations, and its omission from the table of values and concepts that make up culture.¹

This quote from the French philosopher Gilbert Simondon is a good starting point to investigate the character of humans' relationship with machines (the human-machine relationship). It is clear that Simondon believed, unlike some of his philosophical contemporaries, that the human is connected in an essential way with the machine as a *pars pro toto* for technology. In philosophy, it is not typical to take this a step further and consider the human-machine relationship as symbiotic. One of the reasons behind this is that symbiosis is often considered the association of two *biological* systems, usually for mutual benefit. Thus, the question arises: how can a biotic system be connected with an abiotic one? In this article, I will explain that the interconnectedness of the human and technology is such that the idea of a symbiotic relationship emerges as the clear explanation because of the interdependency of both components, as is seen in symbiotic characteristics in nature. Both components contribute to it and cannot exist without each other, even to the extent that human evolution and technological development were and still are mutually interdependent. With the aid of the ideas of French philosopher Bernard Stiegler, the German philosophical anthropologist, zoologist, and sociologist Helmuth Plessner, as well as other thinkers dealing with the human-technology relationship, I will explain that the entanglement of the human and technology is to be considered as symbiogenesis, as a protracted symbiosis between, respectively, the biotic and the abiotic components of the two partners as a tacit internalisation of dealing with artefacts. With this long-lasting symbiogenetic process causing both physical and cognitive transformations in human's ancestors, nature has taken a turn and thereby gave the biological evolution a new direction with the emergence of the modern human with an artificial or prosthetic life form.

In the classical philosophy of technology, the human relationship with technology was often first described as negative. During the first half of the last century, the approach was critical, with a focus on the implications for the human condition and society.² In the French literature, however, the approach of technology was basically an effort to

1 Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Cécile Malaspina and John Rogove (Minneapolis, MN: Univocal Publishing, 2017), 15–16.

2 Philip Brey, "Philosophy of Technology after the Empirical Turn," *Techné* 14, no. 1 (Winter 2010), 36–38.

understand and to evaluate technology *per se*. This resulted in the orientation of the French literature being mostly anthropological, emphasising (paleo)biological aspects. From this perspective, technology is not specifically human and begins with animals.³ The idea of human interconnectedness with artificiality was not new, having been articulated some decades earlier by Helmuth Plessner. Based on biological insights, he explained that the human distinguishes himself from the animal in that he is by nature artificial in the sense that he needs artificiality to be able to live his life.⁴ The human originates from nature and remains biologically an animal, but his way of living is not comparable with that of animals because he needs to establish culture to maintain his autonomous existence in the world.

According to Plessner, the underlying characteristic of this paradoxical life form is that the human is the only organism that virtually lives outside (above, behind) itself, a characteristic he defined as excentric positionality.⁵ Plessner does not give an underlying cause for the human life form; rather, he only intends to indicate the essential distinctions between the human, the animal, and the plant. Natural artificiality being one of the consequences of the excentric human life form is considered a fundamental law of anthropology. The human life form cannot be imagined without the use of artefacts in a cultural and social context; however, this living excentrically and in artificiality gives the human a feeling of unbalance that forces him to continuously seek new technical solutions. Consequently, the human is continuously developing his technologic culture as an ongoing process.⁶

The idea of human artificiality was also described by Bernard Stiegler, using different terminology. He calls this uniquely human part *tekhne*, meaning all domains of skill, including a range of non-technical skills such as language, art forms, and professional skills. That *tekhne* is prosthetic; it is entirely “artifice.” The underlying cause for the origin of those skills is that the human must compensate for his original default (*défaut originaire*).⁷ He traces this idea back to the Prometheus myth in which Epimetheus, Prometheus’s brother, forgot to give the human the qualities or properties that maintain him in nature. In other words, the human starts with a lack. Unlike Plessner, Stiegler places the characteristic of the prosthetic life form in an evolutionary perspective, inspired by

3 Sacha Loeve, Xavier Guchet, and Bernadette Bensaude Vincent, “Is There a French Philosophy of Technology?: General Introduction,” in *French Philosophy of Technology: Classical Readings and Contemporary Approaches*, edited by Sacha Loeve, Xavier Guchet, and Bernadette Bensaude Vincent (Cham: Springer Publishing AG, 2018), 10.

4 Helmuth Plessner, *Levels of Organic Life and the Human. An introduction to Philosophical Anthropology*, trans. Millay Hyatt (New York: Fordham University Press), 288.

5 Plessner, *Levels of Organic Life*, 271.

6 Plessner, *Levels of Organic Life*, 297.

7 Bernard Stiegler, *Philosopher par accident: Entretiens avec Élie During* (Paris: Editions Galilée, 2004), 43.

the anthropologist André Leroi-Gourhan, and tries to provide an answer to the question of how the intertwining of the human and technics originated, concluding that the human and his tools have invented each other, making him a prosthetic being.⁸

In relation to human technicity, both philosophers assume that something has been exteriorized from out of the human that in the animal remained interior. The aforementioned concept of excentric positionality implicitly signifies that the human life form is basically outside himself, in contrast with the animal that is closed as a centric life form. In the footsteps of Leroi-Gourhan, Stiegler uses the concept “*extériorisation*,” that is generally speaking analogue to Plessner’s way of thinking: concluding that the production of artefacts was accompanied by the bringing out of thinking and language, i.e., a social life form.⁹ But Stiegler also poses the philosophical question of what was inside that was able to be exteriorized during the evolutionary development of humans. His compromise is that the inside invented the outside, and the other way around; however, that answer is not entirely satisfactory, although understandable and possibly even explainable, when translated to empirically obtained data. Plessner gives no answer to this question since he believes it to be unanswerable because the biological a priori of this characteristic cannot be further analysed by reducing it to other qualities.¹⁰

Both ways of thinking about the origin of the human relationship with *tekhnè* and/or the natural artificial life form that emerges from this relationship require an evolutionary explication of what has taken place during the process of bringing out or of exteriorisation understood as the condition that characterises the human way of living. The origin of the prosthetic or natural artificial human is not easy to understand from a gene-centric, Neo-Darwinist perspective. Today, other approaches are possible based on changing views of the evolutionary developments of organisms, focusing on top-down causation that fits in the Extended Evolutionary Synthesis. From this perspective, the biological concept of symbiogenesis could be significant in understanding the paradoxical development of the human as a natural artificial life form. This concept is thought to be a process of protracted symbiosis through which new structures, such as organs, tissues, physiologies, or other new features, appear.¹¹ From this point of view, the origin of the human-technology relationship should be understood as precisely symbiogenetic, in which the human ancestor originating from nature has developed an artificial life form in a long-lasting symbiotic relationship with tools, and by this symbiogenesis, his physical and

8 Bernard Stiegler, *Technics and Time, 1: The Fault of Epimetheus*, trans. Richard Beardsworth and George Collins (Stanford: Stanford University Press, 1998), 16-17, 93-94, 193.

9 Stiegler, *Technics and Time, 1*, 116.

10 Plessner, *Levels of Organic Life*, 100. Plessner derives this idea from the German physiologist Hermann von Helmholtz, who introduced the concept of ‘organic modals’ for this final quality.

11 Lynn Margulis, “Serial Endosymbiotic Theory (SET) and Composite Individuality: Transition from Bacterial to Eukaryotic Genomes,” *Microbiology Today* 31 (2004): 172.

cognitive aspects gradually changed into that of the modern human.

Symbiosis is not a commonly discussed concept in philosophy, even less so the idea that the human relationship with technology is at its origin symbiogenetic. By contrast, symbiosis is broadly discussed in biology and finds its origin in the second half of the nineteenth century, when it was coined by the German botanist Anton de Bary, designating the condition in which two different species live on or in one another.¹² This concept lasted until the 1960s, when the American microbiologist Lynn Margulis developed the appealing idea that symbiosis is one of the biological mechanisms that might have given the evolution of life a new direction. She showed that the mitochondria, the energy factories of a cell, were originally oxygen-respiring protobacteria. These microbes were probably ingested by anaerobic motile protists, eventually merging to form a new energetically self-supporting organism with organelles and a nucleus—the so-called eukaryotic cell. From an evolutionary point of view, this newly developed unit was the basis for the origin of multicellular organisms, including humans and other mammals. Margulis called this development symbiogenesis, a process based on a protracted symbiotic association.¹³

Despite all objections to this idea at the time, this mechanism viewed evolution from a new perspective. Instead of a descending (vertical) evolutionary development through mutations, natural selection, and adaptation (Neo-Darwinism or Modern Synthesis), the perspective of lateral (horizontal) acquisition of traits as an addition to the classic evolutionary struggle of life came into view. An entangled life form as the result of a symbiogenic process may benefit both the constituent organisms and change the pre-existing traits of the partners. A classic example is the mycorrhizal symbiosis between plant roots and fungi, in which the plant gains water and minerals from the far-reaching fungus, while the fungus benefits from the photosynthetic sugars made by the plant. It is currently assumed that almost all organisms are the products of symbiogenesis, and that important evolutionary changes have been gained laterally or horizontally.¹⁴ From that perspective, the Canadian biologist Jan Sapp made the remark “that we are beginning to understand that nothing in evolution makes sense except in the light of symbiosis”.¹⁵ The question is whether that could also apply to the human-technology relationship.

12 Nathalie Oulhen, Barbara J. Schulz, and Tyler J. Carrier, “English translation of Heinrich Anton de Bary’s 1878 speech, ‘Die Erscheinung der Symbiose’ (‘De la symbiose’),” *Symbiosis* 69, no. 3 (2016): 133, DOI: 10.1007/s13199-016-0409-8.

13 Margulis, “Serial Endosymbiotic Theory,” 172.

14 Angela E. Douglas, “The Significance of Symbiosis,” in *The Symbiotic Habit* (Princeton: Princeton University Press, 2010), 1.

15 Jan Sapp, “The Symbiotic Self,” *Evolutionary Biology* 43, (2016): 601. Doi 10.1007/s11692-016-9378-3. In this paper the author paraphrases a 1973 comment from the evolutionary biologist Theodosius Dobzhansky. See Theodosius Dobzhansky, “Nothing in Biology Makes Sense Except in the Light of Evolution,” *The American Biology Teacher* 35, no. 3 (1973): 125, <https://doi.org/10.2307/4444260>.

Interesting insights are currently developing that contribute to a better understanding of the human technology entanglement. In the next sections I explain the perspectives from which the question can be answered.

1. Placing Ourselves Outside Ourselves

In contrast to animals, humans make and use tools in order to live autonomously in the lifeworld they themselves have shaped. This view is rather apodictic or essentialistic because there are also animals other than humans who have that specific ability; however, this did not lead to the transformation of their lifeworld as is seen in the evolutionary development of the human. Indeed, there is a *forme fruste* of exteriorisation or excentric positionality in the great primates that have close evolutionary connections with the human, like the chimpanzee and the bonobo; however, their life form has not become artificial or prosthetic, and they still live as animals.

This difference in development has not gone unnoticed in the anthropological and philosophical literature. As noted, Plessner introduced the concept of positionality, with which he wanted to explain that this indication is not the same as position. Positionality is the way an organism dynamically deals with its surroundings. It does not occupy a position, but claims a position and can only be by becoming; process is the mode of its being.¹⁶ Humans have thus, from that perspective, acquired an excentric positionality whereas animals have a centric positionality. Leroi-Gourhan expressed this distinction between the human and the animal in a similar way:

The whole of our evolution has been oriented toward placing outside ourselves what in the rest of the animal world is achieved inside by species adaptation. The most striking material fact is certainly the 'freeing' of tools, but the fundamental fact is really the freeing of the word and our unique ability to transfer our memory to a social organism outside ourselves.¹⁷

This remark suggests that Leroi-Gourhan, like Plessner, also thought the human life form as being outside itself, while both thinkers also emphasise social interconnectedness. Inspired by this way of thinking, Stiegler worked out a philosophy that tries to explain what has taken place in the human ancestor during its evolution that enabled this animal to place his technical and social activities outside himself, by asking what was inside that

16 Plessner, *Levels of Organic Life*, 123.

17 André Leroi-Gourhan. *Gesture and Speech*, trans. Anna Bostock Berger (Cambridge MA: The MIT Press, 1993), 235.

made it possible to move his material and social existence outside. For this explanation, Stiegler used an aporia that was mentioned in the Meno of Plato: if you are looking for something you have to know what you are looking for, and if you do not know you will not find it. And if you find it, how sure are you that it is precisely that you were looking for? In other words: how could the human ancestor as an animal come up with the idea of using a stone as a tool if he was not looking for it?¹⁸

This aporetic way of thinking means there has to be an inside that gives the possibility to have a mental representation of the outside, in the sense that it is clear beforehand what should be searched for. Stiegler explains that this would mean that the ancestor—as an animal, or as an original man as portrayed by Rousseau—was able to have a transcendental representation based on an original knowledge of an object that did not exist at the time, for example a tool for cracking a nut. This idea of representation has its roots in the philosophy of Plato, and was eventually followed up by Kant, who articulated the question of transcendental knowledge.¹⁹ In order to avoid that aporetic problem, Stiegler, in short, finds the solution in the concept that the inside and the outside have invented each other in the interaction between the human and the object. The “who” found out the “what” and the other way around. He describes this interaction using Jaques Derrida’s concept of *différance*, that neither the “who” nor the “what” is, but their co-possibility, the movement in their mutual coming to be, their coming into convention.²⁰ The “who” is nothing without the “what,” and vice versa. *Différance* is below and beyond the “who” and the “what”; it poses them together, a composition engendering the illusion of an opposition. But it is not an opposition, because the human invents himself in technics and technics invents itself in the human. This pairing is a process wherein life in an organising manner negotiates with non-life, but in a way that this organisation functions under its own rules.²¹

Stiegler is well aware that this process also implies the introduction of the hypothesis of a “technological consciousness” and a certain form of anticipation. In other words, in the interactive and negotiating process, the human becomes gradually reflective about his

18 Stiegler, *Technics and Time 1*, 97.

19 Stiegler, *Technics and Time 1*, 99.

20 Stiegler derives the word or concept *différance* from Jacques Derrida, who uses it as a method to put words in perspective or to deconstruct them. By using an ‘a’ instead of an ‘e’ he refers to differing, both as spacing/temporising and as the movement that structures every dissociation. As such, it refers to the origin of differences and the differences between differences, the *play* of differences. See Jacques Derrida, “Difference,” in *Margins of Philosophy*, trans. Alan Bass (Brighton: The Harvester Press Ltd, 1982). Stiegler put *différance* in a slightly different perspective because in the described process time plays a role, for the biology as well for the artefact, both for the ‘who’ and the ‘what’. In fact, there is a functional doubling of *différance*.

21 Bernard Stiegler, “Leroi-Gourhan: l’organique organisé,” *Les cahiers de médiologie* 2, no. 6, (1998): 190.

existence, for example, seeing the artifacts left behind by his ancestors as an exteriorised memory. The way the human is cognitively in the world changes over time through manipulative interactions with stones and the products made from them. The consequence is that the history of tool use is also the history of humanity, starting with the flaked stone tool. The description of the start of human history is today read in manipulated stones. Stiegler also asks what the appearance of these flaked artifacts triggered, and what plasticity of the human cerebral cortex corresponds with this obtained stone; which proto-stage of the mirror is thus installed? His answer is that the proto-mirage is the paradoxical and aporetic beginning of exteriorisation. It was a long process, during which the human gradually emerged like a statue out of a block of marble. The paradox is to have to speak of an exteriorisation without a preceding interior—the interior is constituted in exteriorisation.²²

What are the epistemic implications of the long process of exteriorisation and interiorisation, which basically show that the pursuit of evolution did not occur through life alone? As discussed above, Stiegler considered the history of the flaked pebble to be the history of humanity, a condition that he named with a new word: epiphylogenesis.²³ This concept literally means that there is an additional external material aspect that influenced the natural course of evolution and led to the human. This addition is not genetic in nature, but is obtained through the manipulative interaction of the mineral flint stone. Somehow, this additive process led to a reflective memory: the processed flint was the first mirror held up to the human. At this point, hominisation became a process of exteriorisation, and human evolutionary development became an ongoing entanglement of the human and *tekhne*.²⁴

It is important to note that Stiegler describes the brain as a part of the physical body, a biological factor that is able to react plastically to changing external situations. Human brains have a larger volume than those of other great primates. In mutually inventing each other, the tangible and abiotic material surroundings changed the body, physically as well as mentally, with changes to the brain and other anatomical structures such as the hands and the female pelvis. From a contemporary perspective, there was a physical interiorisation leading to (phenotypical) biological changes in the body that adapted to the changing life circumstances under the influence of making artifacts. To say it more clearly, the addition of the external material aspects was not just an addition to the phylogenetic evolutionary development; rather, it also induced at the same time changes in the dual aspect of the human ancestor's body, a concept which Plessner specifies as the entangled biological and

22 Stiegler, *Technics and Time 1*, 141.

23 Stiegler, *Technics and Time 1*, 135, 142.

24 Stiegler, *Technics and Time 1*, 93–94.

lived body.²⁵ That dual aspect of which, unlike animals, the human is aware, that during the long period he emerged as a statue out of marble, physically and cognitively changed into the modern human. Technology has gradually become a condition for being human, to which his body has genotypically and phenotypically adapted. The interaction of the “who” and the “what” is a continuous process that is still ongoing, and is in fact a process of co-evolution. A forgotten side effect is that the human can now only think through a technological frame of mind, a characteristic he is not aware of, and that according to Stiegler implies that philosophy has denied and repressed its own question, too—that is, the question of technology.²⁶

Stiegler emphasises that what has happened should not be understood as a rupture with nature but rather as a new organisation of life; life organising the inorganic and organising itself therein by that very fact. Exteriorisation is the pursuit of life by means other than life.²⁷ The emphasis of this rupture is by Plessner placed slightly differently. He does not consider the human natural artificiality based on the centralized (animal) form of positionality as a new organisation of life.²⁸ What has fundamentally changed is that the human as a being is aware of the distance to himself, and has become conscious of the centrality of his existence: he is himself, he knows of himself, he notices himself, what makes him an *I*.²⁹ This means that the excentric life form itself, with all the consequences, should be considered a new organisation of life that manifests itself in the making of culture. From these viewpoints, nature has taken a turn, reorganising the human ancestor’s animal life form in a human evolutionary (phylogenetic) line. According to Stiegler, the eventual consequence has been the rise of the modern human that made a technological culture in order to maintain himself autonomously with this new condition. Through and with that turn, there originated a third genre of “being: ‘inorganic organised being’” or man-made technical objects as an intermediate between inorganic beings of the physical sciences and the organised beings of biology.³⁰ These nonorganic organizations of matter have their own dynamic when compared with that of either physical or biological beings, a dynamic, which cannot be reduced to the “aggregate” or “product” of other beings.

In other words, abiotic beings have developed with their own dynamics. These outside beings were, during a protracted symbiosis, interiorized horizontally or laterally into the human *in statu nascendi*. This long-lasting symbiosis is to be considered as a form of endosymbiogenesis which also made abiotic beings gradually part of human biology.

25 Plessner, *Levels of Organic Life*, 273.

26 Stiegler, *Philosopher par accident*, 15, 22.

27 Stiegler, *Technics and Time 1*, 17, 163.

28 Plessner, *Levels of Organic Life*, 272.

29 Plessner, *Levels of Organic Life*, 269–270, author’s emphasis.

30 Stiegler, *Technics and Time 1*, 17.

Margulis defines endosymbiosis as a topological condition, being a kind of symbiosis where one partner lives inside of the other. Symbiogenesis refers to the appearance of new tissues, new organs, physiologies, or other new features.³¹ As for the novelties, the analogy with endosymbiogenesis begins to impose itself as the meeting of two beings, one biotic and the other abiotic, in a paradoxical entangled life form, creating a new organization of life.³² This co-evolutionary coupling is a long-lasting process in which life is negotiating with the non-living being, made possible through the biological ability to internalise that form of interaction.

2. Symbiosis Concept Inside and Outside Philosophy

In the philosophical literature, but also outside that field, the idea of connecting symbiosis with technology is uncommon but not unknown. In this section, I introduce some thinkers who have contributed to the discussion on symbiosis in relation to non-biological views. Not all ideas are useful, but some of them broaden the horizon. From that latter perspective, the comments of Simondon are of interest; he proposed that all life forms are not only symbiotic relationships with other organisms but also with technical objects. His ideas about symbiosis are probably based on his knowledge about the biological concept, which he uses extensively in one of his earlier works.³³ Therein, he remarks that the human is bearer of tools or instruments according to a concrete apprenticeship, a sort of instinctive symbiosis with the technical objects that are employed in a determinate milieu according to intuition and an implicit, almost innate, knowledge. The human technological frame of mind mentioned above is by him understood as a technical subconsciousness, which cannot be verbalised in clear terms by reflective activity; for example, it is found in farmers or shepherds who directly grasp the value of seeds, the exposure of a plot, or the best place to plant a tree or to set up a pasture. Those men take part in the living nature of the things they know, and their knowing is one of profound direct participation that necessitates an original symbiosis, including a kind of fraternity with a valued and qualified aspect of the world.³⁴

31 Lynn Margulis, "Evolution, from a Gaian perspective," presentation on the occasion of acceptance of an honorary doctorate at the Autonomous University of Barcelona, June 6, 2007. <https://www.uab.cat/Document/199/201/LlibreLynnMargulis.pdf>.

32 The concept endosymbiogenesis is, as far as I know, not used by Margulis. It is used more widely and I derived it from an article of Nathalie Gontier dealing with reticulate evolution. See Nathalie Gontier, "Testing the '(Neo-) Darwinian' Principles against Reticulate Evolution: How Variation, Adaptation, Heredity and Fitness, Constraints and Affordances, Speciation, and Extinction Surpass Organisms and Species," *Information* 11, (2020): 352, DOI:10.3390/info11070352.

33 See Gilbert Simondon, *L'Individu et sa genèse physico-biologique* (Grenoble: Jérôme Millon, 1995). This edition is a reprint of the first part of his doctoral thesis, which was published in 1964.

34 Simondon, *On the Mode of Existence*, xvi, 107.

Such a notion of the technical subconsciousness as it is mentioned by Simondon has similarities with the metaphor Stiegler uses when he notices that a fish can never see that the water in which it is swimming is wet.³⁵ As already noted, after exteriorisation, the human forgets what was interiorised in the beginning. The human is unable to remember what happened, and therefore naturalises his knowledge.³⁶ The same is no less true for his life form, which is basically prosthetic or artificial but is at the same time social. According to present-day insights, the development of tools is made possible in groups by the integration of aspects of technical and social cognition. Causal network cognition is a panhuman trait, despite possible variation in individual cognition.³⁷ The philosophical idea that all life forms are symbiotic can also be applied to the interindividual relationships between people. Simondon points out that the technical object becomes the medium and symbol of this relationship; a mental and a practical universe of technicity establishes itself, in which human beings communicate through what they invent. He adds that this is separate from the social working community and from individual relationships. Due to the developments of information and communication technology, this relationship has only deepened now six decades later, with the human and his developed technology more intensely brought together.

The aforementioned article by Lynn Margulis points to the relationship with machines too in the explanation of the Gaia hypothesis, as developed by James Lovelock in collaboration with her. Margulis' guiding principle is that living and non-living matter, self and environment are inextricably interconnected. She believes that, although we are, as humans, biologically separate, we cannot live without machines like plants cannot live without animals that pollinate and disperse them. It would be possible in the future that the human-fostered technology that she designates as the most recent form of "living organization" will be integrated into still more adept ecosystems.³⁸ Margulis has as a biologist always given technology a place in her thinking about symbiosis and symbiogenesis, based on the idea that life as a whole and not just human life naturally incorporates its inanimate (i.e. abiotic) environment as it evolves. From that perspective, technology is part of the human survival strategy, and has extended our ability to sense and manipulate the environment that supports us. The fabrication by living beings of useful objects and materials outside their bodies is far more ancient than its tenure with modern humanity. Machines are to be considered as natural products of evolution, and are coevolving with us even as you read. In other words, the machine is in man, and as

35 Stiegler, *Technics and Time 1*, 109.

36 Stiegler, *Philosopher par accident*, 2004, 15.

37 See Marlize Lombard and Peter Gärdenfors, "Causal Cognition and Theory of Mind in Evolutionary Cognitive Archaeology, *Biological Theory* 18, (2021), <https://doi.org/10.1007/s13752-020-00372-5>.

38 Margulis, "Evolution, from a Gaian perspective," 19.

such our second nature and that of all our ancestors.³⁹ Inspired by Stiegler, Derek Woods goes so far as to call symbiosis a kind of prosthesis or technological process. For example, the lichen as a symbiosis of a fungus and an alga is considered by him as a nonhuman technology by which one autopoietic life form externalizes functions into another.⁴⁰

Influenced by Margulis, an additional interesting approach is put forward by the Portuguese evolutionary biologist and philosopher Nathalie Gontier, who presents the concept of reticulate evolution, which is evolution by means of symbiosis, symbiogenesis, lateral gene transfer, infective heredity, and hybridisation. She pays special attention to the role of symbiogenesis bringing forth interactions between the human, animals, plants, and machines. Her starting point is that a more pluralistic account of evolution is needed, and that reticulate evolution may play a role in that discussion. In that view, she is supported by the idea that network-like evolution is not only confined to biological evolution, but also abundantly occurs within sociocultural evolution, an idea that fits in the Extended Evolutionary Synthesis. She introduces the word symbiont as a unit of reticulate evolution, which in biology refers to the host as well as to the partner, or to the material, cognitive, cultural, or technological artifacts that form the basis of reticulate cognitive or sociocultural interaction.⁴¹ From that perspective, the human and his artifacts may be considered (materialized) symbionts that have over time synergistically brought forth more specialised cognitive behaviour and sociocultural repertoires. What she wants to make clear is that reticulate evolution finds place at community levels where synergistic, organizational traits delineate the units that evolve at such levels. She stresses that this new light on evolution may have consequences for the anthropological sciences.

Outside of philosophy, the symbiotic merging of the human and technology was first proposed in the 1960s by the computer specialist and psychologist Joseph Licklider. At that time, a relationship between the human and the electronic computer was expected to emerge, which would allow actions to be performed more effectively than by the human alone. He interpreted this symbiosis as a viable, productive, and thriving partnership, in a time when computers were almost only used for calculations. He stressed that this human-computer symbiosis should be distinguished from the idea that tools and machines are mechanical extensions of the human that result in his replacement by automation, with those who remain generally helping the machine rather than being helped. By contrast, computing machines will do the routinisable work required to prepare the way for insights

39 Dorion Sagan and Lynn Margulis, "Welcome to the Machine," in *Dazzle Gradually: Reflections on the Nature of Nature*, eds Lynn Margulis and Dorion Sagan (White River Junction, VT: Chelsea Green Publishing, 2007), 78.

40 Derek Woods, "Prosthetic Symbiosis," *CR: The New Centennial Review* 22, no. 1 (Spring 2022): 160. <https://www.muse.jhu.edu/article/874474>.

41 Nathalie Gontier and Anton S. Sukhoverkhov, "Reticulate Evolution Underlies Synergistic Trait Formation in Human Communities," *Evolutionary Anthropology* 32 (2023): 29, DOI:10.1002/evan.21962.

and decisions in technical and scientific thinking. He hoped that human brains and computers would become very tightly coupled, and that the new partnership would think in ways that no brain has had yet ever thought.⁴² In the light of current developments, Licklider is right that in these latter situations the coupling has characteristics of a symbiotic relationship: human brain and computer functions complement each other, and the interactions have taken a place in the reticulate network outlined by Nathalie Gontier, for which the modern application of information and communication technologies are good examples.

Éric Brangier and Sonia Hammes-Adel , who as ergonomists made a practical analysis of the concept, spoke of technosymbiosis as a cohabitation of humans and technology, in which they transfer what is programmable in themselves to technology, while at the same time the technologies become symbiotic agents that transform human beings. In their vision, technology is considered as a human extension in that it stretches human skills, aptitudes, capacities, and properties. Changes in technology enable humans to bring about changes in their own activities. This co-action leads to co-dependence, as humans rely on their technosymbiont and are confident in their capacity to use this symbiont and to interact with it. From a technosymbiotic perspective, humans experience a sense of mastery that indicates that they understand what technology means and how it can be used to improve their degree of efficiency and quality of life.⁴³ With their explanation of the human-technology symbiosis, these authors want to emphasise the intimate and interactive character of the relationship of the human and technology. They also point to the possibility of feedback with technology that influences its acceptance and the establishment of a durable partnership.

Recently Andrea Folkers and Sven Opitz described an example of this partnership with the concept of “symbiotic engineering,” meaning techniques that manipulate symbiotic relationships to repair or optimise life processes and ecosystems.⁴⁴ An illustration may be the reduction of the atmospheric methane that contributes to climate warming, and is partially produced by symbiotic microorganisms in the stomachs of ruminants. Modification of these methane producing gastric microorganisms could eventually lead to a worldwide reduced methane emission in the atmosphere. From this perspective the continuing process of the human-technology symbiogenesis could be used to influence

42 Joseph C.R. Licklider, “Man-Computer Symbiosis,” *IRE Transactions on Human Factors in Electronics* 1 (1960): 4, <http://groups.csail.mit.edu/medg/people/psz/Licklider.html>.

43  ric Brangier and Sonia Hammes-Adel , “Beyond the Technology Acceptance Model: Elements to Validate the Human-Technology Symbiosis Model,” in *Ergonomics and Health Aspects of Work with Computers*, ed. M.M. Robertson (Heidelberg: Springer-Verlag, 2011), 20, DOI:10.1007/978-3-642-21716-6_2.

44 Andrea Folkers and Sven Opitz, “Low-carbon Cows: From Microbial Metabolism to the Symbiotic Planet,” *Social Studies of Science* 52, no. 3 (2022): 331, Doi: 10.1177/03063127221077987.

other symbiotic relationships as a form of biopolitics. The authors are emphasising the symbiotic entanglement of species and suggest to correct human activities with a technological influence on a biological system.

In some ways, the co-action and co-dependence of humans and technology can be found in the ideas of Kevin Kelly, who suggested that the human is the reproductive organ of technology. He considers the human relationship with technology to be symbiotic, too. It is the human that replicates the objects made by him and spreads ideas.⁴⁵ That may be true, but it is also true the other way around. It is reminiscent of the comment made by Richard Dawkins, that a chicken is the egg's way of making another egg.⁴⁶ Like the chicken is biologically ready to make an egg, the prosthetic human is programmed through evolution to make objects that are useful for him. In fact, this is in line with the situation that applies for technology and that Stiegler articulated with the comment that the human invents himself in technics and technics invents itself in the human; the human enables technology to replicate technology. Extrapolating the above mentioned idea of Wood, technology can even be thought of as an autopoietic life form that in mutual interest externalizes functions into the human, and the other way around. Maintaining an underlying social life form supports the creation and use of technology. From these points of view, the human-technology relationship is considered a mutualistic form of a protracted symbiosis and therefore a never-ending process of symbiogenesis.

What this short literature overview shows is that for almost all these authors, the described relationship of the human and technology is thought as symbiotic, although some of them use this concept mainly as a heuristic metaphor. That means that in their approach they miss an element that goes beyond the fundamental character of this symbiotic life form that has its roots in nature, and about which Simondon notes in the epigraph to this article; that they in fact misunderstand the machine because they don't know the nature and the essence of it. Except for Margulis, only Gontier and Woods place the concepts symbiosis and symbiogenesis in an evolutionary perspective, and thereby pave the way for an attractive approach to clarify the origin of the human technology relationship. Especially Gontier accentuates that the sociocultural evolution requires us to recognize the plural nature of evolution, and that from that point of view horizontal reticulate transmission has been of great importance in for example the development of language. She expresses it clearly by noting that symbiotic interactions also impact our cognitive niches.⁴⁷ She is right in that respect but she does not make, however, a connection with the symbiogenic origin of the human prosthetic or natural artificial condition that makes up his cultural

45 Kevin Kelly, *What Technology Wants* (London: Penguin Books, 2011), 296.

46 Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 2006), 354.

47 Anton V. Sukhoverkhov and Nathalie Gontier, "Non-genetic Inheritance: Evolution above the Organismal Level, *BioSystems* 200, (February 2021): 2, DOI: 10.1016/j.biosystems.2020.104325.

life form and that cannot be separated from the development of language. Influenced by Leroi-Gourhan, Stiegler already noted that language and technics are amalgamated in the process of exteriorisation (giving rise to techno-logical memory).⁴⁸

The philosophical-anthropological way of thinking of these two authors is supported by contemporary scientific evidence for the hypothesis of tool-language co-evolution, meaning that there are strong indications of a relationship between, tool making, language, and cognition.⁴⁹ The development of technics and language are interrelated which implies a social interconnectedness between the human ancestors that in the end made the symbiogenesis with artefacts possible. As mentioned before, the production of artefacts was accompanied by the bringing out (exteriorisation) of thinking and language, i.e., a social life form. The interactions with tools supported by the use of language opened the way to human cultures. Stiegler thinks that he can afford to say that in that development technics is the pursuit of life by means other than life, creating a new stage of the history of life that invented the human.⁵⁰ After all, the origin of the human natural artificial or prosthetic life form is to consider a good example of an essential outcome of a reticulate, interactional, or symbiogenic evolution as the concept has been elaborated by Gontier. It is clear that thinking the symbiosis of human and technology only as a heuristic does too little justice to the real meaning of this relationship. In the next section I will discuss the effects of interaction with stones that eventually led to the making of tools.

3. Constitution of the Human Body

In the second section, I briefly discussed the plasticity of the dual aspect of the human body influenced by a changing exteriority. The material exterior, the “what,” starting with the flint that as an exosymbiont was further developed into technology by the human ancestor, has gradually internalised itself as a form of endosymbiogenesis throughout a lengthy evolutionary process, in which the whole body participated in an enactive way. The human mind and body form a reciprocal relationship with the artifacts as “inorganic organized beings”, adapting to the changing life form that emerged through the use of those artifacts. This is exactly what Stiegler stresses about the etymological presence of the verb “to come” in the con-venance of the simultaneous arrival of the interiority and the exteriority. He emphasises that a “prosthesis” does not complement or replace something because there is nothing lost, rather it is added. Written as pros-thesis, it

48 Stiegler, *Technics and Time 1*, 177.

49 Dietrich Stout, Thierry Chaminade, Jan Apel, Ali Shaftel, and A. Aldo Faisal, “The Measurement, Evolution, and Neural Representation of Action Grammars of Human Behavior,” *Scientific Reports* 11 (2021): 6, <https://doi.org/10.1038/s41598-021-92992-5>.

50 Stiegler, “Leroi-Gourhan: l’ingorganique organisé,” 190.

brings in an element of time, a perspective: “The prosthesis is not a mere extension of the body, it is constitution of this body *qua* ‘human.’”⁵¹ In other words, the development of the body was realised through the long interaction between exteriority and interiority. I will put this interaction—which can actually be referred to as endosymbiogenesis—into a naturalistic perspective that has emerged the last decade or so, and that helps to overcome the dualist representational logic and to be as such an alternative for cognitive models that are popular in archeology.⁵² The philosophical solution that Stiegler suggests for the origin of the prosthetic human can only find its confirmation in naturalising the process that happened in the past.

Earlier, I remarked that the human invented himself in technics and technics invented itself in the human, and that this process induced biological and mental changes in the dual aspect of the human body, the entangled physical and lived body. This specific dual aspect of the body as it is defined by Plessner is, as mentioned, not confined to the human, but also applies to animals that are, in contrast to humans, not aware of that situation. That awareness should be interpreted as a property based on the human excentric positionality, or *mutatis mutandis* on Stiegler’s concept of exteriorisation as it was articulated by Leroi-Gourhan. The dual aspect implies that the human is simultaneously living within his lived body but also exists virtually outside that lived body, a situation that Plessner indicates as a true split in nature. The human lives at both sides of the split as a psychophysically neutral unit of these two spheres, but also represents the split itself. Using the term dual aspect in this sense, Plessner turned against the dualism of body and mind that was prevalent at the time. He considered the human reflective ability not from a phenomenological subject perspective, but from a virtual distance of the self from where the human is involved in himself and his lifeworld. The idea is that the individual—the living thing—is a body, is inside its body (as inner life or psyche), and is outside its body from a point of view from which it is both.⁵³ That human characteristic of virtually living outside himself (excentrically) in his body is a property of the biological body. That is the core of excentric positionality, and in fact also that of being exteriorised as introduced by Leroi-Gourhan. It is impossible to obtain empirical knowledge of how the process of exteriorisation could have happened; however, ideas that provide some clarity have emerged in recent years, which I will discuss briefly.

The cognitive scientist Edwin Hutchins proposed the premise that thinking is the interaction of the brain and body with the world. These interactions are the thinking

51 Stiegler, *Technics and Time 1*, 152–152.

52 Thomas Wynn, Karenleigh A. Overmann, Lambros Malafouris, “4E Cognition in the Lower Paleolithic, *Adaptive Behavior* 2, no. 2 (2021): 101, DOI: 10.1177/1059712320967184.

53 Plessner, *Levels of Organic Life*, 271–273.

processes themselves. In other words, thinking is not something that happens in the brain.⁵⁴ Practically, this means that an internal representation of a target such as a flint stone cannot be seen without the involvement of the body in relation to the environment. Cognition is more than a neural process. This way of thinking was earlier worked out by the pragmatist John Dewey, but also by Plessner. Consciousness is a process of undergoing in which the successful activities of the organism react to the environment to bring about modifications favourable to their own future.⁵⁵ In a similar way, Plessner remarks that consciousness is not in us, but we are rather “in” consciousness, that is, we relate to our surroundings as motile, lived bodies.⁵⁶

In contrast to what was assumed by archaeologists some decades ago, Thomas Wynn and his colleagues consider prehistoric stone tools not as windows to the prehistoric mind, but as components of thinking itself.⁵⁷ These authors recently proposed a solution for the problem stated above, how the “who” invented the “what,” focussing their attention on 4E cognition. They derive this perspective from the Material Engagement Theory of Lambros Malafouris as a theoretical framework in cognitive archaeology, in which cognition is viewed as influenced by being in a body.⁵⁸ By eschewing a dualistic cognitivist hominin homunculus, 4E cognition focusses on the tools themselves. In this approach, it is acknowledged that the brain’s function is influenced by being in a body that is located in a particular environment, which may even only be an object. On one hand, an object to be manipulated is considered an extension of the arm and hand (extended, embodied, enactive), while on the other, the purpose of the object to be manipulated is generally located in an environment (embedded). In other words, the brain cannot be seen separately from its bodily and environmental context, an idea that was also elaborated by Francisco Varela and colleagues more than 30 years ago, meaning that cognition in its most encompassing sense consists of the enactment or bringing forth of a world by a viable history of structural coupling. This reflects one of the possible evolutionary pathways. We are always constrained by the path we have laid down, but there is no

54 Edwin Hutchins, “The role of Cultural Practices in the Emergence of Modern Human Intelligence,” *Philosophical Transactions of the Royal Society B*, 363, no. 1499 (2008): 2011, DOI:10.1098/rstb.2008.0003.

55 John Dewey, “The Need for a Recovery of Philosophy,” in *The Middle Works of John Dewey, 1899–1924*, eds. Jo Ann Boydston and Larry Hickman (Charlottesville, VA: InteLex Corporation, 2003), 7–8.
56 Plessner, *Levels of Organic Life*, 62.

57 Wynn, Overmann, and Malafouris, “4E Cognition in the Lower Paleolithic,” 101. 4E cognition stands for cognition as embodied, embedded, enactive and extended. Cognition is here interpreted as a dynamic interaction of the brain, the body, and the material and social environments.

58 The basis of the Material Engagement Theory, human cognition is viewed as a dynamically interactive system that, in addition to brains, includes bodies and material forms. See Karenleigh A. Overmann and Thomas Wynn, “Materiality and Human Cognition,” *Journal of Archaeological Method and Theory* 26 (2019): 458, <https://doi.org/10.1007/s10816-018-9378-y>.

ultimate ground to describe the steps that we take.⁵⁹

I noted that this way of thinking was articulated by Dewey, who remarked that "... it is only by processes of [the] active manipulation of things in order to realise his purpose that he discovers what the properties of things are."⁶⁰ This is a description of a situation after several hundreds of thousands of years of human development. How could the pragmatic basis of this idea be placed in a developmental evolutionary perspective? Wynn understands the activities of the stone knapping hominin from an ergonomic point of view (gestures, edges, masses, angles, and surfaces), while placing the manipulating activities in the Gibsonian concept of affordances, in that an affordance of the environment is what it offers the animal or provides for it.⁶¹ In lithic technology, these affordances are the opportunities and constraints detected by the knapper in the material at his disposal, i.e., the flint stone. The revealing of these affordances should not be seen as the result of an one-off confrontation but as the outcome of long-term manipulating with stones. In this context affordances should be considered visual and haptic/motor features of objects on the landscape that are perceptually detected and structured by an agent's biological capacities and capabilities.⁶² Manipulating stones or other objects gives an agent bodily awareness of the character of that objects and gives parts of its body the possibility for acting with them as an affording action with its target-object.⁶³ In regard to the just mentioned quote of Dewey, is it imaginable how the successive generations of human ancestors gradually learned to manipulate flint stones effectively, with the ultimate consequence that the human and the tool have become each other's complement.⁶⁴

In other words, manipulating not only gives the agent information about the flint stone as an affordance but also about what the body experiences during that interaction with the stone mediated by the senses and what it is able to do with his parts. Internal representations emerge from using objects for specific purposes and recognising the

59 Francisco J. Varela, Evan Thompson, Eleanor Rosch, "Evolutionary Path Making and Natural Drift," in *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge MA: MIT Press paperback edition, 1993), 214.

60 John Dewey, *Reconstruction in Philosophy* (New York: Henry Holt and Company, 1920), 115.

61 James J. Gibson, *The Ecological Approach to Visual Perception* (New York: Psychology Press, Taylor and Francis Group, 2015), 119. Gibson was an American psychologist who developed the field of ecological psychology.

62 Thomas Wynn, "Ergonomic Clusters and Displaced Affordances in Early Lithic Technology," *Adaptive Behavior* 29, no. 2 (2021): 188, DOI: 10.1177/1059712320932333.

63 Hong Y. Wong, "On the Necessity of Bodily Awareness for Bodily Action," *Psyche* 15, no. 1, (2009): 31–48, DOI:10.1093/pq/pqv007.

64 James J. Gibson, *The Ecological Approach to Visual Perception*, 119. The central idea of Gibson's concept of affordances is the complementarity of an animal and the environment; both are inseparable from each other. That idea has similarities to the philosophies of Plessner and Dewey related to that.

properties that make them usable and do not precede the meaning of the use. In our ancestors, the long history of interactions with stones finally led to a situation of thinking about tools rather than thinking with tools, referred to as meta-affordance with the focus on means and not on ends. Eventually the hand-axe became meta-cognition in material form that performed the function of memory and task affordance in real time and space.⁶⁵ This characterisation of reflection on making and using tools fits with the emerging of an excentric way (virtual distance) of thinking. The consequence has been that the “who” became gradually able to apply the detected characteristic of the “what” in his lifeworld and with that the quality-associated cognitive skills. The developmental or negotiating process of the coming together of the human and his tools may be considered as the two inventing each other. That long-lasting evolutionary process of coming together can be interpreted as a form of endosymbiogenesis that eventually led to the natural artificial or prosthetic human, in which technology is cognitively interiorised or embodied in the dual aspect of the human body. Adaptation of the cognitive capacities of both bodily aspects (physical and lived body) of the human to the manipulated affordances has made this possible. Malafouris and Gosden summarise this process clearly: “The term human becoming signifies that humanity is not a genetic set-up or an evolutionary stage, but an accomplishment, a dynamic coevolutionary entanglement of people, materials, and things. Human becoming is never finished; it is always ongoing.”⁶⁶

With the outcome of this symbiogenesis, nature has indeed taken a turn. In that very developmental process, the human has gradually internalised the quality *tekhnè* on his own, not to be considered as a compensation of an original lack, as it is expressed by Stiegler, but as “making use” of a disposition such as symbiogenesis that nature offered him in relation to the abiotic things around him at the right time and place. Through the process of internalising, these abiotic things have been given the opportunity to become a whole with a biological system in the capacity of a natural artificial or a prosthetic being, the human. Just as, in nature, symbiotic relationships of biotic systems are necessary to ensure the existence of the partners. We find this exemplified indeed in the human where symbiogenesis of a biotic and an abiotic system has led to interdependence of both systems.

Therefore, the question that should be asked is what the nature of this symbiotic relationship really is. It is becoming more and more clear that, despite all blessings, the dependence on each other is not only for mutual benefit, and that in some areas the

65 Thomas Wynn, “Ergonomic Clusters and Displaced Affordances in Early Lithic Technology,” *Adaptive Behavior* 29, no. 2 (2021): 187, DOI: 10.1177/1059712320932333.

66 Lambros Malafouris and Chris Gosden, “Mind, Time and Material Engagement”, in *The Oxford Handbook of History and Material Culture*, ed. Ivan Gaskell and Sarah Anne Carter (Oxford: Oxford University Press 2018), 2.

relationship runs up against its limits. Being natural artificial or prosthetic is not value-neutral, and there are aspects of it that are detrimental for the humans themselves as well as for their lifeworld. The human life form, as the outcome of endosymbiogenesis with technics, and the resulting technological evolution have eventually also resulted in ecological problems such as global warming, climate change, and loss of biodiversity that ultimately may be threatening for all life forms. In her work *The Symbiotic Planet*, Margulis herself asked not without reason whether we have the intelligence and discipline to resist our tendency to grow without limits.⁶⁷

Due to their excentric positionality which, as explained, is to a large extent based on the meta-cognition of long-lasting tool use, humans have started to realize that they are part of a symbiotic complexity as a basic property of living systems, indeed, and are not living outside of it. They have always been part of a process they were unaware of, and that now confronts them with the consequences of their life form. They are, however, the only organisms on the planet that can reflect on this situation, and therefore also know that they are ultimately morally responsible for the negative effects on the biosphere that they created themselves. From that perspective, Erik Hom and Alexandra Penn rightly notice that the Anthropocene forces us to re-examine our relationships with the “natural world” and also that the human agency and responsibility should empower us to take a more active role.⁶⁸ This implies that the human creativity that has been accompanied by the development of his prosthetic life form will have to provide the solution to turn the tide, with in mind that our planet is a symbiotic planet, and that the human relationship with technology is ontologically symbiotic too, as explained in this article. The consequence will be that humans’ activities should basically be in accordance with the symbiotic biosphere they live in and are a part of.

67 Lynn Margulis, *The Symbiotic Planet: A New Look on Evolution* (London: Phoenix 2001), 160.

68 Erik F.Y Hom and Alexandra S. Penn, “Symbiosis and the Anthropocene,” *Symbiosis* 84, (2021): 258, <https://doi.org/10.1007/s13199-021-00794-0>.

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